MINISTRY OF HIGHER AND SECONDARY SPECIAL EDUCATION OF UZBEKISTAN

BUKHARA STATE MEDICAL INSTITUTENAMED AFTER ABU ALI IBN SINO

DEPARTMENT OF ANATOMY

"APPROVED"
by Vice-Rector for Academic and ucational
work, Associate prof. G.J.Jarilkasinova
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Education field: 510000 - Healthcare
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5111000 - Professional education (5510100 - Medicine business)
5510200 - Pediatric Medicine
5510300 - Medico-prophylactic business
5510400 – Dentistry (by directions)
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EDUCATIONAL - METHODICAL COMPLEX ON GROSS ANATOMY

Bukhara 2021

The scientific program was approved by the Resolution of the Coordination Council No. ___ of August ___, 2021 on the activities of educational and methodological associations in the areas of higher and secondary special and vocational education.

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The working educational program for anatomy is compiled on the basis of working educational curriculum and educational program for the areas of 5510100 - Medical business.

This is discussed and approved at the department
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The working educational program for anatomy is compiled on the basis of working educational curriculum and educational program in directions of 5510100 – Medicine

This is discussed and approved by the scientific-methodological Council of BSMI

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Annotation

The educational - methodical complex on Gross anatomy is the study of the shape and form of the human body. The human body has four limbs (two arms and two legs), a head and a neck which connect to the torso. The body's shape is determined by a strong skeleton made of bone and cartilage, surrounded by fat, muscle, connective tissue, organs, and other structures. The spine at the back of the skeleton contains the flexible vertebral column which surrounds the spinal cord, which is a collection of nerve fibres connecting the brain to the rest of the body. Nerves connect the spinal cord and brain to the rest of the body. All major bones, muscles, and nerves in the body are named, with the exception of anatomical variations such as sesamoid bones and accessory muscles.

Blood vessels carry blood throughout the body, which moves because of the beating of the heart. Venules and veins collect blood low in oxygen from tissues throughout the body. These collect in progressively larger veins until they reach the body's two largest veins, the superior and inferior vena cava, which drain blood into the right side of the heart. From here, the blood is pumped into the lungs where it receives oxygen and drains back into the left side of the heart. From here, it is pumped into the body's largest artery, the aorta, and then progressively smaller arteries and arterioles until it reaches tissue. Here blood passes from small arteries into capillaries, then small veins and the process begins again. Blood carries oxygen, waste products, and hormones from one place in the body to another. Blood is filtered at the kidneys and liver.

The body consists of a number of body cavities, separated areas which house different organ systems. The brain and central nervous system reside in an area protected from the rest of the body by the blood brain barrier. The lungs sit in the pleural cavity. The intestines, liver, and spleen sit in the abdominal cavity.

Height, weight, shape and other body proportions vary individually and with age and sex. Body shape is influenced by the distribution of muscle and fat tissue.

CALENDAR-THEMATIC PLAN FOR LECTURE CLASSES FOR 1-COURSE STUDENTS I SEMESTER

№	Theme	Hours
1	History of the development of anatomy. Introduction to anatomy. Methods of studying anatomy. General principles of the structure of bones. Functional anatomy of the bones of the trunk.	2
2	Functional anatomy of the bones of the upper, lower extremities and pelvis.	2
3	Development of skull bones and their structure. Structure of the bones of the cerebral part of the skull.	2
4	Structure of the bones of the facial part of the skull. Orbita. Mouth cavity. Nasal cavity. Temporal, infratemporal, pterygoid fossa. Skull of the newborn.	2
5	General information about bone connections. Connections of the bones of the trunk and shoulder girdle. Connections of the bones of the upper, lower extremities, pelvis. X-ray of the joints of bones.	2
6	Information about the muscles. Development of muscles. Auxiliary apparatus of muscles. Muscles and fascia of chest, abdomen and back. Diaphragm. The vagina of the rectus abdominis muscle, the white line, the inguinal canal.	2
7	Muscles, fascia, topography of the neck and head.	2
8	Muscles and fascia of the shoulder girdle, upper and lower extremities.	2
9	Topography of the upper extremity. Topography of lower extremities.	2
	TOTAL	**18**

Lecture № 1. History of the development of anatomy. Introduction to anatomy. Methods of studying anatomy. General principles of the structure of bones. Functional anatomy of the bones of the trunk.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. The subject of anatomy, its goals and objectives. 2. History of the development of anatomy. 3. Anatomical nomenclature. 4. Methods of studying anatomy. 5. The role of the skeleton in the human body. 6. Basic properties and chemical composition of bone. 7. The internal structure of the bone. 8. Classification of bones. 9. Phylogeny of the skeleton. The inner skeleton and its role in vertebrates. Evolution of the skeleton. 10. The main stages of the ontogenesis of the human skeleton. Age changes in bones. 11. Vertebral column (structure, function, development, developmental abnormalities).

	12. Thorax (ribs and sternum, features of their development and structure, chest shape and developmental anomalies).
The purpose of the lesson: To reveal the goals and objectives of anatomy, its place among medical sciences and the importance for practical medicine. On the basis of data on the structure of the skeleton of vertebrates received in secondary school, to familiarize students with the structural and functional features of the human skeleton, its phylogenesis and ontogenesis, as well as the structure of the skeleton of the trunk and its features in connection with the upright walking. All this information is necessary for further study of histology, physiology, pathological anatomy, surgery, orthopedics and traumatology.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation, cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience
Monitoring and control	1. What does anatomy study. Methods of studying anatomy. 2. The main stages of the development of anatomy. 3. Anatomical nomenclature and its significance. 4. Functions of the skeleton in the human body. 5. The structure of the bone. The structural unit of the bone. 6. The main stages of phylogenesis of the skeleton. 7. Development of bones. Primary and secondary bones. 8. The main stages of the development of anatomy. 9. Anatomical nomenclature and its significance. 10. Functions of the skeleton in the human body. 11. Relationship between structure and function on the example of the structure of the bones of the trunk.

Technological map of the lecture lesson

Stages, time	Teacher	Students
Preparatory stage (5minutes) Stage 1 Introduction (15 minutes)	Verification of student progress 1.1. Introduces the topic of the lecture, its purpose and expected results.	Preparation of training tools. Listen, write
2 stage Main part (50 minutes)	2.1. In order to attract students' attention and check the level of their knowledge,	2.1. Listen. They think. Answer and listen to the right answers

	question answer. - What does the word "anatomy" mean? - What methods can be used to study anatomy? 2.2. Using visual materials, continues the presentation of the lecture material 2.3.-The main stages of the development of anatomy. -Anatomic nomenclature and its meaning. -Functions of the skeleton in the human body. - The main stages of the development of anatomy. -Anatomic nomenclature and its meaning. -Functions of the skeleton in the human body. 2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights of the lecture 2.3. Remember, write, try to answer questions 2.4.Write, give examples
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "skeleton"	4. Write down the task

Theoretical part of the lecture:

Human anatomy is the science of the origin and development, the forms and structure of the human body. Anatomy studies the forms and proportions of the human body and its parts, individual organs, their construction, microscopic structure. The tasks of anatomy include the study of the main stages of human development in the process of evolution, the features of the structure of the body and individual organs in different age periods, the formation of the human body in the conditions of the external environment.

The importance of anatomy in the medical education system is undeniable. Professor of Moscow University Ye.O. Mukhin (1766-1850) wrote that "a doctor not an anatomist is not only not useful, but also harmful." Anatomy and physiology constitute the foundation of medical education, medical science. "Without anatomy, there is neither therapy nor surgery, but only signs and prejudices," wrote the famous obstetrician-gynecologist A.P. Gubarev (1855-1931)

Macroscopic anatomy (from the Greek makros - large) studies the structure of the body, individual organs and their parts at levels accessible to the unaided eye, or by means of instruments giving a small magnification (magnifier).

Microscopic anatomy (from the Greek mikros - small) studies the structure of organs with a microscope. With the advent of microscopes from anatomy, a histology (from the Greek histos

- tissue) - the study of tissues and cytology (from the Greek kytos - cell) was isolated - the science of the structure and functions of the cell.

Systematic anatomy studies the structure of a "normal", i.e. healthy, person whose tissues and organs are not altered as a result of a disease or developmental disorder. In connection with this normal (from Latin normalis - correct), we can consider such a structure of a person, in which the functions of a healthy organism are provided. At the same time, the norms of the norm for a greater or lesser number of people (mass, height, body shape, structural features, etc.) will always be in the range of maximum and minimum values due to individual features of the structure. By the definition of G.I.Tsaregorodtsev, "the norm is a special form of adaptation to the conditions of the external environment, in which the organism is provided with optimal vital activity." Systematic anatomy is called normal anatomy, in contrast to pathological anatomy, studying organs and tissues affected by this or that disease.

The presence of individual variability in the shape and structure of the human body allows us to talk about variants of the structure of the organism (from Latin variatio - change,), which are expressed as deviations from the most frequently occurring cases, accepted as the norm.

The most pronounced persistent congenital abnormalities are called anomalies (from Greek anomalia - abnormality). Some anomalies do not change the appearance of a person (right-sided position of the heart, all or part of internal organs), others are pronounced and have external manifestations. Such anomalies of development are called ugliness (underdevelopment of the skull, limbs, etc.). Ugly studies the science of teratology (from the Greek teras, the native case teratos - a freak).

Plastic anatomy. studies the external forms of the human body, the proportions

Comparative anatomy studies and compares the structure of the body of animals standing at different stages of evolution. The structure of the human body is the result of the long evolution of the animal world. To understand human development in phylogenesis (development of the genus, from the Greek phylon - genus, genesis - origin), the anatomy uses data from paleontology, fossil remains of human ancestral bones. The study of the human body is helped by materials that

Age anatomy. studies the development of a particular person in ontogenesis (from the Greek on, the genitive, ontos-existent, existing), in which the prenatal period (studying embryology) is singled out, and the postnatal period, (from the Latin natus-born)

Modern anatomy is called functional, because it considers the structure of the human body in connection with its functions. It is impossible to understand the mechanism of bone reconstruction without taking into account the functions of the muscles acting on it, the anatomy of blood vessels without the knowledge of hemodynamics.

In accordance with anthropometric signs, the following types of human constitution are distinguished in anatomy: dolichosporous (from the Greek dolichos-long), which is characterized by a narrow and long trunk, long limbs; brachymorphic (from the Greek brachys - short) - short, broad trunk, short limbs; and mesomorphic (from the Greek mesos - average).

The history of anatomy. The sources of anatomy go away in remote times. Rock paintings show that already primitive hunters knew about the situation of vital organs. The mention of the heart, liver, lungs and other organs of the human body is contained in the ancient Chinese book "Neijing" (XI-VII centuries BC). In the Indian book "Ayurveda" ("Knowledge of life", IX-III centuries BC) there is information about muscles, nerves.

A certain role in the development of anatomy was played by the successes achieved in ancient Egypt in connection with the cult of embalming corpses. Valuable data in the field of anatomy were obtained in Ancient Greece. The greatest doctor of antiquity, Hippocrates (460 - 377 BC), who is called the father of medicine, formulated the doctrine of the four main types of physique and temperament, described some bones of the roof of the skull. Aristotle (384-322

BC) distinguished from the animals, which he opened, tendons and nerves, bones and cartilages. He belongs to the term "aorta". The first in ancient Greece were the autopsy of people Gerofil (born around 304 BC) and Erazistratus (300-250 BC). Herophilus (Alexandria School) described some of the cranial nerves, the membranes of the brain, the sinuses of the hard shell of the brain, the duodenum, as well as the membranes and vitreous body of the eyeball, the lymphatic vessels of the mesentery, the small intestine. Erasistratus clarified the structure of the heart, described its valves, distinguished blood vessels and nerves, among which isolated motor and sensitive.

Outstanding physician and encyclopaedist of the ancient world Claudius Galen (131-201) described 7 pairs (out of 12) of cranial nerves, connective tissue and nerves in muscles, blood vessels in some organs, periosteum, ligaments, and also summarized the information available before him on anatomy. He tried to describe the functions of organs. The facts obtained by autopsies (pigs, dogs, sheep, monkeys, lions), Galen carried over to the person without proper reservations, which was a mistake (corpses of people in Ancient Rome, as well as in antique Greece, were forbidden to open). Galen considered the structure of living beings (man) as "predetermined from above", It is no accident that therefore the works of Galen used the patronage of the church for many centuries and were considered infallible.

The greatest thinker and physician of the East Abu or Ibn Snna (Avicenna, 980-1037) wrote the "Canon of Medical Science", which contained information on anatomy, consonant with the ideas of Galen. "Canon" was translated into Latin and after the invention of printing republished more than 30 times.

In the second millennium, the development of cities, commerce, culture has served as a new impetus to the development of medicine. There are medical schools. One of the first was the opening of a school in Salerno, near Naples, where once every 5 years it was permitted to perform an autopsy of human corpses. The first universities are opening. Since the XIII century, universities have distinguished medical faculties. In the XIV-XV centuries. in them for demonstration students began to open 1-2 corpses a year. Especially great contribution to the anatomy was made by Leonardo da Vinci and Andrei Vesaliy. An outstanding Italian scientist and artist of the Renaissance, Leonardo da Vinci (1452-1519), having opened 30 corpses, made numerous sketches of bones, muscles, heart and other organs and compiled a written explanation for these drawings. He studied the shapes and proportions of the human body, proposed the classification of muscles, explained their function from the point of view of the laws of mechanics.

The founder of scientific anatomy is the professor of the University of Padua, Andrei Vezaliy (1514-1564), who based his own observations made at the opening of the corpses, wrote the work "On the structure of the human body" (De Humani corporis fabrica), published in Basel in 1543. Vesalius systematically and quite accurately described the anatomy of a person, pointed to the anatomical errors of Galen. The research and innovative work of Vesalius predetermined the further progressive development of anatomy. His disciples and followers in the XVI-XVII centuries. a lot of anatomical discoveries, corrections, corrections were made; many organs of the human body were described in detail.

In the XVI-XVII centuries. public exposures of human corpses were made, for which special premises were created - anatomical theaters (for example, in Padua, 1594, Bologna, 1637). The Dutch anatomist F. Ruysch (1638-1731) perfected the method of embalming corpses, injecting colored masses into blood vessels, created a large collection of anatomical preparations for that time, including preparations showing developmental anomalies and anomalies. Peter I during one of the visits to the Netherlands acquired from F. Ruysch more than 1500 preparations for the famous St. Petersburg Kunstkamera.

In 1628, the book of the English physician William Harvey (1578-1657) was published, in which he cited evidence of the movement of blood through the vessels of the great circle of blood circulation.

A special place in the history of anatomy and surgery is occupied by N.I. Pirogov (1810-1881). Starting his medical career at Moscow University, he continued his studies of anatomy and surgery in the Derpt (now Tartu) University. At the initiative of NI Pirogov, the Anatomical Institute was established at the Medical-Surgical Academy, and the system of anatomical training of doctors was improved. NI Pirogov attached great importance to accurate knowledge of anatomy. The great merit of NI Pirogov as anatomist is the discovery and development of the original method of studying the human body on the cuts of frozen corpses in order to study the relationship of organs with each other and with the skeleton. The results of many years of N.I. Pirogov summarized in his book "Topographic Anatomy Illustrated by Slits Carried Through a Frozen Human Body in Three Directions" (1852 - 1859). N.I. Pirogov studied the fascia and cell spaces in the human body, published the work "Surgical anatomy of arterial trunks and fascia" (1838). He owns the "Complete Course of Applied Anatomy of the Human Body" (1843-1848) and many other studies on anatomy and surgery. In the name of NI Pirogov, a linguistic triangle is called a section of the vertebelobic nape of the neck, aponeurosis of the biceps brachii of the shoulder (Pirogov's fascia), a lymph node located in the deep ring of the femoral canal, and other anatomical formations.

An outstanding researcher in the field of functional anatomy and the theory of physical education was P.F. Lesgaft (1837-1909) - the author of the fundamental work "Fundamentals of theoretical anatomy." PF Lesgaft is the founder of theoretical anatomy in Russia. He described the patterns of bone substance rearrangement under the influence of muscle traction, formulated the principles of the development of blood vessels and their relationships, depending on the structure and function of the organs, showed the importance of anastomoses between the arteries in the blood supply to organs and parts of the body.

BA Betz (1834-1894), who studied the structure of the adrenal medulla, as well as the cerebral cortex and described the large pyramidal neuron (the cell of Betz), was a well-known representative of the Kiev anatomical school.

In the field of experimental anatomy, the founder of the Leningrad school of anatomists V.N.Tonkov (1872-1954) fruitfully worked. Attaching great importance to the experiment, he investigated collateral circulation, plasticity of blood vessels under various conditions of life, blood supply of nerves, first (in 1896) used X-ray radiation to study the skeleton.

An outstanding representative of the Kharkov school of anatomists was V.P.Vorobiev (1876-1937) - a researcher of the vegetative nervous system, the author of methods for studying nerves. V.P.Vorobyov described the nervous plexus of the heart and stomach in humans, one of the first to study the innervation by electrostimulation of nerves in animals. He created a five-volume "Atlas of human anatomy." A great contribution to the study of the functional anatomy of the human lymphatic system and animals was made by D.A. Zhdanov (1908-1971).

Anatomical nomenclature. Until 1955, anatomy and medicine were used in the list of anatomical terms adopted at the congress of the German Anatomical Society held in Basel, Switzerland in 1895. This list was called the Basel Anatomical Nomenclature (BNA) and contained 5,600 terms.

The modern International Anatomical Nomenclature was adopted at the VI International Congress of anatomists in Paris (1955) and was named the Parisian anatomical nomenclature (Parisian Nomina Anatomica - PNA). The list of Russian equivalents was approved in 1974 at the VIII All-Union Congress of Anatomists, Histology and Embryology (Tashkent).

Methods of studying anatomy.

1. The method of preparation (dissection), which gave the name to science.
2. The method of cutting a frozen body (Pirogov's method NI).
3. Corrosion method (injection of vessels, ducts and cavities with plastic masses, followed by dissolution of tissues in acids or alkalis).
4. X-ray methods (fluoroscopy, radiography, computed tomography).

5. Nuclear-magnetic resonance (NMR) tomography.

6. Endoscopic methods.

7. In addition to the above methods, the study of human anatomy uses: the method of enlightenment, histotopography, histological and histochemical methods, electron microscopy.

8. Computer programs. Interactive graphical computer programs allow not only to study in detail the structure and topography of organs, but also to individualize the learning and control of knowledge through assignments and tests of varying degrees of difficulty.

9. Educational films, video films, transparencies, tables, dummies of bodies, educational games.

A characteristic feature of vertebrates is the presence of an internal skeleton. The human skeleton consists of a large number of separate bones (over 200). And it weighs 5 - 6 kg.

At the beginning of its appearance, the solid skeleton served to protect the body from harmful external influences. This role is played by invertebrate animals with an external skeleton (insects, mollusks, crustaceans).

In vertebrate animals, a well-developed internal skeleton became a support, support, a framework for soft tissues. Later, some parts of the skeleton turned into levers, driven by muscles and the skeleton acquired a motor function.

Thus, the skeleton has 3 main functions:

- supporting - attaching soft tissues and organs to different parts of the skeleton;
- motor - due to the structure of bones in the form of long and short arms, connected by moving joints and driven by muscles;
- protective - due to the formation of the bone box - the skull, which protects the brain, the bone spinal canal, which protects the spinal cord, the bony thorax protecting the vital organs - the heart, lungs, the bone pelvis, which protects the internal organs.

Among the other functions of the skeleton is its participation in metabolism, calcium, and phosphorus, as well as the hematopoietic function of the red bone marrow located inside the bones.

The main function of bones is the support function. Changing this function leads to a change in the bones themselves, their size, shape.

Basic properties of bone. The role of bones as skeletal formations is based on the fact that they possess two seemingly difficult compatible properties - great elasticity and considerable hardness, due to the presence of the corresponding chemical substances in the bones.

The bone substance is 30% organic and 70% inorganic. Organic matter is represented by ossein, and inorganic - by salts of calcium and phosphorus (phosphoric acid lime - 51.04%).

Elasticity, elasticity of bone depends on ossein, and its hardness - on mineral salts. The combination of inorganic and organic substances in one bone and gives it an extraordinary strength and elasticity.

Elasticity of bones is subjected to every minute tests with all possible mechanical influences, especially when jerking, striking, stretching. A skull that has fallen to the floor from a height of human growth, usually does not break; at the moment of impact it is deformed, but immediately, due to elasticity, it returns to its former form. Inflicted by pressure from above, the skull is flattened, becoming 10% lower, but not breaking.

As for the hardness of bones, the following figures give an idea of it. A fresh human bone withstands a pressure of 15 kg per 1 mm2, whereas a brick can withstand only 0.5 kg, i.e. resistance to pressure in the bone is more than 30 times that of a brick. It is more than 2.5 times that of granite. Of the technical materials, only the reinforced concrete can be compared with the bone by the connection of hardness with elasticity. The most solid bone of our skeleton is the tibia, on which the greatest burden lies with the support of the body in an upright position. This bone is able to withstand a load of up to 1650 kg, i. E. about 25 times its normal load. So great is the reserve technical strength of the natural structure.

A simple combination of a mineral substance with an organic substance would not give the effect that is achieved in the bones. Here the structure of the bone plays a huge role.

On the cuts of bones are distinguished 2 types of bone substance: compact and spongy. Under the microscope, it can be seen that both the compact and spongy bone material is constructed from the bone material plates, grouped in a certain way around the bone-penetrating channels. Bony cells lie between plates of bone substance, plates - the product of the vital activity of cells, their intercellular substance. All this is osteon - the structural unit of the bone. Osteons form larger ones - bone plates, beams or sponges of a spongy substance, they are not randomly arranged, but oriented so as to best distribute the load falling on them. Since the bones are subjected to a double action - the pressure and the traction of the muscles, the bone plates are arranged along the lines of compression and extension forces. The plates go as they would be sent by their civil engineer if he had to build a crane of the appropriate shape and achieve the greatest strength with the least waste of material. For example, the pelvic floor plates in the region of the hip joint lie along the lines that continue the direction of the femoral plates and make up one system with them. If, after a fracture of the femur, it fuses incorrectly, that is, the axis of one part will be at an angle to the other axis, then the old bone plates will dissolve and new, new loads will appear in their place.

The content of mineral and organic matter in bones is subject to large fluctuations. Those bones, which are affected by a large mechanical load, are richer in the salts of lime. For example, the femur contains more than the humerus.

With age, the chemical composition of bones changes even more. In the childhood, the bones are very elastic: there are relatively few mineral substances in them. Therefore children quite often with impunity fall from the big height, and in general do not suffer very much at constant bruises and falls. The flexibility of their skeleton is such that they can easily thrust your toes into your mouth.

In old age, the content of mineral substances can reach up to 80% or more. The bones lose their elasticity, become fragile, so the old people easily break their bones and heal for a long time.

The spaces between the crossbars - the bone cells contain the red bone marrow - the organ of the hematopoiesis. It also participates in the nutrition, development and growth of bone.

In the tubular bones, the bone marrow is also in the central canal, which is therefore called the medullary cavity or canal. The ostium is of two kinds, red and yellow.

Red marrow is a tender red mass consisting of a reticular tissue, in the loops of which there are young and mature blood cells, as well as osteoblasts and osteoclasts.

The yellow bone marrow mainly consists of fat cells. During the growth of the body, when a large hematopoietic and osteogenic function is required, red marrow predominates. As the child grows, the red bone marrow gradually becomes yellow.

Outside, the bone is covered with a periosteum - a connective tissue membrane consisting of two layers: the outer fibrous and internal bone-forming. It is rich in blood vessels and nerves, participates in nutrition and growth of bone in thickness.

The articular surfaces of the bones are covered with cartilage, which provides sliding during movement. It should be noted that, unlike bone, articular cartilage is devoid of blood vessels.

Classification of bones

There are long (tubular), short, flat, mixed and pneumatic bones.

Long bones are located on the limbs. In each tubular bone, the middle part is distinguished - the diaphysis and the two ends (epiphyses) - proximal and distal. If the bone has not completed growth in length, then at the border of the epiphyses and diaphysis, metaphyses or growth zones are isolated.

Short bones exist in those places where mobility is combined with a heavy load (brush, stop). They usually have several surfaces and a thin layer of compact matter.

Flat bones form the walls of any cavities, for example cavities of the pelvis and skull. The spongy substance in such bones is located between two compact plates called diploe.

Mixed bones can not be assigned to any of the above types. An example is the temporal bone.

Pneumatic bones contain cavities filled with air. They are typical for birds, and humans are found in the skull.

Phylogenesis of the skeleton

In the course of the long evolution of the animal world, the skeleton underwent a significant morphological rearrangement. At the lower stages of evolution, as well as in the embryonic period, in all vertebrates the first rudiment of the inner skeleton is the spinal string - the chord, originating from the internal embryonic leaf - the endoderm. The chord is a characteristic feature of the lower representative of the chordate type, the lancelet, in which the skeleton consists of a spinal cord elongated along the body and the surrounding connective tissue surrounding it.

In the future, a cartilaginous skeleton appears. Such a cartilaginous skeleton is observed in lower vertebrates (cyclostomes, selachians, sharks). Aquatic species of animals could manage a cartilaginous skeleton, since the mechanical load to keep the body in water is incomparably less than on land. But in the transition from the aquatic environment to the aerial, to the terrestrial mode of life, only the skeleton of bone helped the animals to lift their body above the ground and firmly rise to their feet. In more highly organized vertebrates, beginning with teleost fishes and ending with mammals, the skeleton becomes bone. With the development of the skeleton of the skeleton, the chord disappears, with the exception of residues - gelatinous nuclei of intervertebral discs.

Thus, in the evolution of animals, a consistent change in the species of the skeleton occurs as a phenomenon of adaptation to the environment. This change is also observed in the process of ontogeny, i.e. in the process of individual development of man. At the first stage of development, the axial skeleton is represented by the rudiment of a dorsal string surrounded by a connective tissue. Then the spinal cord is replaced by a part of the cartilaginous elements of the vertebrae, and only then does the skeleton appear, almost completely displacing the spinal cord.

Further changes in the shape and internal structure of the bones occurred under the influence of external conditions. The climate, the way of life of the animal, the way of feeding, the habitat, leave their imprint on the whole organism and on its separate parts. Under the influence of the above factors, there are changes in the Functions and this creates a contradiction between the old form and the new functions. The function corrects the form, the form regulates the functions.

In human embryonic development, bones do not develop from scratch. Bone is usually created on a site previously occupied by cartilage or connective tissue. In other words, bones are formed by replacing one tissue with another.

There are three stages of development of bones:

1. Connective tissue
2. Cartilaginous
3. Bony.

The formation of some bones begins in places already occupied by connective tissue. Such bones are called bones of connective tissue origin or primary bones. These include the integumentary bones of the skull and collarbone.

Other bones are formed in the places occupied by the cartilage. These bones refer to bones of cartilaginous origin - to secondary bones.

The earliest stages of embryogenesis are the first to form a webbed skeleton. By the end of the 4 weeks of the intrauterine period, mesenchymal cells form a dense mass, which is a sign of the formation of cartilage. Further increase in density leads to the formation of a cartilaginous skeleton, i.e. the cartilage acquires the shape of a bone.

Beginning with the 8th week of the uterine life, cells appear in the thickness of the bundles of dense connective tissue of the cartilaginous skeleton, which begin to produce calcium compounds, they are called osteoblasts. Thus, the cartilaginous skeleton passes into the third stage - the stage of ossification, and the emerging points of bone formation are called ossification points.

Flat bones of the facial skull, mostly have membranous origin (primary bones), and long tubular bones are secondary, i.e. develop from cartilage.

Primary bones develop relatively simply. Approximately in the middle of the model of the future bone, which initially has the form of a connective tissue membrane, the nucleus / point / ossification appears. - Due to the multiplication of bone cells, a bone is formed.

With the development of secondary bones based on the cartilage model, bone can be formed by replacing the cartilage with bone tissue from the depth of the cartilage (endochondral ossification) or by forming ossification points on the cartilage surface (perichondral ossification)

Due to the perichondrium bone cells are formed, the bone substance gradually replaces the cartilage in the diaphysis, and the perichondrium becomes the periosteum - the perichondral, periosteal ossification. In the epiphyses of tubular bones, the ossification points appear inside the carriage - the endochondral ossification. For a long time the cartilaginous metaphyseal zone is preserved. Due to it, the bone grows in length, due to periosteum - in width. With the ossification of the metaphysis, growth in length stops, the bone acquires a stable size.

With the development of the human skeleton, the order of ossification is functionally determined and begins with the most loaded central parts of the bones.

From the second month of uterine life, the first points of ossification appear in the diaphysis and metaphysis of tubular bones bearing the greatest burden. They ossify peri-and endochondria.

Shortly before birth or in the first years of life, secondary points appear, from which epiphyses (endochronic) are formed. Additional points of ossification are laid in the appendages - apophyses.

Long-term growth of the organism and a huge difference between the size and shape of the embryonic and final bone are such that it is inevitable that it will be restructured during growth. In the process of restructuring, along with the formation of new osteons, there is a parallel process of resorption - resorption of old ones, the remains of which can be seen among the newly formed systems. Resorption is due to osteoclasts. The growth of bone in thickness is due to the periosteum. Growth in length - due to metaepiphysis cartilage or growth plate.

Thus, ossification and bone growth are carried out due to the vital activity of osteoblasts and osteoclasts - creation and destruction.

Vertebral column.

The study of the human skeleton begins with the spinal column. The morphological and functional significance of this organ is very great. It is the most important sign of vertebrate animals. It connects parts and organs of a complexly built vertebrate body; it serves as a reliable protection and support for the central nervous system, or at least for the spinal cord and nerves emerging from it. Supporting his upper end with his head, the spine also transfers the weight of the body to the lower extremity belt. From the position and shape of the spine depends the very possibility of erectile dysfunction. These are the main functions performed by this body.

No less attention deserves its morphological significance. With particular clarity, the metamerism and segmentation of the body of vertebrates were imprinted on it - that primary sign of their structure, which connects them with the most ancient invertebrates. On the long path of development from lower fish to human, the spine retained its segmented structure - this feature of the deepest antiquity and consists of separate segments - vertebrae.

Accordingly, the 3 main functions of the spine / support, protection, movement), each vertebra has a body, arch, processes. In different departments from the spine, parts of the vertebrae have different sizes and shapes; specific features. Because of this, the vertebrae are divided into cervical, thoracic, lumbar, sacral, coccygeal.

Development of the spine.

The mesodermal rudiments are loosened from the primary intestinal endoderm and form a pair of metamerically located sacs, which, growing, are divided into two sections: 1) the dorsal, lying on the sides of the chord and neural tube, they form the primary segments of the body - the somite; 2) abdominal parts lying on the sides of the intestine - splanchnotomes, forming pair pouches - containing the cavity.

Somites, in turn, are divided into a sclerotome, giving rise to the skeleton and myotome, which gives rise to the musculature.

Thus, vertebrae develop from primary segments - mesoderm somites, located along the sides of the neural tube. Cells of sclerotomes migrate from both sides to the middle line and accumulate around the chord. These are the beginnings of the vertebra. They represent the membranous stage of development of the vertebrae. Then the vertebrae are replaced with a cartilaginous tissue.

Cartilage bodies of the vertebrae gradually grow over the chord, squeeze it and it gradually disappears, remaining between the vertebrae or inside the vertebral bodies.

Vertebrae refer to secondary bones, i.e. to the bones that develop through the cartilage.

In the thickness of the cartilaginous model of the future vertebrae, there are usually three main nuclei of ossification: one in the center and two lateral.

In the process of reproduction of bone cells and growth due to the central nucleus, a body is formed, and two lateral points form an arc, transverse processes and half of its spinous side.

Knowing these features of the ossification of the vertebra makes clear the origin of some anomalies in the development of the spine, leading to severe disturbances in its statics and dynamics, and arising as a result of non-dissolution of certain ossification points between themselves. All the variants of not merging the points of ossification are called spina bifida. The gaps between each two neighboring points of ossification point to the places of possible congenital vertebra clefts remaining in the case of non-dissolution of the bone nuclei.

Of greatest practical interest is the spina bifida of the lumbar and upper sacral vertebrae. At the age of 8-10 years, it occurs in all children and is a noschalny manifestation of age-related variability. In 25% it remains for life and is treated often as a pathological phenomenon. However, as shown by the X-ray study of a large number of healthy people, it is not accompanied by any functional disorders and is a physiologically conditioned version of the norm.

Different degrees of spina bifida sacral vertebrae are encountered so often (according to A.D.Speransky - 60%), which can no longer be qualified as an anomaly. According to the frequency of the presence of such an anomaly should be regarded as the norm, but what was previously considered the norm-a deviation from the usually encountered device of the sacrum.

Non-closure of the sacrum of the sacral vertebrae occurs only in humans. This anomaly was not observed in anthropoid apes and in the skeletons of prehistoric people.

According to Speransky, the underdevelopment of the posterior wall of the sacral canal arose in the course of evolution in connection with the transition of a person to a vertical appearance during standing and walking. As one of their mechanical factors in this process, they indicate, as it were, the breaking action on the sacrum of the ligaments and muscles of the pelvis and hip, which is especially significant when standing and walking.

Split arches, spinous processes of the vertebrae on the right and left occasionally occur in the thoracic and lumbar spine. The nuclei of ossification in the arch of the vertebra merge in the 1st year of life. On the 3rd water life ¬ni arcs grow to the bodies of the vertebrae,

Evolution of the spine was mainly along the way of differentiation of its departments in connection with the transition to the terrestrial lifestyle and the movement of the body along the ground, with the help of the limbs.

In fish, all the vertebrae are almost identical, distinguish between the body and tail sections in the spine.

There are no necks in the fish, cervical vertebrae bear ribs. The immobile head directly passes into the trunk and the anterior end of the body retains a stable streamline shape, very beneficial for movement in water.

With the transition to land, beginning with amphibians, the neck acquires the ability to move (lowering, lifting, and keeping the head at the right height, moving to the side), so that the cervical ribs are lost, being preserved only as the rib part of the transverse processes. Thus, the cervical spine is formed.

The presence of cervical ribs in the ancestors of mammals (including human pre-humans), in addition to paleontological and comparative-anatomical data (cervical ribs of reptiles) is confirmed by the fact that the 7th cervical vertebra in a person in 2% of cases carries an articulating it is an edge (on one, less often on both sides). In other cases, this rib even reaches its sternum with its front end. The existence of articulating ribs is also recorded on other human vertebral vertebrae. These anomalies can be considered atavistic. The embryo normally lays a free 7th cervical rib, but does not develop, retaining a rudimentary character.

Preservation of the developed ribs caused the allocation of the rib cage to the spinal column (called thoracic), as the ribs remained only in this department, and in the rest they turned into rudimentary formations included in the transverse processes of the vertebrae. The development of the lungs, as well as limbs, contributed to the allocation of the thoracic section.

In connection with the development of hind limbs in tetrapod vertebrates there was a fusion of the pelvic girdle with an axial skeleton. This belt, growing at the ancient terrestrial vertebrates in the dorsal direction, met with the ends of the ribs (they were short in this area), with which its articulation occurred. Initially, the belt was articulated with only one vertebra, which, under heavy load, increased in size and became sacral (the beginning of the extraction of the sacral section).

Later, the pelvic girdle became articulated with two or more vertebrae, which merged into one sacral bone. This led to the strengthening of the spine and the allocation of its lumbar and sacral parts. The crucifixion occurred in 2 classes of vertebrates: in birds and mammals, and only in those of them, in which the body rests entirely only on the hind limbs.

The coccygeal department of the human spine is especially interesting in connection with the question of the existence of the outer tail of our ancestors. Closer relatives of man from the animal world - anthropoid apes - are devoid of the outer tail. Reduction of this organ has come in some of them (orangutan) even further than in humans, and the number of coccygeal vertebrae has decreased to 3. There are a number of facts pointing to the presence of the outer tail of the human ancestors. In the human embryo on the second month of the uterine life, there is a freely protruding appendage at the posterior end of the body, it is indisputably similar to the tail of the embryo of a mammal of an animal. In the further development of the embryo, the tail ceases to grow, becomes blunted at the end and, as it were, absorbed by the growing neighboring parts of the trunk.

However, such a normal course of development is sometimes disturbed and a peculiar appendage is preserved even after birth. Several cases are described in the literature. Sometimes the outer caudal appendage contained solid skeletal parts - the extension of the spine. But more often it was soft to the touch. In one infants, when he was angry and crying, the tail rhythmically swung from side to side (Gremyatsky).

In the area of the buds of the caudal vertebrae - the tailbone of a human, a peculiar relationship is observed. The number of segments initially appearing here in a person is not less than 8. On the second month, some of them are resorbed. The remaining ossification occurs incomplete and with a great bump.

These features have caused the division of the spine of a person into fully defined departments, each of which is characterized by specific features of the vertebrae.

The number of vertebrae in a series of mammals sharply fluctuates, reflecting the general line of evolution - a decrease in their number in the direction from the lower to the higher and the human.

The number of cervical vertebrae in almost all mammals is 7, regardless of the length of the neck (for example, in a mouse, mole, giraffe).

In the thoracic region, the number of vertebrae varies from 9 to 24, correspondingly the number of surviving ribs. In humans, the number of thoracic vertebrae is 12, but it can vary between 11-13.

The number of lumbar vertebrae also varies greatly in animals -2-9, in humans 4-6. Most often there are 5. This depends on the degree of adhesion to the sacrum; if the V-lumbar vertebra grows with the sacral and descends to it - (sacralization), then the lumbar vertebrae will remain 4. If the I sacral vertebra does not integrate with the sacrum, it will be similar to the lumbar vertebra - lumbarization, then the lumbar vertebrae will be used. Thus, the number of pre-vertebra vertebrae in a person is 24, but it can increase to 25 and decrease to 23.

This number of pre-vertebral vertebrae clearly reflects a progressive decrease in their number in the course of evolution and ranges from 28-25 in monkeys to 24 in humans.

Also, the sacrum is famous for a different number of vertebrae spliced together, and from monkeys, towards the person, is observed by an increase in the number of sacral vertebrae with which the pelvic girdle articulates.

In lemurs it is articulated with 2 sacral vertebrae, in American monkeys - from Z, in gibbons that can walk on 2 legs - from 5. In humans, in connection with its straight leg, the sacrum reaches its highest development.

The tail section of the spine varies greatly depending on the length of the tail - from 3 to 46 vertebrae (in mammals). In humans, the coccegea consists of 4 vertebrae, and fluctuations from 1 to 5 are possible.

As a result, the total number of vertebrae varies between 30-35, most often 33 (7 + 12 + 5 + 5 + 4).

The spine of a person is not straightforward. It has bends that give it, when viewed from the side, some resemblance to the letter S.

In the cervical part, the convexity of the spine is directed forward, in the thoracic - back, in the lumbar - again forward and in the sacral - again back. Consequently, in those departments where the ribs or pelvic bones are attached to the spine, there is a bulge back, which increases the capacity of the corresponding cavities - the thoracic and pelvic. The forward convexities of the spine are called lordosis, reversed backwards by kyphosis.

Thanks to these bends, the human spine represents a springing device, which is extremely important mechanically. The blows and jerks transmitted to the spine during walking, jumping and falling, are weakened and damped in its springing mechanism and either do not reach the skull at all or reach it in a very weakened state.

The sharply expressed curvatures of the spine constitute a specific feature of man and arose in connection with the vertical position of the body. In typical mammals running along the ground, the main part of the spine has the appearance of a slightly curved arch, thrown from the forelimbs to the rear. The whole weight of the body is suspended to this arch, leaning on columns of the skeleton of the fore and hind limbs.

In the human embryo and fetus, the spine has the shape of a simple arc, directed by dorsal convexity. By the time of birth, he straightens; the curvatures that are characteristic of a person develop gradually: thus, in connection with the attempts of the child to hold the head, cervical lordosis arises, while trying to sit - thoracic kyphosis, and when the child begins to hold on the legs - lumbar lordosis.

The appearance of 2 lordosis causes the development of 2 kyphoses (thoracic and sacral, coccygeal), which is associated with maintaining equability in the vertical position of the body, distinguishing a person from an animal.

Curvatures of the spine significantly increase its resistance, because according to the laws of mechanics, the curved post has more resistance than the straight.

Initially, the spine with its bends is held by the active force of the muscles, and then, as the ligament apparatus develops, the bends are fixed by the elastic forces of the spine itself, which keep the formed bends in the adult even when the spine is removed from the body.

Curved in this way, the spine, thanks to its elasticity, withstands the load of the heaviness of the head, upper limbs and trunk with a springy counteraction. With increasing load, the bends of the spine are strengthened, under reverse conditions they become smaller.

The bends of the spine soften the tremors and shaking along the spine, which occur when jumping and even when walking; the force of the push goes to the strengthening of the curvature of the bends, not fully reaching the skull and the brain in it.

In addition to bends in the sagittal plane, bends of the spine to the right, and rarely to the left, so-called scoliosis, are observed. In this case, the right side of the shoulder girdle occupies a higher position, and the right hand is longer than the left one.

Scoliosis is associated with improper planting, for example, on a school bench - school scoliosis. To prevent scoliosis, rational gymnastics is needed.

In old age, the spine loses its bends due to a decrease in the intervertebral cartilage and vertebrae themselves.

Due to the loss of elasticity, the spine bends anteriorly, ob¬ding one large thoracic bend - the old hump, with the length of the spinal column greatly reduced. The difference compared to the previous length can reach 5-6 cm.

To the skeleton of the trunk is the thorax. The thorax protects the lungs and the heart, as the spinal column protects the spinal cord. It also protects part of the digestive canal. The real thorax appeared only in terrestrial vertebrates, namely in reptiles.

The human thorax has specific features. Its shape is often compared with a barrel. In the upper part it opens with an entrance, and in the lower part - with a wider outlet. The entrance is limited to 1 thoracic vertebra, the first pair of ribs and the upper edge of the sternum. Through this narrow ring pass: esophagus, respiratory gordo, large blood vessels, nerves, muscles; The lower orifice of the thorax is limited by the last thoracic vertebra, lower ribs, costal cartilages, the lower edge of the sternum, this opening in mammals is closed by a flagellate barrier that looks like a dome.

The spine extends deeply into the cavity of the thorax, dividing it into the right and left halves, in which the lungs are placed.

On the cross-section, the chest of the human embryo has a different shape, whose adult has.

In the embryo, the cell is compressed laterally, its anterior-posterior (dorsoventral) diameter is greater than the transverse diameter, in the adult it is vice versa.

The first type of thorax should be considered primitive; we find it in the greater part of mammals and it is adapted to the four-footed grooming, in which the weight of the thoracic organs presses on the sternum.

In an adult, the thorax is adapted to other conditions of equilibrium in a direction parallel to the sternum, and not perpendicular to it. This form of the thorax gradually acquires the higher primates in connection with their half-straightened body of the body as it moves along the ground.

Person-specific form of the chest can be somewhat modified under the influence of physical exercises: it can become wider and more extensive.

On the other hand, such influences as constant lacing or diseases - rickets, can change the chest to the worst.

The shape and size of the chest are also subject to significant individual variations due to the degree of development of the muscles and lungs, which in turn is related to the lifestyle and profession of the given person.

Usually distinguish 3 forms of the chest: flat, cylindrical and conical.

In people with well-developed muscles and lungs, the thorax becomes broad, but short, acquires a conical shape. Such a breast cage is as if in a state of inspiration - inspiratory.

In people with poorly developed musculature and lungs, the thorax becomes narrow and long, acquires a flat shape (flattened in the antero-posterior diameter), is as if in a state of exhalation - the expiratory chest.

Cylindrical foil is intermediate.

When rickets - the chest of children has the shape of a chicken breast, - with a keel.

The trumpeters and glass blowers are wide and convex. In shoemakers - who use their breasts as a support for the heel when the nails are nailed to the sole, a depression appears on the front wall of the chest, it becomes hollow: the funnel-shaped chest of shoemakers.

The ribs form the main part of the chest. At different chest levels, the rheoras are not the same, differing in size, position, and form. The longest ribs, like hoops encompassing the chest, are in the middle of the thorax. To the upper and lower divisions, the ribs gradually decrease. The number of ribs is equal to the number of thoracic vertebrae.

The embryo contains as many pairs of ribs as there are vertebrae, but later the cervical, lumbar and caudal fins are reduced.

A typical human rib represents a bone arch that at one end passes into the cartilage, the other end attached to the vertebra. The rib has a body, a head, a tubercle, etc. The anterior end of the rib by the cartilage is connected to the sternum. Cartilages of 8-9-10 pairs of ribs fuse with the cartilages of overlying ribs.

Thus, the ribs are different and true, the last two ribs show signs of underdevelopment, especially the 12th, they do not reach the sternum and are deprived of cartilage at the end. The last ribs are called fluctuantes.

The presence of 13 ribs in a man on at least one side was found in men in 6%, in women - in 2%.

As a rule, the human embryo is laid 13th rib, but then it is reduced and 13 thoracic vertebra acquires all the signs of lumbar. Cervical ribs are also described.

The thorax in front is closed with an elongated flat bone - chest, as peculiar in man as the whole thorax. The sternum lies against the spine, two clavicles and 7 pairs of ribs are attached to it. The sternum is divided into 3 parts - the body, the handle, the sword-like process.

The strongest part of the sternum - the handle - serves as a support not only for the upper ribs, but also for the clavicles.

There is a difference between the male and female breastbone, associated with the difference in the shape of the chest. The male sternum is absolutely and relatively longer than the female (difference is about 20 mm).

Sternum is first formed in terrestrial vertebrates - in reptiles. In mammals, its development is closely related to the development of ribs.

Ribs develop first in the form of segmented mesenchymal, connective tissue bands - membranous stage. Gradually ventral, i.e. the front ends of the right, as well as the left ribs, grow together, turning into two sternal bands. Then the sternal bands grow together from top to bottom and turn into an unpaired formation - a webbed sternum. Then the ribs and sternum turn into cartilaginous formations.

The main nucleus in the body of the rib appears at the end of the second month of intrauterine development. The nuclei in the head and tubercles appear during the onset of sexual maturity. The fusion of all nuclei occurs after 25 years.

The sternum arm usually has 1 core of ossification. In the body of the sternum there are from 4 to 14 nuclei of ossification, the fusion of which occurs on the 4-6 month of intrauterine life. The xiphoid process ossifies from the first nucleus in the 6-20 year of life and by this time is fused with the sternum.

With development, the most important anomalies in the sternum are closely related:

1) an opening of various flax and shape, occurring in a quantity different in its body and the xiphoid process.

2) the division of the xiphoid process on a different length into 2 plates.

Separation and the opening of the xiphoid process can easily be explained by varying degrees of delay in the fusion of the two striae of the breast bone during the embryonic period of its formation.

Summing up, it is necessary to emphasize that the skeleton of the trunk of a man has the following characteristics characteristic of him, conditioned by the vertical position and development of the upper limb as an organ of labor.

1) vertically placed vertebral column with bends;

2) gradual increase in vertebral bodies from top to bottom, where they merge into a single bone in the region of connection with the lower limb through the pelvic girdle - a sacrum consisting of 5 vertebrae;

3) a broad and flat chest with a predominant transverse size and the smallest anteroposterior.

Equipments of the lesson: posters, models, slides

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Lecture № 2. Functional anatomy of the bones of the upper, lower extremities and pelvis.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. Functional anatomy of the bones of the upper extremities belt and free upper limb. The role of labor in the formation of the upper limb in humans. 2. Functional anatomy of the pelvic bones and free lower limb. Sexual differences in the structure of the pelvis. 3. Phylogeny of limb bones. 4. The main stages of ontogeny of the skeleton of extremities. Age changes in limb bones. 5. Anomalies of development of limb bones.
The purpose of the lesson: To familiarize students with the features of the development, structure and function of the skeleton of the limbs. All this information is necessary for further study of histology, physiology, pathological anatomy, surgery, orthopedics and traumatology.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation, cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience
Monitoring and control	1. Features of the structure of the skeleton of the upper limb 2. Peculiarities of the structure of the pelvic bones and lower limb 3. Features of the structure of the human hand. 4. Sexual differences in the structure of the pelvis. 5. The role of labor in the formation of the human hand. 6. The main stages of phylogenesis of the skeleton of the limbs. 7. Development of limb bones in ontogenesis. 8. Structure of the skeleton of the brush. 9. Structure of the skeleton of the foot. 10. Ontogeny and phylogeny of the skeleton of extremities.

Technological map of the lecture lesson

Stages, time	Teacher	Students
Preparatory stage (5minutes) Stage 1 Introduction (15 minutes)	Verification of student progress 1.1. Introduces the topic of the lecture, its purpose and expected results.	Preparation of training tools. Listen, write
2 stage Main part	2.1. In order to attract students' attention and check	2.1. Listen. They think. Answer and listen to the right

(50 minutes)	the level of their knowledge, question answer. -What bones are related to the bones of the limbs? - Sexual differences in the structure of the pelvis in men and women. 2.2. Using visual materials, continues the presentation of the lecture material 2.3.-Features of the structure of the skeleton of the upper limb Features of the structure of the pelvic bones and lower limb Sexual differences in the structure of the pelvis. -Strengthen the skeleton of the brush. -Stroke of skeleton of foot. 2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	answers 2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights of the lecture 2.3. Remember, write, try to answer questions 2.4.Write, give examples
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "bone"	4. Write down the task

Theoretical part of the lecture:

The movement of most of the vertebrates is primarily due to the limbs that reach full development in terrestrial forms that lift their body above the ground.

The prototype of the limbs of vertebrates are the paired fins of fish that develop from the lateral cutaneous folds. Fins are equipped with a muscle and a cartilaginous skeleton, and are a flexible arm necessary for movement in a liquid medium.

In connection with the changed conditions of existence for terrestrial, the fin turns into a five-fingered limb.

The skeleton of the limbs of vertebrates, standing at the level of development above the fish, represents a remarkable unity in its composition and in the order of placement of bone elements.

At the base of the limb lies a group of 3 fan-divergent bones that make up the limb of the limbs. The belt serves as a mediator, the connection between the limb and the vertebral column.

The humeral girdle usually does not articulate directly with the vertebrae. It is attached to the thorax with the help of ligaments and muscles and articulates with the breastbone. The shoulder belt consists of a scapula, clavicle and coracoid, which in amphibians, reptiles and birds is an independent bone adjacent to the sternum. In viviparous mammals, the coracoid is reduced and grows to the scapula, turning into its beak-shaped process. Clavicles are developed in those mammals whose limbs can produce movement in all directions (rodents, bats, monkeys, humans). In forms with limbs doing monotonous motion in the same plane when running, swimming, etc. (ungulate, predatory, cetaceans), the collarbone is completely reduced.

The shoulder belt is very mobile. The pelvic girdle, on the other hand, is firmly attached to one or more vertebrae that have become part of the sacrum. Thus, the pelvic girdle, mainly supporting the weight of the body, provides less mobility to the hind limbs. It consists of an anus, pubic and ischium bones.

In mammals, these three parts of the pelvic bone grow into one unnamed bone. On the joint site of these bones, an articular fossa is placed for articulation with the thigh.

Both pelvic bones on the ventral side are connected with each other by symphysis, a fusion in which only the bony bone participates. As a result, you get together with the sacrum an immobile bone ring-the pelvis, which serves as a support for the hindlimb. The supporting role of the pelvis is especially evident in man in connection with the vertical position of his body. Because of this, the pelvis bears the entire weight of the upper body, transferring it to vertically standing lower limbs. It is necessary to note the sex differences of the pelvis. In women, in connection with the need to bear the fetus and give birth to the pelvis as a whole is wider and shorter, the sacrum is wide and straight, and the wings of the ileal bones are almost horizontal. In men, the pelvis is generally narrow and high. The angle between the lower branches of the pubic bones in women is obtuse, and in men - less than 90 degrees.

The skeleton of free extremities in fish is represented by a series of articulate rays in the fin, usually connected with larger plates at its base,

The skeleton of the extremities of terrestrial animals due to the transition to another mode of life strongly changes, although the radiant structure remains in them, reducing to 5 rays.

The skeleton of free front and hind limbs has the same type of device for all terrestrial vertebrates, from amphibians to humans.

Each limb consists of 3 parts or links that follow one another. The first link is the shoulder of the forelegs, the hip of the hind legs, the second link: the forearms in the anterior, the shin in the posterior ones, the third in the forelegs in the rear, forming 5 rays in the distal sections, the free parts of which are called fingers. This type of structure of extremities in a series of terrestrial vertebrates undergoes various modifications in connection with the conditions of their life. These modifications are manifested in the fusion of individual elements among themselves or in their reduction (wings of birds, reduction of fingers in ungulates, etc.)

The setting of the limbs also varies from the lowest terrestrial species to the higher ones. In amphibians and reptiles, the shoulder and thigh are located under a direct angle to the lateral surface of the body. The ulnar and knee joints form an angle open medially. The movements in these joints occur along an axis parallel to the vertebral column (crawling, jumping).

The higher forms are reinstalled. The extremities are located in the sagittal plane with respect to the body, the shoulder turning back and the hip forward, whereupon the elbow joint is directed forward with the flexion joint, and the knee joint is turned back.

The axes of movement in the joints are located transversely, which is most suitable for translational movements.

In order for the front limb brush to lean on the soil, a cross-pronation occurs. As a result of all these movements, the animal rises above the ground, becomes 4 feet and can use it when walking and running. When walking, some animals rely on the entire lower surface – foot walking, while others - running fast, rely on fingers, fingers. Climbing mammals develop a grasping cohesion, characterized by the opposition of the thumb to all others, for example - all four limbs in monkeys.

In humans, the anatomical and functional features of the limbs were formed under the influence of straightness and labor.

The forelimbs, which have become the upper, because of its vertical position, have lost the locomotor function. Thanks to the labor activity that singled out man from the environment of animals, they turned into a kind of grasping body, adapted to the fulfillment of the various and subtle movements needed during the work. The hand has become an organ of labor. Accordingly, the bones of the hand became thinner and lighter, and are very tightly interconnected.

Pronation and supination are especially developed. Freedom of movement of the upper limb is also due to the presence of the clavicle, which deletes the cohesion from the trunk, giving it greater freedom of movement.

Man also has a twisting (torsion) of the shoulder, associated with the vertical position of the body. The thorax is compressed from the front to the back. The scapula is adjacent to it from behind, its articular surface is directed laterally. Depending on this, the articular surface of the head of the shoulder, articulating with the scapula, turns 90% inward relative to the distal epiphysis of the shoulder. Torsion develops gradually in the course of ontogenesis.

Particularly adapts to the work of the brush. The wristbones become small, the fingers, on the contrary, are lengthened, becoming very mobile. The thumb is off to the side, it can be contrasted with the rest (this can not be done by monkeys). A person's brush is able to grasp an object, grab it, which is very important when working.

All these features of the structure of the upper limb of man arose as a result of improving the hand in the process of labor activity. Therefore, Engels said, "the hand is the organ of labor and at the same time its product." The hand is still an organ of touch (for the blind) and an organ of expressive movements.

According to the literary data, under the influence of functional (working or sports / load, the bone system is restructured, which is a consequence of the favorable effects of physical labor and sport.

As a result of working hypertrophy, the compact substance of the metacarpal bones and phalanges of the hand grow to a different degree in representatives of different sports. The greatest thickness of a compact substance in heavy-athletes, the brush of which withstands the force load (R.I.Khudaiberdyev, N.L.Voznesenskaya).

The lower limbs of a person serve only to move the body in space, the entire weight of the body rests on them, therefore the bones of the lower limb are thicker, more massive and the mobility between them is much less than that of the upper limb. The difference between the upper and lower limbs especially affects the brush and foot.

The foot, as the ultimate support of the body, has lost the properties of the grasping leg of the monkeys, so that the fingers, which do not play any part in the support, are greatly shortened. The thumb stands in line with the other fingers and does not have the same mobility as on the arm.

The human foot, compared with the feet of other primates, experienced a one-sided specialization, turning into a walking and supporting apparate. Only in an insignificant degree has it retained its former grasping ability, which, perhaps, is considerably developed and perfected by long exercises. Known are the armless artists who painted complex pictures with their feet. In Moscow there is a skilled embroiderer, armless from birth, performing embroidery with her toes.

The main differences between the human foot and the foot of the higher monkeys lies in the development of the thumb in length and thickness, in the loss of ability to oppose other fingers, in decreasing the length of the remaining fingers, in strengthening and enlarging the proximal part of the foot and in the development of its arch.

The human foot performs two main functions: it supports the body when standing - a static function and helps its movement - a dynamic function.

Accordingly, two parts are distinguished in the foot:

1) the lateral half represented by the calcaneal, cuboid and bones of the IV and V rays;

2) the medial half, composed of the heel and all the other bones of the foot.

The lateral part - the arch is less curved, flattened and gives a solid imprint to the living one, because represents a large supporting surface This is the pedestal of our body.

The medial half is curved arcuate, raised above the ground and can be compared with a lever or spring, it is flexible and flexible.

When examining the skeleton of the foot from the medial side, an arch is located in the position of the bones, the apex of which is formed by the talus bone, one part of the arch is formed by the heel bone, the other by the scaphoid, wedge-shaped and metatarsal. The support of the arc in 2 places: the hill of the calcaneus and the head of metatarsal bones. The arc is compared with an arch or vault.

Distinguish: high, normal, low and low (flat) height of the arch of the foot. The height of the arch of the foot depends on age, profession and physical activity. According to the literature, flat feet in children from 8 to 18 years old occurs from 44.6% in girls), up to 55.6% in boys (Bekhterev). A large percentage of flatfoot to 19 years, the authors explain the physiological flattening of the foot, associated with the formation of the feet.

A study of the height of the arch of the foot in the age plan showed that children from 1 to 3 years old experience a sharp decrease in the arch of the foot. From 7 to 9 years, the increase in the height of the arch somewhat slows down, and then from 9 to 17 years, it gradually increases.

G 17 to 25 years flat feet is rare - in 1,2%. Beginning with 50 years, there is a gradual decrease in the arch of the foot (R.I.Khudaiberdyev, Abidov, Ushakov, etc.).

Among the abnormalities of limb development, the first thing to note is the change in the number of fingers or their fusion. The fistula of the fingers is called syndactyly. There is not so rare and polydactyly - an increase in the number of fingers (usually up to 6). It is possible and such a serious ugliness, as the absence of one or more limbs, associated with violation of the bookmark of the limbs.

Violation of the development of limb bones is possible after birth. The most typical example is rickets, in which the process of normal ossification is disturbed and this leads to deformation of bones ("rachitic tibia").

Equipments of the lesson: posters, models, slides

References:

1. Inderbir Singh. Textbook of anatomy. 2016

2. Netter's Clinical Anatomy, John T. Hansen, PhD, USA 2019

3. Dr. BD. Chaurasia. Human anatomy. 2019

4. Richard L.Drake, A.Wayne Vogl, Adam W.M.Mitchell, Richard M.Tibbits, Paul E.Richardson. Gray`s atlas of anatomy. Second edition. 2015.

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Lecture № 3. Development of skull bones and their structure. Structure of the bones of the cerebral part of the skull.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. The value of the skull, the number of bones forming it. 2. Division of the skull on the brain and facial. 3. Development of the skull. Primary and secondary bones. 4. Development of the cerebral skull: development of the bones of the skull roof and the skull base bones. 5. Vertebral theory of the development of the skull. 6. Structure of the bones of the skull. 7. Pneumatic bones. Sinus. 8. Osteoporotic, osteosclerotic bones. 9. The shape of the skull 10. Periods of growth and changes in the shape of the skull 11. Skull capacity 12. Pathological forms of the skull
The purpose of the lesson: On the basis of general information on the structure of the bones of the skeleton to acquaint students with the features of development, the structure of the bones of the brain cranium, their age characteristics, sex differences.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation, cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience
Monitoring and control	1. List the bones of the brain area of the skull. 2. Development of the skull. Primary and secondary bones. 3. Development of the roof and the base of the cerebral cranium. 4. Structure of the bones of the skull 5. Pneumatic bones of the skull 6. The paranasal sinuses, their significance. 7. What are the shapes of the skull? 8. Structure of the bones of the skull 9. Phylogeny of the skull. 10. Ontogenesis of the skull.

Technological map of the lecture lesson

Stages, time	Teacher	Students
Preparatory stage (5minutes)	Verification of student progress	Preparation of training tools. Listen, write

Stage 1 Introduction (15 minutes)	1.1. Introduces the topic of the lecture, its purpose and expected results.	
2 stage Main part (50 minutes)	2.1. In order to attract students' attention and check the level of their knowledge, question answer. -What skull bones can you name? -What are airborne bones? 2.2. Using visual materials, continues the presentation of the lecture material 2.3.- List the bones of the brain area of the skull. -Development of the roof and the base of the cerebral skull. -Strengthening of the bones of the skull -Pneumatic bones of the skull -Paranasal sinuses, their significance. -What are the shapes of the skull? 2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	2.1. Listen. They think. Answer and listen to the right answers 2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights of the lecture 2.3. Remember, write, try to answer questions 2.4.Write, give examples
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "skull"	4. Write down the task

Theoretical part of the lecture:

The bones of the head together constitute the skull. With the exception of the lower jaw, the skull bones are firmly connected to each other by seams and form receptacles for a number of organs.

The skull on the one hand is a receptacle for the brain and some sense organs (the organs of sight of the booby, olfactory senses), and on the other hand it is the support of the initial parts of the digestive and respiratory tubes. It is accepted to divide the skull into the cerebral and to the inner or outer facial. the support of the initial part of the respiratory and digestive systems of organs and associated formations.

The composition of the cerebral sequence includes;

a) Unpaired: occipital, cuneate, frontal, latticed

b) paired: temporal, parietal.

The visceral skull consists of:

a) Unpaired: vomer, lower jaw, latticed, sublingual,

b) paired; upper jaw, lower nasal concha, palatine, malar, nasal, tear

Despite the close anatomical connection of the cerebral skull with the facial, they have different origins.

For a correct understanding of the complex structure of an adult skull, it is necessary to become acquainted, at least in general terms, with its development.

The cerebral skull, which is a continuation of the spine, develops from the sclerotomes of the head somites of the pair segmental mesoderm sacks, the middle germinal leaf.

At the person around the chord, 34 pairs of somites are laid. The mesenchyme of the occipital sclerotomes surrounds the developing brain and sense organs, forms first the membranous and then cartilaginous capsule of the original skull, which, unlike the spine, remains unsegmented.

The development of cartilage comes from the base of the brain, where all vertebrates are laid 2 cartilages on each side of the chord that penetrates the skull to the place where the cerebral appendage of the pituitary gland is located. A pair of cartilages is formed in front of the pituitary gland

Subsequently, all these cartilages coalesce with each other into a single plate, in which a hole remains for a long time to pass the anterior part of the pituitary gland.

These cartilages of the beginning are in connection with the paired cartilaginous nasal capsule lying in front of the olfactory organ. On the sides, parachhords fuse with cartilaginous auditory capsules formed around the rudiments of the organ of hearing. Between the nasal and auditory capsules is located about each side of the skull of the indentation for the organ of vision

Thus, with respect to the chord, the cerebral skull can be divided into the chordal and prechordal parts.

In the chordal part, in the posterior part of the parochondal cartilage, one can sometimes notice traces resembling the fusion of several vertebrae, while in the prechordal part, even the slightest traces of segmentation can not be detected, especially since this part is outside the region of the location of the head somites.

Based on this, the so-called vertebral theory of the skull, formulated by Goethe and Oaken, is important only for the chordal part of the skull. The "vertebral theory" of the skull, which was very popular in the first half of the 19th century, was created by the poet Goethe in 1790, when, as the legend says, while in Venice he drew attention to the skull of a ram that fell under his feet, , resembling vertebrae. Goethe expressed the opinion that the entire skull is a product of the fusion of a series of altered vertebrae, like a sacrum. To a similar opinion, independently of him came Oken in Germany, Saint-Hilaire in France and some others. The enthusiastic supporters of this theory reached such an absurdity that the jaws were equated to the ribs or limbs, the teeth were considered homologs of bones, the sky aperture, etc. The record was broken by the German zoologist Carus, who declared that the whole person is only a variant of the vertebra.

The first major successes of embryology solved this theory. Works in the field of comparative anatomy of a number of zoologists, among whom the names of Russian researchers Severtsev, Koltsov and others occupy a prominent place, dealt a mortal blow to this theory.

According to comparative anatomy it was found out that two parts must be distinguished in the skull: the prevertebral lying in front of the Turkish saddle, which develops independently of the vertebrae - the prechordal and behind it, the development of which is preceded by the spinal cord and the spine elements. This is the vertebral or chordal part, which retained certain traces of segmentation.

Absence of segmentation in the entire brain skull is explained, of course, by its role as a protective device for the brain, which requires complete immobility in all parts.

The formation of cartilage in mammals and humans captures one base of the primordial skull, while the cranial lobe remains membranous.

In the skull of the higher vertebrates, the cartilage is finally replaced by bone and exists only in embryonic life, with the exception of small residues that persist in adults (cartilage of the nose).

In the final result, the cerebral skull is a mosaic of bones that are joined together motionless.

Individual bones have several centers of ossification. Bone patches that develop from individual centers normally coalesce with age, forming a single bone. In the same cases, when such a fusion does not occur, additional bones of the skull arise. They often correspond to additional bones (independent bones) of lower animals, for which, in comparison with mammals, a much larger number of independent bones of the skull is characteristic.

The upper part of the scales of the occipital bone develops as a cover bone and corresponds to the self-intertemporal bone of some mammals. As a rule, after birth, it merges with the lower part of the scales into a single formation. But sometimes the confluence does not occur and the upper part remains independent (the "Inca bone" named after the ancient people of South America, in which it met in 20% of cases).

Scales of the frontal bone develops from 2 symmetrical points of ossification (metopic suture).

The bone marrow of mammals is characterized by a reduction in the number of bones, many of the bones that exist in the lower forms separately exist in more advanced forms as one bone. Characteristic is also the articulation of the skull with the spine by two condyles, and not by one, as is the case with reptiles and birds.

Development of the bones of the cerebral skull.

Bones of the cranial vault develop as primary bones. With the development of the brain around him a variety of layers of mesenchymal cells (the brain develops from primary brain bubbles), which initially cover the developing brain. Then the mesenchymal cover of the brain turns into a connective tissue envelope. This embryonic stage of development of the bones of the cerebral skull is called the stage of the membranous skull. Starting from the end of the second month, ossification points appear in the bones of the skull roof directly on the basis of membranous tissue. Thus, the bones of the roof of the cerebral cranium and many of the facial bones are transferred from the membranous to the bone stage, therefore they belong to the primary bones. This is evidenced by the preservation of the sites of the membranous skull in some places of the skull of the newborn in the form of so-called fontanelles.

Bones of the skull base pass through all 3 stages of development: membranous, cartilaginous, bone. Since the brain and nerves develop before the appearance of the membranous cartilaginous skull, the holes and channels of it form around them. Therefore, in the occipital bone, like a hole in the vertebrae, a large occipital foramen is formed, in which the medulla oblongata, vessels and nerves are located.

In the main, temporal and other bones of the skull, holes for the passage of nerves and blood vessels are similarly formed. The development of the cartilaginous basis of the secondary bones of the skull and their ossification occurs according to the type of development of the vertebrae.

Thus, the skull bones for development can be divided into 3 groups:

I. Bone of the cerebral skull

a) primary: the bones of the cranial vault, parietal, frontal, scales of the occipital bone, scales and the drum part of the temporal bone;

b) secondary: bones of the base: wedge-shaped (with the exception of the medial plate), body and lateral parts of the occipital bone, stony and mastoid part of the temporal bone.

II. Bones that develop in connection with the brain (nasal) capsule:

a) primary - tearful »nasal, opener

b) secondary - latticed and inferior nasal concha.

III. Bones that develop from the visceral arches:

a) immobile: upper jaw, palatine bone.

b) mobile: lower jaw, hyoid bone and auditory bones

The bones of groups II and III form the facial skull.

It should be noted that the integrity of the bones of the roof of the skull ensures the integrity of its cavity, where the brain is located. The breach of tightness that occurs in newborns and young children leads to a pulsation of the brain through a defect in the bone.

Experiments on animals, as well as clinical practice, showed that if the breach of the seals of the skull is broken, the brain begins to pulsate through the defect of the skull.

Electroencephalographic studies have shown that pulsation of the brain with preservation of tightness is absent.

A general overview of the skull.

The skull is made up of many bone elements. The number of them in humans is much less than in lower vertebrates. Some of the bones were lost in the process of evolution, others merged, forming complex bones of the skull.

The human skull is more spherical in shape, it is especially pronounced in the cerebral skull. In this regard, the facial section of a person is placed not in front of the brain, but under it.

The spherical shape of the human skull, propped up by the spinal column, is favorable for the balance of the head, which is very important for the bulky and heavy brain of a person.

The ratio of the cerebral and facial regions is quite typical for man: unlike monkeys, the human brain clearly predominates over the facial part.

The bones of the human skull represent a peculiar structure. On their saws a thicker outer and thin inner plate of dense substance is visible, between them is enclosed a spongy substance containing red bone marrow and numerous blood vessels (especially the veins). The rich blood content is very characteristic for the skull wall. These veins, through numerous branches, communicate with both the internal veins and with the veins that are located outside the cranial roof.

It is assumed that such a mechanism helps to equalize blood pressure inside and outside the skull. Outgoing veins out through the roof are called venous alumni. Especially significant are graduates of parietal, occipital, temporal bones.

The inner surface of the bones of the skull is not smooth. It has pits, as if made by the pressure of the fingers on the pliable walls. Pits and elevations represent to some extent the imprints of the surface of the brain. In addition, blood vessels can be seen on the inner surface of the cranial bones, one can judge from them the thickness and character of the branching of the vessels of the cerebral membrane. In humans, they are more pronounced than in other mammals.

Some bones of the skull are distinguished by the presence of cells filled with air and lined with a mucous membrane. Such cells are called sinuses. The presence of air in some skull bones makes it possible to separate them into a special group of air-bearing bones (pneumatic bones). Pneumatization of the bones causes a reduction in the weight of the skull without much harm to strength. These cavities are additional to the nasal cavity, for they are all in communication with it.

Nasal bony sinuses are present in the upper jaws, frontal, basal and latticed bones. At the time of birth, the nasal sinuses are not yet developed, with the exception of the right and left maxillary sinuses, which are indicated only in the form of small pits. Developing along with the skull, the nasal sinuses grow periodically: then more slowly, then more quickly. Noticeably their growth coincides with eruption and tooth replacement, then with the onset of puberty. The size of the bony sinuses is individually different, in the so-called osteoporotic turtles, in which the spongy substance predominates over the compact, the airborne sinuses are relatively large in osteosclerotic skulls consisting of relatively dense bones, the airway sinuses are less distinct and less capacitive. Frontal sinuses: the right and left airway cavities of the frontal bone are at the bottom of each of the halves of the scales of this bone. In a child of one month, the sinuses have the appearance of pits visible from the mucous membrane of the nasal cavity.

By the end of the first year of life, the bottom of the pits extends to the lower part of the scales of the frontal bone. By the age of 6 the frontal sinus cavities reach the size of a pea. In the future, the dimensions of these cavities increase up to 20 years. To old age frontal sinuses decrease Frontal sinuses lie in the frontal plane. The right sinus is separated from the left by a thin septum. Often, the septum is diverted to the right or left, on which the different size of the frontal sinuses depends. Often in the septum there is a hole that communicates the right and left sinuses with each other. Each of the frontal sinuses opens from below into the corresponding middle nasal passage.

The sinus of the base bone is located in the body of the underlying bone. A thin vertical wall divides into the right and left halves. Appears on the 4th month of embryonic development. By birth has the appearance of a pit, to 5 months of a pea, in adults its value is from pea to walnut. With age increasing, the sinus is approaching the bottom of the Turkish saddle. The right and left sinus openings look like a slit, limited to the bottom and medially to the edge of the Bertine shell, these openings open into the upper nasal passage. In more than the normally developed sinus of the main bone of its cell, small wings and sometimes the backs of the Turkish saddle reach. Sometimes they extend into the wall of the canal of the optic nerve.

The sinus of the maxillary bone is a maxillary cavern, the largest of all airway cavities. Its capacity is from 15 to 40 cm3. and more. It occurs before other airborne sinuses. The newborn has a small fossa, gradually develops to the period of puberty. Growth is slow, it is in connection with the development of temporary and permanent teeth. Only after the onset of puberty, the development of the sinus is accelerated. In old age, depending on the loosening of the bones of the skull, the volume increases.

The maxillary sinus communicates with the middle nasal passage.

The presence of airborne sinuses not only reduces the weight of the skull, in sinuses the inhaled air warms, the sinuses play the role of resonator cavities.

Forms of the cerebral skull

The shape and size of the skull are due to the shape and growth of the brain and its individual parts. The bony skull develops later than the brain; He is his bone case and repeats his shape with his inner outlines.

Not only internal, but also external factors influence the external surface of the skull during its formation, therefore the relief of the external surface of the skull differs significantly from the relief of its inner surface, especially in the front part of it.

In the formation of the external relief of the skull, undoubtedly, the corresponding muscular traction is of great importance; muscles, strengthened on the skull, with its thrust exert a simulating effect on it, especially the effect of chewing musculature on the lateral surfaces of the skull and on the lower jaw.

Many authors, analyzing the question of the origin of different forms of the head, attached great importance to the position of the fetus in the uterus and the deformation experienced by the baby's head during childbirth.

However, if we do not take into account pathological cases, the genital deformations quickly pass and do not matter for the final shape of the skull. Significantly important is the flattening of the occiput, which occurs in the child as a result of prolonged lying on the back in the cradle, if it is fixed for a long period of time immovably. This method was widespread among the peoples of Central Asia and the Caucasus. A particularly striking example of the influence of mechanical influences on the shape of the skull is the fossil skulls of representatives of those peoples who had a custom of wearing tight and tight hats from childhood. As a result, there were high, so-called tower skulls. If, from the first days of life, the children were bandaged in the frontal plane (in the girth of the chin), a saddle-shaped shape of the skull was obtained.

N.N.Miklouho-Maclay saw in women of New Guinea on the skull a transverse furrow, formed as a result of the custom from childhood to tie a head with a rope used to wear on the end of her bag with belongings.

Changes in the shape and associated growth of the skull and its bones are conventionally divided into 3 periods:

1) from birth to 7 years;

2) from 7 years to puberty,

3) from sexual maturity to 25-26 years,

1. From birth to the end of the first year of life, the skull grows evenly and relatively quickly. From 1 year to 5 years, usually the flat occipital becomes more prominent, the parietal region increases, the face grows noticeably in width, the fontanels overgrow

2. The second period is characterized by a slowdown in the growth of the skull as a whole. There is a noticeable growth of the roof of the skull, especially accelerated at the age of 6-8 and 11-13 years.

3. In the third period of development, the size of the frontal bone increases noticeably. The brain skull generally broadens and becomes taller. The facial skull becomes longer and narrower. The sutures of the skull become less pronounced with age, and in old age most of them are entirely replaced by bone tissue. Earlier, the sagittal seam grows, the coronal suture grows last. After the overgrowth of the joints, the permanent shape of the skull is established.

Asymmetric forms of the skull are explained by a non-simultaneous partial infection of its sutures on the right and left. Local infection of the joints causes a local delay and even complete cessation of the skull growth, while in other parts the skull is still growing. With early overgrowth of the sagittal seam and growth in the coronary and lambdoid sutures, the skull is long and narrow, low, the forehead and occiput protrude strongly, the skull has the shape of a boat.

With premature overgrowth of coronary and lambdoid sutures, the skull grows intensively in the swept seam width and especially in height, acquiring a tower-like shape.

It has long been proposed to distinguish between long-headed dolichocephalians, short-headed brachycephalians and middle-mesocephalic forms.

(Index =% ratio of the largest length of the head to its largest width).

Skull capacity increases with age and, moreover, not gradually, but periodically in accordance with the uneven growth of the brain.

By the end of 3 months of embryonic life, the skull capacity reaches 10 cm3, and by 6 months, the response to 120 cm.cube, and then until birth, on average, increases by 100 cm. The capacity of the skull of the newborn is 450 ohms3.

In the first year of life, the capacity of the skull increases monthly by 60 cm3, after the first year of life the capacity of the skull increases significantly more slowly. The increase in the capacity of the skull ends by 20-24 years of life, reaching usually 1500-1700 cm3.

Of great interest are the pathological cases of extremely small and excessively large values of the capacity of the skull. Pathological smallness is known as microcephaly. In the literature, cases of the capacity of the skull in an adult person of 400 cm3 and less are described. Naturally, microcephaly is associated with mental inferiority. The skull of a microcephalus usually differs from a small volume with a sloping forehead, strongly developed superciliary arches, close temporal lines, a flat occiput. According to these signs, many researchers regarded microcephaly as atavism.

They explained microcephaly with early overgrowth of the sutures (Virchow, 1858), but more often than not, the skull of microcephaly has open sutures.

Obviously, microcephaly is caused by a pathological process in the brain, a premature cessation of its growth.

Abnormally large skull sizes are usually associated with hydrocephalus by increasing the amount of fluid in the ventricles of the brain.

Capacities of the skulls of long-extinct animals and humans are determined in order to judge the size and weight of their brains.

On this material, some bourgeois scientists craniologists have tried and are trying to establish a connection between the capacity of the skull and belonging to a particular scattering, and to bring a correspondence between the capacity of the skull and the cultural level of the people, i.e. to bring the biological substantiation of class division in capitalist society, the division of people into so-called higher and higher races (the school of Bushan).

Tideman found that the average capacity of the skull of a Negro and a European is the same. There is no special evidence for the general position that the very capacity of the skull, as well as individual features of it, including racial anatomical features, have no influence on the state of mental abilities and development.

Proceeding from the tendentious idea that the long (dolichocephalic) skulls are the receptacle of the more developed brain, a number of reactionary scientists in the capitalist countries began to develop a racist theory about the existence of supposedly "higher" and "lower" types of skulls that characterize different human races.

Of course, the European skulls turned out to be "supreme", and the skulls of the colored peoples are "inferior."

For example, some considered the skulls of Bushmen and Australians to be primitive, as they appeared to be skeletons with the skeletons of the Neandertals.

However, as studies of objective scientists have shown, the Australian skulls differed from the Neanderthal, and the Neanderthal traits themselves, according to M.A.Gremyatsky is common in all modern races. An interesting example of this is the skull of an American palaeontologist She, who had a striking resemblance to the Neanderthal skull.

Fascist anthropologists of Hitler's Germany tried to prove that the dolichocephalic shape of the skulls is part of the Aryan race. And this serves as a biological sign of the superiority of the Germans over other races, which gives them the right not to conquer other nations and world domination.

Race is a naturally historical category "It is characterized by a combination of hereditarily transmitted morphological characters common to a group of people living in a certain territory. All modern mankind is at the same stage of development, but in different periods of the existence of mankind there were different races associated with certain areas of settlement of individual groups. At the same time, the conditions of the material life of society played an important role. The more and more extensive communication of people leads to their continuous mixing and blurring of sharp edges between the races. Therefore, there is no scientific data for dividing races into higher and lower races. Therefore it is impossible racial, i.e. biological signs to justify the right to political, i.e. social superiority. The same is said about the anatomical facts. Thus, the elongated form of the skull is also found in modern races.

The presence in all races of long and short skulls, and sometimes also of Neanderthal features, does not indicate differences, but rather the similarity, the single origin of all modern races from the Neanderthal ancestor.

The different level of social and cultural development of the living people is explained not by biological factors, but by social factors.

Equipments of the lesson: posters, models, slides

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Lecture № 4. Structure of the bones of the facial part of the skull. Orbita. Mouth cavity. Nasal cavity. Temporal, infratemporal, pterygoid fossa. Skull of the newborn.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. Anatomy of the bones of the facial skull 2. Structure of the orbit, mouth and nose 3. Temporal, infratemporal, pterygo-palatine fossae 4. Skull of the newborn 5. Skull phylogeny
The purpose of the lesson: On the basis of general information on the structure of the bones of the skeleton to acquaint students with the features of development, the structure of the bones of the facial skull, the orbit, nasal cavity, the skull of the newborn, the pits of the lateral surface of the skull.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation, cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience
Monitoring and control	1. What bones are part of the facial skull? 2. How many walls has an orbit and a nasal cavity? 3. List the walls and messages of the 3 pits of the lateral surface of the skull. 4. What features does the newborn's skull have?

Technological map of the lecture lesson

Stages, time	Teacher	Students
Preparatory stage (5minutes) Stage 1 Introduction (15 minutes)	Verification of student progress 1.1. Introduces the topic of the lecture, its purpose and expected results.	Preparation of training tools. Listen, write

2 stage Main part (50 minutes)	2.1. In order to attract students' attention and check the level of their knowledge, question answer. - What bones are part of the facial skull? - What features does the newborn's skull have?2.2. Using visual materials, continues the presentation of the lecture material 2.3. -Anatomy of facial bones -The structure of the orbita, mouth and nose -The temporal, infratemporal, and pterygoid-palatal fossa -The skull of a newborn 2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	2.1. Listen. They think. Answer and listen to the right answers 2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights of the lecture 2.3. Remember, write, try to answer questions 2.4.Write, give examples
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "bones of the facial skull"	4. Write down the task

Theoretical part of the lecture:

Part of the visceral skull are:

a) unpaired: vomer, mandible, ethmoid, hyoid,

b) pair; the upper jaw, lower turbinate, Palatine, zygomatic, nasal, lacrimal

Facial (visceral) part of the skull develops from derivatives of the jaw (mandibular) and hyoid visceral arches. It is known that in the early periods of embryonic development the human embryo is laid the system of Gill arches and slits between them in the number of five on both sides.

In terrestrial animals the Gill slits are only in its infancy. Gill or visceral arches they are laid in the embryonic period in the amount of 5 couples: I mandibular arch, hyoid 2 arc called gioeni, and the rest are called the Gill of the first, second,etc.,

Visceral arches are initially laid in the form of paired cartilages, and thus mandibular and gioeni arc consist of 2 divisions; subsequently from cartilage visceral arc formed bone.

1) Mandibular arc consists of 2 divisions: upper-abnormality cartilage and the lower cartilage Mechelen. From Mechelen cartilage developing mandible. Twin beginnings it gradually merge to grow at 2 year after birth. The lower jaw, curving upward its rear end, bond to the brain skull, and formed a brand new joint that do not have homology in other vertebrates. The rear end Mechelen cartilage becomes bone in the ear – the hammer.

2) Gioeni arc to its upper part forms a third hearing bone, the stapes, the rest gioeni arc goes to the education of the hyoid bone (small horns and part of the body), and the styloid processes of the temporal bone.

3) the Third visceral or Gill arc gives the rest of the body of the hyoid bone, its large horns. Of the remaining Gill arches occur the cartilage of the larynx, unrelated to the skeleton.

Bones that develop in connection with the brain (nasal) capsule:

a) primary - tear" nasal, vomer

b) secondary - ethmoid and the inferior nasal Concha.

Bones, developing from the visceral arches:

a) a stationary upper jaw, the Palatine bone.

b) a movable lower jaw, the hyoid bone and the auditory bones

Sex characteristics of the skull in humans.

The female skull is difficult, and sometimes impossible to distinguish from the male skull. In determining membership of the skull and the particular gender is taken to refer not to the positive, predominantly negative symptoms. Usually notice that the female cranium has less capacity than men's. The sockets in the female skull is more paranasal cavity less developed. The anteroposterior size of the base of the skull in women, shorter women's skull has a more correct shape of the arch, are less developed at this tuberosity from the muscles. However, this cannot be considered reliable evidence.

Sometimes sex signs on the skull are so poorly expressed that will with certainty measure gender of the individual moreover, approximately 20% of female skulls have a capacity below the average capacity of male skulls.

The relatively smaller size of the female skull does not signify development of the brain in comparison with a man, and correspond to smaller sizes of the female body and its proportions.

The skull

The base of the skull: composed of bottom surfaces such as facial and cerebral skull. Distinguish between external and internal base of the skull.

The outer base of the skull extends from the front incisors to the upper nuchal line in the back. Side of the border are infratemporal crista and the base of the mastoid process.

The front part of the outer skull base as a solid sky. The middle part extends from the rear edge of the hard palate to the front edge of the foramen Magnum and the posterior portion to the upper nuchal line.

At the internal base of the skull differentiate 3 cranial fossa.

a) front -to the rear edges of small wings.

b) the average pit to the top of the pyramid of temporal bones.

in) rear pit to the sulcus of the transverse sinus.

In the area of the facial skull are important cavity: eye sockets and nasal cavity.

In the facial skull there are 3 pits that have practical value

1) temporal fossa

2) infratemporal fossa

3) pterygoid-palatal fossa.

Age features of the skull

A human skull of different ages differ not only in size but also the ratio of the bones. These last differences are more distinctive than the size of the skull. First, the skull of children of early age is relatively large compared to the size of the body.

The skull of the newborn is deprived by growing teeth. Baby can suck, but not able to chew. Part of the skull, associated the chewing apparatus, remains underdeveloped, accounting for a height of 1/7 of the height of the skull, when in adults it takes about 1/3.

The lower jaw is very low, it forms a branch with the body in an almost straight line. The upper jaw is also underdeveloped in height and is devoid of sinuses.

Poorly developed nasal cavity. The orbits are rounded. Mastoid process is not evident. Frontal and parietal hillocks are almost conical hills. In General, the skull of a newborn differentiate two characteristic features:

1) a small amount of the facial skeleton compared with brain.

2) the presence of fontanelles

The skull of the newborn bears the traces of all 3 stages of ossification which are not yet ended. Fontanelles are the remnants of the first, membranous stage, they are at the intersection of the seams, where the remains fontanelles connective tissue. Their presence is of great functional importance, as it enables the bones of the skull roof greatly displaced, so that the skull during childbirth adapts to the shape and size of the birth canal. The following fontanelles:

1) Frontal, diamond shaped, located on the site of the intersection of 4 sutures, sagittal, frontal and 2 halves coronal. Overgrown at the 2nd year of life. Shape it is more or less pronounced diamond (3.5 cm x 2.5 cm)

2) Occipital - between the two parietal bones and the occipital bone scales. Overgrown at the 2nd month after birth.

3) Lateral fontanelles: Them 4 - 2 on each side. The front (wedge-shaped) grows at 2-3 month of life, the mastoid Fontanelle at the end of the 1st or during the 2nd year of life. Fontanelles pliable, they consist of connective tissue. They can easily protrude and to get involved depending on the changes of volume of the brain under the influence of his blood vessels and affect the circulation of the brain respiratory movements.

The differences of the human skull from the skull monkeys.

Comparing the shape of a human skull on the skull of the highest apes (e.g., chimpanzees), we notice the following important differences:

I the Front part of the roof of the skull of a monkey is separated from the rest by deep interception of the postorbital constriction.

2. The roof seems flattened and narrowed, so that the sides of it are clearly visible cheekbones.

3. Frontal and parietal hillocks is not expressed.

The top of the skull fossils of human ancestors detects the intermediate type of structure between a form peculiar to modern man and form the roof of the apes. From the back of the head are other differences of a human skull.

1) the Great height of the skull, sharply distinguish the human skull from the APE, and fossil hominid skulls.

2) Lack of human transverse roller at the back, instead the person a little elevation.

3) in monkeys skull flares, in humans, the widest part is the top.

Side shows that largely prevails in human brain skull over the front. Projection of the cranial 2.5 times the projections of the facial skull, From apes, the ratio is 1:1. The human feature is the convex shape of the cranium, high forehead rising sharply curved frontal bone.

Not only the apes but the Neanderthal forehead sent back, and the frontal bone is flattened.

Double curved the temporal line are characteristic of the person. Do apes lines are less curved and lie close to the medial plane move in a sagittal crest.

Mastoid process, to which is attached the sternocleidomastoid muscle, well developed in humans. From fossils of human ancestors it was poorly expressed. The anthropoids almost absent.

Front: high forehead is extremely characteristic of the person. It is caused by the large convexity of the frontal bone and the considerable angle of inclination to its horizontal plane.

Neanderthals and fossil hominid forehead low and flattened. The lower jaw is the only movable bone of the skull. The body and its limbs her form an angle of up to 110 -130 0 adult.

Apes, this angle is close to 90°, the Neanderthals, it increases camping. On the front surface of the body has a chin projection, its presence characterizes the jaw of modern man. Neanderthals, this projection is almost not expressed, but apes instead it has a curving back surface of the front edge of the jaw.

Chin peculiar to man of all mammals. On the back is the mental spine of the 2 tubercles - instead apes have a pit. To her and to the spine are attached the muscles of the tongue. In a series of fossil jaws of human ancestors, you can pick up all transitional forms from the fossa characteristic of apes, combined with a complete lack of chin, advanced to the spine, which corresponds to the protruding chin. This transformation is due to a change in method of origin of the muscles of the tongue.

In monkeys, these muscles are attached to the lower jaw from the fleshy part, while the modern man tendons. The second method of attachment opens up a much greater opportunity for a varied and subtle movements of these muscles involved in the reproduction of human speech.

Modern humans have a relatively ancient hominids thin and light jaws, which is associated with the decline of the the teeth a significant part of which is replaced with artificial cooking. As a whole the mandible was subjected to reduction. Of a person has developed a new form of work of the jaws related about social life and work.

Gerasimov, Mikhail Mikhailovich, Soviet anthropologist, archaeologist and sculptor, known for his remarkable work in the reconstruction of a human face to the skull. Reconstruction, the restoration of the portrait of the subject based on the structure of the skull in M. Gerasimov based on regularities of location of soft tissue on the skull. M. Gerasimov on the basis of many years study thickness of soft tissues by examining the sagittal and frontal cuts the exact size and the regularity of arrangement on a large number of corpses. Moreover, account was taken of the ratio of the form of orbit with dimensions of age, shape pear-shaped hole with the shape of the nose. For example: a few elongated shape pear-shaped hole corresponds to the long nose and hump-backed, on the contrary, low and wide pear-shaped hole corresponds to the tapered nose, low back, etc. Using their own methods of reconstruction of the soft parts of the face to the skull, Gerasimov since 1927 have created dozens of sculptural portraits, starting with the Pithecanthropus and Sinanthropus. Verification, which was subjected to the reconstruction Gerasimov skulls of modern humans (whose photos are preserved, but does not show the Reconstructor) has confirmed the correctness of the developed techniques. Gerasimov created on the basis of skulls portraits of many historical figures: Yaroslav the Wise, Andrey Bogolyubsky, of Timur, Shahrukh, Ulughbek, Admiral of Ushakova, Kotovsky and others.

The value of the works of Gerasimov's reconstruction of the portrait of a man the skull is not only in creating true portraits of historical figures, during which there was no photography, but also in establishing the identity of the victim of the crime, i.e., helps the prosecution. Example: Gerasimov handed over the skull and asked to create a portrait. Created portrait was exactly like one of two persons missing three years ago. Another example: Gerasimov created sculptural portrait based on skull, which was presented to him. Kotovsky widow learned of her husband in this portrait.

For the work "Bases of restoration of the face on the skull" (1949), he was awarded the State prize.

Equipments of the lesson: posters, models, slides

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Lecture № 5. General information about bone connections. Connections of the bones of the trunk and shoulder girdle. Connections of the bones of the upper, lower extremities, pelvis. X-ray of the joints of bones.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. Classification of connections of bones 2. The development of joints bones 3. The structure of the joints 4. Classification of joints 5. Properties of synovial fluid 6. Joints of the spine 7. The bones of the thorax 8. The bones of the shoulder girdle 9. The shoulder joint 10. The elbow joint 11. Connection of bones of the forearm 12. The wrist joint 13. Connection of bones of a brush 14. Connections of bones of a basin 15. The pelvis as a whole 16. The hip joint 17. The knee joint 18. Connection of bones of the shin 19. The ankle 20. Connecting the bones of the foot 21. Foot overall
The purpose of the lesson: To acquaint students with the characteristics of the structure, development, classification and functions of bones and joints General joints of bones of trunk, upper extremities, lower extremities, pelvis.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation, cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience

Monitoring and control	1.Classification of connections of bones 2.The development of joints bones 3.The structure of the joints 4.Classification of joints 5.Properties of synovial fluid 6.Joints of the spine 7.The bones of the thorax 8.The bones of the shoulder girdle 9.The structure of the shoulder and elbow joints. 10.How connect the bones of the forearm? 11.How connect the wrist joint? 12. How connect bones of the hand? 13.The bones of the pelvis 14.The pelvis as a whole 15.The hip joint 16.The knee joint 17.Connection of bones of the Shin 18.The ankle 19.Connecting the bones of the foot

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Stages, time	Teacher	Students
Preparatory stage (5minutes) Stage 1 Introduction (15 minutes)	Verification of student progress 1.1. Introduces the topic of the lecture, its purpose and expected results.	Preparation of training tools. Listen, write
2 stage Main part (50 minutes)	2.1. In order to attract students' attention and check the level of their knowledge, question answer. -What kind of connections of bones do you know? -What elements of the joint? 2.2. Using visual materials, continues the presentation of the lecture material 2.3.- The structure of the joints - Classification of joints - Properties of synovial fluid - Connection of the spine - Connection of bones of the thorax - Connections of the bones of the shoulder-belt - Connection of bones of the lower limbs, pelvis	2.1. Listen. They think. Answer and listen to the right answers 2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights of the lecture 2.3. Remember, write, try to answer questions 2.4.Write, give examples

	2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "joint"	4. Write down the task

Theoretical part of the lecture:

Bones fit together in various ways. Depending on the nature distinguish between continuous (sedentary) and discontinuous (usually movable) connection.

Continuous connection is called synarthroses. There are several species.

I. Syndesmosis—continuous connection of bones with connective tissue. These include ligaments, membranes, sutures. Such compounds are characterized by great flexibility and a very small elasticity.

The connective tissue between the covering bones of the skull (sutures— suturae) performs not only a binder but also shock-absorbing function. Closer to old age usually occurs ossification of the sutures: sagittal—35 years, coronary—38-41 year, lambdoidea—42-47 years; for individual seams, this process is stretched to 80 years.

Sutura squamosa — scaly form a seam, sutura serrata — the serrated suture, sutura plana — flat seam.

According Niacin H (1975), in the joints of the skull contains blood vessels, providing metabolic processes in the tissues and is a potential source of tumors of the blood vessels at a turnip operational processes.

Blood through the arteries gets into the seams on both sides. The vessels of the joints involved in the blood supply to surrounding areas of the bones.

II. Synchondroses—continuous connection of bones with cartilage (intervertebral discs, cartilage between the bones of the skull base and in other places). For synchondrosis characterized by low mobility and large elasticity.

III. Synostosis—continuous connection of bones by means of bone tissue. This type is often formed by the ossification of cartilage. An example of compounds of this type is the connection between sacral vertebrae.

Intermittent connections are called diarthroses, or joints—articulationes synoviales.

Joints begin to form in 4-6 weeks of embryonic development from the mesenchyme. In the so-called mezenhimal bag there are groups of cartilage cells growing on the future direction of the length of the limbs. Between these groups remain a between — the cavity of the future joint. Drawn to this period of the beginnings of the bones gradually take the form of future articular surfaces. Recent peripherally closed by bundles of connective tissue fibers participating in the formation of the joint capsule. In some cases, remnants of mesenchyme between the two future joint surfaces turn into cartilage. Last as if divides the joint cavity. If this cartilage is circular shape, it is called intra-articular disc (discus—circle), if it has the form of a Crescent — a meniscus (men — month).

Currently there is a view that the formation of the articular cavity is a process that appears to be enzymatic. Developing the joint is tightly closed by a joint capsule.

M.M.Diterihs wrote: "Factors modeling the form of the articular ends and, therefore, the whole joint, it is necessary to admit that muscular rod, the pressure force, abrasive action of traffic and interconnection influence growth, touching parts of the skeleton...". And further: "Each movement in a joint, every contraction of the muscles, the ligaments - all of it - a gradual and logical operation of the cutter functional devices, and all this leaves its mark on the shape of the joint, continuously improving it and gradually leading to the degree of the ideal healthy, fully developed and designed articulation...".

List the required components of any joint: articular surfaces of bones covered with cartilage; II — the articular capsule; III—the joint cavity; IV—intra-articular fluid (synovia).

The articular surfaces of articulated bones are covered with hyaline cartilage, sometimes this cartilage is fibrous (in the temporomandibular joint, sternoclavicular).

The structure of joint cartilage is designed to power pressure and displacement, in which connection groups of the cartilage cells chondral and connective tissue fibres have a curved orientation.

The joint capsule consists of outer and inner layers. The first of these fibro — formed longitudinally and circularly oriented collagen fibers. Inner layer — synovial-lined it from the joint cavity flat connective-tissue cells. The surface of the synovial membrane of the smooth-Kai and humid due to the presence in the joint cavity of synovial fluid. Within that shell are exchanged between the blood and synovial fluid that is very important, as the presence of blood vessels in articular cartilage, is denied.

In the composition of such a complex biological substrate, such as the synovia (the transudate of blood), composed of water, proteins, fats, salt wear of the cartilage, and as well enzymes. The presence of this fluid facilitates the sliding of the articular surfaces (see below).

The proportion of synovitis equal to 1.1 g/CC.; viscosity from 1,103 to 5,103 kg. sec/sq. m. It has a defined elastic properties and binding enough. However, the Ukrainian researchers With S.F.Manziy and A G. Berezkin recently reported that the fluid in the joint cavity is moved into flow, and separately serving the act of bending and the act of extension.

Suggested (Ilyenko, 1978) that the nerve endings locality as contained in the walls of blood vessels, epithelial layer of the synovial membrane, Synovial villi and in the articular cartilage, through the channels of feedback indicate the number of physical and chemical properties of synovitis.

Depending on the size of the joint synovial fluid ranges from 0.1 to 4 ml. At the present time, I believe that in addition to the synovia lubricating the articular surfaces, whereby friction is reduced almost to a minimum (the role of engine oil), is a nutritional medium for the articular cartilage, also performs the role of a "hydrodynamic wedge" impeding movement at the extreme phases. In addition, the synovia in the form of a thin film fills in the submicroscopic surface irregularities of articular cartilage, thereby contributing to the best gliding speed increases motion in the joint decreases the viscosity of synovitis reduced friction. Another thing is that even in a static position for movement of multiple joints are typical backlash, oscillating in the range of 3 to 15°.

When driving from the pores of the cartilage covering the rubbing surface of the bone, it produces synovial fluid. The latter migrates along the adjoining surfaces, thereby protecting them from breaking under load. So the liquid reduces the friction coefficient. The accumulation of synovitis most often takes place in the eversion of the capsule and in the crevices between the contacting articular parts.

The experiments established (Berezkin, 1969) that immobilized dogs synovial fluid is almost absent. In contrast, in animals treated with the cross-country load, its amount is increased 2-3 times compared to the norm.

Recently, V. N. Pavlova introduced the concept of "synovial environment of the joints," which, in its view, form a synovial sheath, synovial fluid and articular cartilage. However, it should be clarified that the latter does not participate neither in the production nor in the adsorption of synovial fluid. Thus, the main function of synovial fluid following (for Pavlova, 1980):

1) locomotor — ensuring, together with the articular cartilage of the free movement of articulated surfaces;

2) metabolic — participation in an intense exchange processes between the contents of joint and vascular channel of the body;

3) trophic — mainly in relation to the peripheral avascular layers of the articular cartilage;

4) barrier (protective) enzymes synovitis at the wrist, dissolving foreign cells and substances. Currently, for the treatment of certain diseases (deforming osteoarthritis, rheumatoid arthritis) offers an introduction to the artificial joint synovial fluid (in that it is composed of polymers).

Usually in old age, when the sliding of the articular surfaces somewhat disturbed, the motion in the joints can cause noises (crackle, crackle, clicking), not accompanied by pain sensations. Their appearance is explained by aspiration of intra-articular soft tissues due to the sharp increase in intra-articular vacuum. Anatomically there is a thinning of cartilage, fibrosis of the capsule and intra-articular ligaments.

The synovial sheath is covered with villi — villi synoviales. It forms folds — plicae synoviales, protrusion — synovial Bursa — bursae, covers the tendons when they pass through the articular cavity.

In the study by using scanning electron microscope (Multirow, 1981) found that the synovial sheath wrinkled. Many different width and height gusset provide, obviously, the stretching of the synovial membrane in the movement in the joint.

Interestingly, sedentary animals (amphibians, turtles) fibers in the joints are absent. The more flexible an animal is, the more the synovial villi; the newborn human they are few and they are poorly developed.

To strengthen the capsules of the joints there are ligaments — ligamenta. The latter vary both intra-and extra-articular. Intraarticular ligaments enveloped by the synovial membrane that isolates the ligament from the joint cavity; extra-articular ligaments are the thickened part of joint capsule. They are very durable. The thickness and number depend on the nature of the activities of the joint.

The greatest concentration of different kinds and functions (reaction to pain, pressure, tension, etc.) of the nerve of the devices takes place in the synovial membrane, bag and periarticular tissues.

The work of the joint connected with the mating shape of the bones, the presence of fissures, elevations. With the increase in the area of the articular surfaces increases the bearing area and the strength of the joint. The magnitude of the motion depends on the gap between connecting bones. If the mating surface of the bones are nearly equal in length, then the range of motion is very small. Such joints are called sedentary.

Inhibit the movement of joints tension in the joint capsule, the extensibility and elasticity of ligaments and skin, mostly — tonic contraction of the muscles surrounding the joint. What is the tone more, the magnitude of smaller. In rentgen found that movement joints are beyond their touching surfaces.

The maximum number of degrees of freedom, realized by the joint is equal to three: flexion—extension, abduction—adduction, supination— pronation.

Now let's list the factors that contribute to the strengthening of the joints.

1. The articular capsule and ligaments. Prevent the latter (Sorokin, 1973) the displacement of bones at a certain position of the limbs or body parts. The strength of the ligaments due not to homogeneity, and passing along their length by numerous bundles of fibers,

whose direction due to the action of mechanical factors. Contribute to strained ligaments along with the articular capsule retention in position of the articular surfaces. In addition, they inhibit certain movements, so they do not exceed known limits.

The joints of the upper limbs allow greater mobility than the lower, but the last joints stronger: they win in a fortress, losing in amplitude.

2. Muscles (stabilizing effect).

3. Congruence moistened by synovia articular surfaces, which to some extent contributes to their "sticking".

4. Negative pressure in the joint cavity.

Glenoid cavity is usually very narrow slit; it can be well seen in done in two mutually perpendicular planes radiographs, and medications, if the artificial fill (e.g., oxygen, solidified paraffin).

Simple joint formed by two bones (e.g., humerus); complex—more than two next located the bones (e.g., wrist, knee, ankle, etc.).

Complex call this joint, the cavity of which is divided by cartilage into two chambers. As is known, the form of the joint surface, which practically do not conform to regular geometric bodies, can be more or less consistent with each other or do not coincide. In the first case the joints are called congruent (congruo — agree, coincide). In the second case — incongruently. At the same time to increase the congruence of the articular are lip — labra glenoidalia and supplementing the articular surfaces of the discs or menisci — disci, menisci. The presence of the latter, dividing the joint cavity as if on two floors, allows each its movement. For example: temporomandibular joint, in the cavity of which has a biconcave cartilage disc along the circumference adherent to the articular capsule. Jaw superior-anterior division (floor) performs lateral movements (similar to joint in ruminants). Movement of the jaw in inferior-posterior division (floor) in the vertical direction about a transverse axis (analogous to a joint in predators).

Something similar occurs in the knee joint, the cavity of which there are menisci. Only in his "top floor" occurs flexion and extension. In the separated from the upper two of the lower meniscus — tibia rotation around the vertical axis (with a bent knee).

Meniscus not covered by the synovial membrane. They are intended not only to increase congruence, but also serve as buffers in the transfer pressure.

The menisci are extremely durable; they damage occurs, as a rule, under the action of indirect forces — a sudden, uncontrolled and uncoordinated movement, for example, during a jump when releasing.

Mixed joints are those that are anatomically separated (disconnected), but functionally United.

An example of a typical combined joint is the temporo-mandibular movement to the right of them is impossible without simultaneous movement in the same left hip.

Movement in the joints can occur around one, two or three axes. Respectively, and produce one-, two -, and three - or multiaxial) joints, for example joints of the spine. The latter, being quite a complex system 122 includes a true joint, 26 synchondroses and 365 ligaments (Chepoi, 1978). In particular, the intervertebral discs is considered as a kind of joint, as the cavity admits the last space made pulposis at the core and it is identified with synovial fluid. Functions of the capsule performs the fibrous ring of the disc (Fig. 10). That is why the spine is very elastic. His movements create the most favorable conditions for balancing the head. Intervertebral discs men maximum load in compression reaches 2200, the women 1400 kg (Panshin, 1973). The limit of tensile strength for men 310, women — 250 lbs. Most durable disc at the level of the 4th and 5th lumbar vertebrae, then the 5th lumbar and 1st sacral, then the 3rd and 4th lumbar, 1st and 2nd lumbar and the 2nd and 3rd lumbar. It also appeared that tear one of the ligaments of the hip joint requires the application of force of not less than 350 kg. And ligaments stronger in the middle section than near the places of their attachment to the bones.

Known very many so-called Achilles tendon on the tibia can withstand a thrust of 400 kg, and the tendon of the quadriceps is torn when a force of 600 kg.

Now all these details are important not only to specialists in aviation and space medicine, but also orthopedists, traumatologists, medical examiner, all those involved in the prevention of violations of reliability of functioning of the organs in unusual situations. That is why the bodies are not only used for training students. Specialists in mechanics of materials, mechanics of polymers are engaged in detailed elucidation of the strength of the individual tissues and organs method to compare biological and technical.

The joints are not passive entities. Their sophisticated innervational apparatus continuously carries information about any changes position (stretching and flattening of the capsule, the pressure synovitis, vibration). Distinguish between rapidly adapting (encapsulated) and slowly adapting (rusticoville) receptor; there are also in the joints of the nerve devices that respond to certain types of movements. They determine the programme of movement in the joint.

Depending on the degree of sensitivity there are three categories of joints:

1) highly sensitive — for example, shoulder, wrist, metacarpophalangeal joint;

2) srednedushevye — for example, elbow, hip, and knee joints;

3) insensitive — for example, ankle and interphalangeal joints.

The success of anatomy reveal new facts the activities of the joints, the incoming information suggests that the structure and function of the joints, clarified a lot already.

Of bones of trunk

The connection between the vertebral bodies

The body of the vertebrae are connected by intervertebral symphysis, symphiysis intervertebralis between vertebrae are intervertebral discs, disci intervertebrales. A slipped disk refers to a fibro-cartilaginous formations. On the outside it consists of a fibrous ring, the annulus fibrosus, fibers which are in an oblique direction to the adjacent vertebrae. In the center of the disc is the nucleus pulposus, nucleus pulposus nucleus, which is the remnant of the spinal string. Because of the elasticity of the disc spinal column absorbs the shocks that are on it have when walking and running the Height of all intervertebral discs is 4 of the whole length of the spine. Their thickness is not everywhere the same: highest in the lumbar, and lowest in infants. When comparing the thickness of the individual disks front and rear it can be noted that in the cervical and lumbar spine, it's on the front more than the rear, and in the thoracic Vice versa.

Median and lateral atlantoaxial joints.

The connection between Atlas and axis vertebrae form 3 joint: doubles combo, atlantoaxial flat lateral joint, artlculaiio atlantoaxialis lateralis, located between the lower articular pits Atlanta and the upper articulated platforms of the axis vertebra, and the other unpaired, median atlantoaxial cylindrical joint, articulatio atlantoaxialis mediana, between the tooth of the axial vertebra and the articular fossa of Atlanta. Between lateral masses and burn Atlanta Atlanta the transverse ligament, ligamentum transversum atlantis. From the upper free edge of the transverse ligament of the fibrous strand leaves the front of the semicircle to the foramen Magnum, forming the ligament of the apex of the tooth, ligamentum apicis dentis. From the lower edge of the same ligament down to the body of the axis vertebra is a fibrous bundle. Top-tion and lower fibre bundles together with the transverse ligament form the Atlanta cruciate ligament, ligamentum cruciforme atlantis.

Lumbosacral joint. Lumbosacral joint, artlculatio lumbosacralis, between the sacrum and fifth lumbar vertebra has the same structure as in the joints between the vertebrae themselves.

Sacrococcygeal joint. The articulation between the coccyx and sacrum — sacral-coccygeal joint, articulatio sacrococcygea, has some peculiarities. Between the bodies I and V sacral coccygeal vertebrae is the intervertebral disc as in the true joints of the vertebrae, but within it is the nucleus pulposus a small cavity. On the anterior surface of the coccyx is the ventral sacrococcygeal ligament, ligamenium sacrococcygeum ventrale, which is a continuation of the anterior longitudinal ligament. On the posterior surface of the bodies of the sacral vertebrae and the coccyx comes to deep dorsal sacrococcygeal ligament, ligamentum dorsale profundum sacrococcygeum, which corresponds to the posterior longitudinal ligament, lig. longitudinale post. The lower sacral hole closed by the superficial dorsal sacrococcygeal ligament, Ligamentum dorsale superficiale sacrococcygeum extending from the median sacral crest and the sacral edges of the hole down to the back surface of the coccyx. It corresponds to nedostatak and yellow ligaments. The lateral sacrococcygeal ligament, ligamentum sacrococcygeiim laterals, is on the lateral surface of the sacrum and coccyx.

Vertebral column as a whole.

Spinal column, columna vertebralls the totality of the vertebrae, sacrum, coccyx, intervertebral discs, articular and ligamentous apparatus. He is the container for the spinal cord, supports the body, is involved in the formation of the thoracic and abdominal walls. On the vertebral column in the back are two longitudinal furrows, sulci dorsales restricted to the spinous and transverse processes, which are deep back muscles. The spine has curves in the sagittal plane. In the cervical and lumbar spine forms a curve, the convexity directed anteriorly, the lordosis, lordosis and thoracic and sacral spine bending back—a kyphosis, kyphosis. Curves of the spine and determine its spring properties.

The newborn has mild thoracic kyphosis, and a slight lumbar lordosis. The formation of the bending occurs primarily in the postnatal period. At the 3rd month, the baby begins to raise its head and appear of cervical lordosis. When the child starts to sit, is formed thoracic kyphosis. At transition in vertical position occurs a lumbar lordosis. The final formation of all the curves for-Canavese to 18 years. The lateral curves of the spine in the frontal plane scoliosis, skoliosis, are in the nature of the pathological curvatures. In old age the spine is almost completely loses its physiological curves. As a result of loss of elasticity, a large thoracic curve, the so-called senile hump.

Length of the vertebral column in relation to the entire body length is about 40%. The height of the spine in old age can be reduced by 6-7 cm Movement of the spine possible around 3 axes: front—flexion and extension; sagittal tilt right and left; vertical—rotational movement.

Joints of the chest, the connection of the ribs with the sternum and the spine

The sternum connects to 7 of the true ribs with the costal cartilage, and the cartilage of the ribs I are connected by synchretism with the handle of the sternum. The remaining 6 costal cartilages (II—VII) form the sternocostal joints, articulationes sternocostales flat. The joint cavity is divided II rib intraarticular sternocostal ligament, ligamentum sternocostale intraarticulare, into two halves. Joints reinforced radiant sternocostal ligaments, ligamenta sternocostalia radiata, which are located in front and behind the joint. Between the cartilage of VI—VIII ribs are interchondral joints, articulationes interchondrales, a bag which is the perichondrium.

The ribs connect to the vertebrae with the costal-vertebral joints, articulationes costovertebrales, consisting of two joints. One of them is the joint head of rib articulatio capitis costae, the other — edge-transverse joint, articulatio costotransversaria, between the rib tubercle and the transverse process of the vertebra.

Thorax as a whole.

Chest, compages thoracis, formed by 12 pairs of ribs with the cartilages, 12 thoracic vertebrae, the sternum, which are joined by ligaments. The rib cage protects organs located in the chest cavity. It has a top and bottom aperture: apertura thoracis superior et apertura thoracis inferior. The first is limited to the rear body of I thoracic vertebra, laterally — 1 edge, at the front, the sternum; the second, rear body XII thoracic vertebra, laterally and front—to-XI and XII ribs, costal arches and xiphoid process.

Right and left costal arcs form under sternal angle, angulus infrasternalis, the size of which is determined by the shape of the chest.

The shape of the chest is individually different and depends on your body type, age and gender. There are two extreme forms of the chest: 1) long and narrow with a low standing ribs and under sternal acute angle, 2) broad and short with a strongly expanded lower aperture and stupid under sternal angle. The upper aperture of the thorax structure is also wide with a predominance of the transverse dimension and narrow, with long sagittal size.

Rib cage women are more rounded, shorter and narrower in the lower part. In men, it approaches the cone, all sizes it more.

The shape of the thorax may vary depending on the illness. So, with rickets, it resembles a "chicken breast": the sagittal dimension more frontal, sternum protrudes forward.

The joints of the belt of the upper limb.

The acromioclavicular joint, articulatio arcomioclavicularis, formed by the acromial end of the clavicle and the acromion of the scapula. Form the articular surfaces are flat. Within the joint cavity there is the articular disc, discus articularis. The joint is strengthened following bundles: 1) coracoid-clavicle, ligamentum coracoclaviculare, running from the coracoid process of the scapula to the under surface of the clavicle; 2) acromion-Lucic-tion, ligamentum acromioclaviculare, situated between the clavicle and the acromion. Movement in the joint is possible around all three axes, but their amplitude is very small.

Sternoclavicular joint, articulatio sternoclavicularis, formed by the clavicular notch of the sternum and the sternal end of the clavicle. To increase the conformity of the articular surfaces within the joint cavity there is an articular disk divides in the geese reach the joint into two divisions. Form the jointed surfaces of bones saddle. The nature of the movements the joint is approaching spherical. Possible movement around the sagittal axis — up and down, vertical, forward and backward, and rotation of the clavicle around the frontal axis and a small circular motion. The joint is strengthened following bundles:

1) costoclavicular, costoclaviculare Ligamentum, extending from the cartilage of rib I to the lower surface of the clavicle; 2) anterior and posterior sternoclavicular, ligamenta sternoclaviculares anterius et posterius, passing in front and behind the joint. Midclavicular ligament, ligamentum interclaviculare, connecting both sternal end of the clavicle above the jugular notch.

Joints of free upper limb

The shoulder joint

Shoulder joint, articulatio humeri, formed by the head of the humerus and the glenoid cavity of the scapula. Between the jointed surfaces of bones, there is disparity to increase congruence on the edge of the glenoid cavity is formed by the glenoid lip and labrum glenoidale. The articular capsule is thin and loose. Starts from the edge of the articular lip and attaches to the anatomical neck of the humerus. Through the cavity of the joint is the tendon of the long head of the biceps. It is libparanoia sulcus of the humerus and is surrounded by the synovial membrane. The joint is strengthened coracoid-humeral ligament,ligamentum coracohumenale starting from the coracoid process of the scapula and woven into the joint capsule, and joint and shoulder ligaments are capsular ligaments. The shoulder joint is surrounded by tendons of the supraspinatus muscle from above, infraspinatus, small round subscapularis in front and lateral deltoid mica. The tendons of the muscles surrounding the joint, will not only strengthen it, but when moving the joint pulls the joint capsule, preventing its infringement. The shape of the articulated surfaces of the joint refers to the spherical. movement in the joint is possible around three mutually perpendicular axes: sagittal— abduction and adduction, vertical — pronation and supination frontal — flexion and extension. The joint can circular rotation.

The elbow joint

The cubital joint, articulatio cubuti is complex and consists of three joints: placelocation, brachioradialis and proximal radioulnar. They have a common cavity and covered one capsule.

Shoulder joint articulation humeroulnaris formed by the block of the humerus and the trochlear notch of the ulna. The joint has a hinge shape.

Brachioradialis joint, articulation humeroradials , is composed of the capitulum and the fovea on the head of the radius Form its spherical.

The proximal radioulnar joint, articulation radioulnaris proximalis, formed by the radial notch of the ulna and the circumferential articularis radii Form joint clinic. the elbow motion is possible around two mutually perpendicular axes: front— flexion and extension and the vertical passing through preselective joint — pronation and supination.

In the elbow joint has the following ligaments: 1) the annular ligament of the radius, ligamentum no radii, which is in the form of a ring covers the head of the radius bone, holding it in the notch of the ulna; 2) the radial collateral ligament, ligamentum collaterale radiate, goes from the lateral epicondyle and passes into the annular bundle; Z) ulnar collateral, ligamentumcollaterale ulnare , passes from the medial epicondyle to the medial edge of the coronoid processes of the ulna and the ulna. The articular capsule on the humerus from the front starts at 1.5 cm above the coronoid and ulnar fossae, behind—above the olecranon fossa, and grasps it from the sides and below the edge of the medial and lateral epicondulus. leaving them free. The bottom is attached to the neck of the radius and at the edge of the trochlear clippings of the ulna. Capsule of the elbow joint thin the front and back.

Joints of the forearm

The bones of the forearm in its proximal and distal segments connected to a combined joint. The proximal radioulnar joint has been discussed earlier.

The distal radioulnar joint, articulation radioulnaris distalis, formed by head of ulna incisura ulnaris and radiation . Additional education in the joint is the articular disc, which prikreplyaet its base to the incisura ulnaris of the radius, and the apex to the styloid process of ulnar bones. The shape of the cylindrical joint. The articular capsule attaches along the edge of the mating surfaces of both the bones and the articular disc. In the gap between the two bones forms a capsule use, recessus sacciformis directed upwards. Movement in the joint is possible around the vertical axis — pronation and supination, passing through the head of the radius bone, and below — through the head of the ulna.

Joints of the hand

The wrist joint, articulation radiocarpea is difficult. The form of the articular surfaces it ellipsoid. It is formed by the articular surface of the radius and articular disk and the Proximal row of carpal bones (scaphoid, lunate, triangular). The articular disc separates the distal radioulnar joint from the wrist. Movement in the joint, combined with movements in middle metacarpal joint. Possible movement around the frontal axis flexion and extension and sagittal — abduction and adduction.

Intercarpal joints, articulationes intercarpeae, connect the carpal bones. These joints are strengthened by the following ligaments: the interosseous ligamenta interossea entercarpea, hands and back intercarpal intercarpea ligamenta palmaria et dorsalia

Middle metacarpal joints, mediocarpeae articulations are the joints formed proximal and distal rows of carpal bones, except the pisiform bone. These joints have extensive joint capsule and acts as a single combined joint. The joint space of the joint's shape. Movement in middle metacarpal joints are closely linked to movements in the wrist, occur around the frontal and sagittal axes. Middle metacarpal joint has a separate joint capsule, which strengthens a number of ligaments.

Joint articulation the pisiform bone ossis pisiformis. The pisiform bone is in the tendon of the ulnar extensor of the brush and forms a joint with the triangular bone which is the articular capsule, strengthened by two ligaments pisohamatum et lia lia pisometacarpeum.

Carpometacarpal joints, articulations carpometacarpeae, -complex joints. They articulates the second row of carpal bones with the bases of the metacarpal bones. The form of the articular surfaces of II-IV carpometacarpal joints belong to the flat. They fortified the back and Palmar carpometacarpal ligaments.

Carpometacarpal joint of the thumb, the articulation carpo – metacarpea pollicis is formed by the trapezium bone and the base of the I metacarpal bones; on the form saddle. Movement in the joint is carried out around two axes; front - opposition (opposition) and reverse movement (reposition), sagittal — abduction and adduction.

Articulationes intermetacarpeae located between the bases of II - V metacarpal bones and are connected by lia metacorpeainterossea , solenaya surface, and the capsule, Palmar and dorsal ligaments.

Metacarpophalangeal joints, articulationes metacarpophalangeae , formed by the heads of the metacarpal bones and the hollows of the bases of the proximal phalanges. Metacarpophalangeal joints II - V fingers have a spherical shape. The joints are reinforced by ligaments. The movement in the II - V metacarpophalangeal joints possible around the frontal axis flexion and extension, the sagittal axis abduction and adduction are possible at the metacarpophalangeal joints also rotational motion. In the I metacarpophalangeal joint are performed only flexion and extension.

Interphalangeal joints of the hand, articulationes manus interphalangeae, located between the head and the base of the middle phalanx, and between the average head and the base of the distal phalanx. Form an articulated hinge surfaces. On the side surfaces of the joint are ligament. Movement in the joint is possible around the frontal axis flexion and extension.

The importance of transverse ligament holds the bending over of bone between the radial and ulnar sides of the Palmar surface.

Differences in the structure of the joints of the upper limb.

Differences in the shape of the joints due to functional characteristics of upper extremities. So, the structure of the joints of the shoulder girdle depends on the individual. In persons engaged in heavy physical labor, there is costoclavicular joint between the first rib and the clavicle. It is formed in place of the same ligament. In persons with highly developed muscles cannot fully extend the elbow due to excessive development of the olecranon and the functional hypertrophy of the flexor muscles of the forearm. When underdeveloped muscles is not only full extension, and hyperextension in the joint. More often it occurs in women. The mobility of the joints in women somewhat more than men. A particularly large amplitude motion in small joints of the hand and fingers.

The joints of the lower limbs

The joints of the belt of the lower extremity

Pubic symphysis, symphysis pubica, refers to a special type joints located at the middle plane. Between the facing each other surfaces of the pubic bones are covered with hyaline cartilage, is discus interpubicus, and in the middle is a small cavity of the symphysis. It is formed At the 2nd year of life. In women during pregnancy, the pubic symphysis can be mobile due to loosening of the cartilage. Pubic symphysis the pubic reinforced top ligamentum pubicum superius, and the arcuate ligament of the pubis, ligamentum arcuatum pubis under the symphysis.

The sacroiliac joint, articulatio sacroiliaca, formed the ear-shaped articular surfaces of the sacrum and the iliac bones. The form of the articular surfaces of the joint refers to flat. Articulated surfaces are covered by fibrous cartilage. The joint is reinforced by strong ligaments: the interosseous sacroiliac, ligamenta sacroiliaca enterossea, the ventral Sacro - popliteal,ligamentum popliteum obliquum— the internal condylar tibial upward and laterally to the articular capsule; arcuate popliteal, ligamentum popliteum arcuatum coming from the lateral condyle of the femur in the composition of the oblique ligament, the Ligament of the patella, ligamentum patellae comes from the apex of the patella to taberositas tibiae . Laterally from this ligament are the medial and lateral supporting ligament, retinaculum patellae laterale et mediate .

The articular capsule of the knee joint begins retreating 1 cm from the edge cover, sides fused with the edge meniscus.

The synovial membrane of the knee joint covers the cruciate ligaments, forming pleats with layers of fat. The most strongly developed wing-like folds, plicae alares. In the synovial membrane has villi. The membrane itself forms a 9 inversions: one unpaired—anterior median and 8 pair 4 front and rear: front-upper and anteroinferior , caudineural and rear-lower (medial and lateral). In the knee secrete a number of mucous bags: bursa subcutanea prepatelais, bursa under the tendon subfasciallis prepattelaris, bursa subtendinea prepattelaris, deep infrapattelaris bursa communicating with the joint cavity. On the rear surface of the joint bags are placed under the tendons of the muscles.

The joints of the lower leg.

Both bones of the tibia in the proximal tibiofibular joint articulates, the articulation tibiofibularis having a flat shape. The front and back of the joint capsule are woven in two bundles: front and rear ligament of fibular head, ligamenta capits anteruius et fibulae posterius

The joints of the foot

Ankle, articulation talocruralis formed by the articular surfaces of the distal ends of the tibia and block talus. The shape of the joint is a hinge, movement is possible in it around the frontal axis flexion and extension. The joint capsule prikreplyaet at the edge of the articular surfaces of bones. Laterally, the capsule is reinforced by ligaments: the medial (deltoid), ligamentum mediale (without the front and rear talofibular,ligamenta talofibularis anterius et postreius , and calcaneal - fibular, ligamentum calceneofibulare.

Articulatonies intertaseae formed between adjacent bones of the Tarsus. These include:

Talus-calcaneal-navicular joint, articulation talocalceneonavicularis transverse tarsal joint, articulatio tarsi transversa calcaneal-cuboid joint,articulation calcaneocuboidea, and V of the navicular joint, articulatio cuneonavicularis.

Articulations tarsometatarseae , formed by the bones of the Tarsus and metatarsus. They are flat and include the following joint: between the medial cuneiform and 1st metatarsal bones, between the intermediate and lateral cuneiform bones and the II—III metatarsal bones, between the cuboid bone and the IV—V metatarsal bones. Joints reinforced strong plantar and dorsal ligaments.

Articulations metatar are located between the facing each other side surfaces of the four metatarsal bones, the shape of the mating surfaces, they are flat.

Metatarsophalangeal joints, formed by the heads of the metatarsal bones and the bases of 1st phalanges. The shape of the mating surfaces of these joints belong to the globular, but the mobility in them is limited.

Interphalangeal joints of the foot, articulaiones interphalangeae pedis, are located between the individual phalanges are ginglymoid form.

Movement in the joint occur around the frontal axis flexion and extension.

Differences in the structure and function of the joints of the lower limbs

The joints of the lower limbs differ in size and shape mating surfaces, and also on the strength of the ligaments.

The differences form the joint surfaces of the condyles of the tibia determine the typical characteristics of the meniscus, their shape and size. Essential for movements in the joints has the form of bones. Sometimes posterior process of the talus is highly developed and transformed into an independent bone that limits the mobility in the ankle joint. When the child begins to walk, he relies not on the whole foot, and on the outer edge. The shape of the foot may depend on the profession. People engaged in heavy physical labor, foot broad and short, the persons engaged in heavy labour, long and narrow. The foot has a vaulted structure, performs reference and spring functions.

Depending on the size of the joint synovial fluid ranges from 0.1 to 4 ml. At the present time, I believe that in addition to the synovia lubricating the articular surfaces, whereby friction is reduced almost to a minimum (the role of engine oil), is a nutritional medium for the articular cartilage, also performs the role of a "hydrodynamic wedge" impeding movement at the extreme phases. In addition, the synovia in the form of a thin film fills in the submicroscopic surface irregularities of articular cartilage, thereby contributing to l) slip with increasing speed of movement in the joint decreases the viscosity of synovitis reduced friction. another thing is that even in a static position for movement of multiple joints are typical backlash, oscillating in the range of 3 to 15°.

When driving from the pores of the cartilage covering the rubbing surface of the bone, is released

2. Muscles (stabilizing effect).

3. Congruence moistened by synovia articular surfaces, which to some extent contributes to their "sticking"

4. Negative pressure in the joint cavity.

Rentgenoanatomy bone joint

Rentgenoanatomy spine

On radiographs of the cervical spine in the lateral projection clearly visible all the cervical vertebrae. The rear arc of Atlanta is located under the occipital bone. Joint cracks visible in the form of oblique lines. Spinous processes of sharply defined, clearly visible gap between the vertebral bodies. Radiographs of the cervical vertebrae in the anteroposterior projection is done in two steps: 1) the 1-111 of the vertebrae and 2) the IV—VII vertebrae. The first picture shows the tooth of the axis vertebra, the second clearly visible vertebral bodies, transverse processes and intervertebral space.

When radiography of the thoracic vertebrae in the picture in the lateral projection defines all of the thoracic spines. Clearly visible intervertebral openings of the shadow from the edges, which allows to determine pathological changes in the ribs. On radiographs in anteroposterior projection reveals the vertebral bodies, the width of which exceeds their height. The shadow of the spinous processes of the sharply defined and projected onto the bodies of two vertebrae and the intervertebral disc.

In the picture of the lumbar spine in the lateral projection showing bodies, arc, spinous processes and intervertebral gap. Transverse processes are projected onto the body of the vertebrae. In the anteroposterior projection clearly visible square-shaped vertebral bodies. Spinous processes are superimposed on the vertebral bodies and intervertebral gaps.

On x-ray of the sacrum and coccyx in the anteroposterior projection visible V lumbar vertebrae, sacrum with coccyx, lumbosacral and sacroiliac joints.

Rentgeno-anatomy of chest.

On x-ray of the thorax in the anteroposterior projection of the visible dorsal segments of the ribs; the lateral parts thereof are projected on each other. Rib grasie not give shade. These images clearly defines the rib of the head and neck. to study the sternum get the pictures in eccentric posterior-anterior projection, resulting in the sternum is projected near the shadow of the spine. This radiograph clearly shows sternoclavicular joint, arm, body, and xiphoid process.

Rentgeno-anatomy of joints of the upper limb.

On radiographs of the clavicle in posterior-anterior projection visible to the acromioclavicular and sternoclavicular joints and the top edge. The joint space Sterno-clavicle joint is determined not complete, as it is superimposed shadows of the upper thoracic vertebrae. Accurate data on the joint can give layer-by-layer tomography in the anteroposterior projection. Acromioclavicular joint has a narrow slit. The x-rays of the shoulder joint in the anteroposterior projection clearly visible bone involved in its formation, the joint space of the acromioclavicular joint, and glenoid cavity of the scapula from its medial and lateral contours. Between head of humerus and glenoid cavity of the scapula is defined by the slit. The young men at the proximal end of the humerus are visible epiphyseal line.

When examining radiographs of the elbow joint in the anteroposterior projection visible humero-ulnar, brachioradialis joint cracks, literally and medialni epicondyles, the block and the head of the humerus. In the picture in the lateral projection throughout the visible crack humero-ulnar joint. Up to 15-17 years in the elbow joint visible cartilaginous epiphyseal line.

Equipments of the lesson: posters, models, slides

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Lecture № 6. Information about the muscles. Development of muscles. Auxiliary apparatus of muscles. Muscles and fascia of chest, abdomen and back. Diaphragm. The vagina of the rectus abdominis muscle, the white line, the inguinal canal.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. The total miologie 2. Muscle as an organ. 3. Distribution patterns of the muscles. 4. Classification of muscles. 5. The auxiliary apparatus of muscles. 6. The muscles and fascia of the back 7. The muscles and fascia of the chest 8. Diaphragma 9. Abdominal muscles 10. The vagina of the rectus abdominis muscle. 11. The white line of the abdomen. 12. The inguinal canal.
The purpose of the lesson: To acquaint students with the basics of the doctrine of the muscles. To reveal the basic concepts of myology. To acquaint students with the structural features of skeletal muscles, their development, classification, mechanism of muscle contraction and muscle biomechanics. To acquaint students with the structure of the muscles of the body, their classification, topography and practical value.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation,

	cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience
Monitoring and control	1.Studies miologie? 2.Structure of skeletal muscle. 3.The auxiliary apparatus of muscles. 4.Differences of skeletal muscles from smooth 5.The function of the muscles. 6.Classification of muscles. 7.Development of muscular system. 8.The structure and topography of the muscles of the chest. 9.The structure of the diaphragm. 10.The structure and topography of the abdominal muscles. 11.The inguinal canal. 12. The vagina of the rectus abdominis muscle. 13. The structure and topography of muscles of the back.

Technological map of the lecture lesson

Stages, time	Teacher	Students
Preparatory stage (5minutes) Stage 1 Introduction (15 minutes)	Verification of student progress 1.1. Introduces the topic of the lecture, its purpose and expected results.	Preparation of training tools. Listen, write
2 stage Main part (50 minutes)	2.1. In order to attract students' attention and check the level of their knowledge, question answer. -What types of muscles do you know? -Where is the diaphragm? 2.2. Using visual materials, continues the presentation of the lecture material 2.3.–Differences of skeletal muscles from smooth. -Muscle function. -Classification of muscles. -Development of muscular system. -The structure and topography of the muscles of the chest. -The structure of the diaphragm.	2.1. Listen. They think. Answer and listen to the right answers 2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights of the lecture 2.3. Remember, write, try to answer questions

	-The structure and topography of the abdominal muscles. -The inguinal canal. The vagina of the rectus abdominis muscle. -The structure and topography of muscles of the back. 2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	2.4.Write, give examples
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "muscle"	4. Write down the task

Theoretical part of the lecture:

The development of the muscles.

The muscles of the trunk develop from the dorsal mesoderm, which lies on the sides of the chord and the brain tube. The mesoderm is divided into primary segments, or myoblasts. After selecting sclerotome going to the education of the spinal column, the remaining part of dorsomedial Somit forms myotome, cells which (myoblast) stretched in the longitudinal direction merge into one another and turn into further in the symplast of muscle fibers. Part of myoblast differentiated in special cells - biosatellite lying next to the symplast. Myotomy grow in the ventral direction and are divided into dorsal and ventral parts. From the dorsal part of myotomal occurs spinal (dorsal) musculature of the trunk, and the ventral - muscles located on the front and sides of the torso and are called ventral.

In each myotome (miomer) after which grow the branches of the spinal nerve (newcomer). Accordingly, the division of myotome 2 parts of the nerve leave 2 branches, of which the dorsal (back) enters the dorsal part of myotome, and ventral (front) in ventral. All originating from the same myotome muscles are supplied by one and the same spinal nerve. Nearby myotomy can knit, but each of the fused myotome holds related nerve. Therefore, the muscles originating from several myotomal (e.g., rectus abdominis), are innervated by several nerves. Original myotome on each side are separated from each other transverse connective-tissue septa, myosepta.

Such a segmented arrangement of the muscles of the body in lower animals remains for life. Among the higher vertebrates and in humans through greater differentiation of muscle mass segmentation is smoothed considerably, although traces of it remain both in the dorsal (the short muscles between the vertebrae thrown over) and ventral muscles (intercostal muscles and rectus abdominis) muscles developed on the torso, stays in place, forming a local, autochthonous, muscles (autoa, autos - self, self-; chthon - earth, Motherland). Another part in the development process moves from the torso to the limbs. Such muscles are called truncatellidae (lat. truncus, the trunk, the torso; fugo - rout). Finally, the third part of the muscles originating on the extremities, moves to the torso. It troscopically muscle (lat. peto - seek). On the basis of innervation always possible to distinguish allochthonous (i.e. developing in a given place) has shifted from the muscles in this area to other muscles of the aliens.

Musculature of limbs is formed from the mesenchyme of the kidney and limb is innervated by anterior branches of spinal nerves through the brachial and lumbosacral plexuses. The lower fish of myotomal torso muscle grow buds that are divided into two layers, located on the dorsal and ventral sides of the skeleton of the fin. Similarly, in terrestrial vertebrates the muscles in relation to the rudiment of the skeleton of the limb is initially located dorsal and ventral (extensor and flexors).

Further differentiation of the rudiments of the muscles of the anterior limbs grow and in the proximal direction (Trincomalee muscle) and cover the autochthonous musculature of the torso from the chest and back (mm. pectorales major et minor, m. latissimus dorsi). In addition to this primary muscles of the front limbs to the upper limbs join truncatellidae muscle, i.e., derivatives of the ventral muscles used for movement and fixing belt and moved him from head (mm. trapezius and sternocleidomastoideus) and trunk (mm. rhomboideus major, levator scapulae, serratus anterior, subclavius, omohyoideus). The waistband hind legs secondary muscles do not develop, as it is fixedly connected with the spinal column. Complex differentiation of the limb muscles of terrestrial vertebrates, especially the higher forms, due to the function of the limbs, turned into complex levers that perform different kinds of movements.

The muscles of the head arise partly from the head of myoblasts, but mainly from the mesoderm of the branchial arches. Visceral apparatus in the lower fish consists of a solid muscular layer (common constrictor), which shares its innervation in some areas, coincident with the metameric arrangement of Gill arches: the Gill I (mandibular) arch corresponds to the V pair of cranial nerves (trigeminal nerve), II Gill (goodnoe) arc - VII pair (facial nerves), the Gill arch III-IX pair (glossopharyngeal nerve). The rest of the common constrictor is supplied by branches of the X pair (vagus nerve) Behind a common constrictor segregated bundle fixed to the belt of the upper limb (trapezius muscle). When the transition from water to land in lower vertebrates stopped Gill respiration adapted for life in water, muscles Gill apparatus (visceral) has spread to the skull, where it turned into chewing and facial muscles, but kept the connection with those parts of the skeleton that arose from Gill arches. Therefore, masticatory muscle arising from the zygomatic arches, and muscles of the floor of the mouth are arranged and attached on the lower jaw and are innervated by the trigeminal nerve (V pair) Of the muscles, appropriate II Gill arch is mainly subcutaneous musculature of the neck and head, innervated by the facial nerve (VII pair).

Muscle arising from two Gill arches, have a dual attachment and dual innervation, such as digastric muscle, anterior belly which is attached to the lower jaw (innervation from the trigeminal nerve), and back-to the hyoid bone (innervation from the facial nerve) Visceral muscles are innervated by the IX and X pairs of cranial nerves, in terrestrial vertebrates part is reduced, the portion for the formation of muscles of the pharynx and larynx. Trapezius muscle loses all connection to the Gill arches and becomes extremely muscle belt upper extremities. In mammals, from it split in separate parts sterno-cleoid-mastoid muscle. The posterior branch of the vagus nerve Innervate the trapezius muscle develops in higher vertebrates in a separate cranial nerve-plus, n. accessorius. Because of brain skull in all its parts is still education, then it can expect muscle development is impossible. So on my head there are only some remnants of muscles, formed from the head of myoblasts. Among them must be attributed the eye muscles, originating from the so-called predosing of myotomal (innervation from III, IV and VI pairs of cranial nerves).

Occipital myotome together with the front body usually formed by the ventral processes of the special page below or hyoid muscle, lying under the visceral skeleton. From the muscles, penetrating anteriorly to the mandible, occur in terrestrial vertebrates muscles of the tongue supplied because of their origin from occipital myoblasts complex of nerve fibres forming the hypoglossal nerve, which is only in higher vertebrates has become a true cranial nerve.

The rest of the hyoid muscles (below the hyoid bone) is a continuation of the ventral muscles of the body innervated by branches from the anterior spinal nerves. Thus, to understand the arrangement and fixing of the muscle should be considered, in addition to their functions, and also development.

Muscle as an organ.

Muscle, musculus, consists of bundles of striated (striated) muscle fibers. These fibers running parallel to each other, associated loose connective tissue (endomysium) bundles of the first order. Several of these primary beams are connected, in turn forming beams of the second order, etc. In General, the muscle bundles of all orders combined connective tissue sheath - perimysium, making the muscle belly. Connective tissue layer between the muscle bundles at the ends of the muscle of the abdomen, go to the tendon part of the muscle.

Muscle contraction is called the pulse coming from the Central nervous system, and each muscle is connected to nerves: afferent, who is the conductor of the "muscular sense" (movement analyzer according to I. P. Pavlov), and efferent, leading to her nervous excitement. In addition, to the muscle fit sympathetic nerves, through which the muscle in the living organism is always in a state of some contraction called tonus.

In muscle occurs very energetic metabolism, and therefore they are very richly supplied with vessels. Blood vessels penetrate the muscle with its inner side at one or more points called the gates of the muscles. In these gates, together with the vessels and nerves enter, together with which they branch out in the thickness of the muscle respectively muscle bundles (along and across).

In muscle distinguish between the actively cutting part of the - abdomen - and the passive part, through which it is attached to the bones, the tendon. The tendon consists of dense connective tissue and has a brilliant light Golden color, sharply different from the red-brown color of the abdomen muscles. In most cases, the tendon is at both ends of the muscle. When it is very short, it seems that the muscle starts from the bone or attached directly to her abdomen. The tendon in which the metabolism is less supplied with blood vessels poorer abdomen muscles. Thus, skeletal muscle consists not only of striated muscle tissue, but also from different types of connective tissue (perimysium, tendon), nerve (nerves of the muscle), endothelial and smooth muscle fibers (vessels). However, the predominant is transversely striped muscle tissue, which property (contractility) and determines the function of the muscle as body reduction. Each muscle is a separate organ, i.e. a holistic education, with its specific, characteristic shape, structure, function, development and position in the body.

Muscle work (elements of biomechanics).

A basic property of muscle where the muscle is contractility. When muscle contraction occurs, shortening it and bringing two points to which it is attached. From these two points of movable attachment point, the punctum mobile, is attracted to the stationary punctum fixum, resulting in the movement of this body part.

In this way, the muscle produces cravings with a known force and a moving load (e.g., bone), doing some mechanical work. Muscle power depends on the number of its constituent muscle fibers and on the square of the so-called physiological cross-section, i.e., area of the incision in that place, through which pass all of the muscle fibers. The magnitude of the reduction depends on the length of the muscle. Bones, moving the joints under the influence of muscles, form in a mechanical sense, the levers, i.e. as if simple machines for lifting heavy loads.

The farther the location the supports are attached muscle, the better, because due to the increased lever arm, better can be used is their strength. From this point of view, by P. F. Lesgaft, distinguished muscles strong, placed far from the fulcrum, and a clever, clip-on near her. Each muscle has a beginning, oggo, and attachment, insertio.

As support for the entire body is the spine located at midline of the body, insofar beginning muscles, usually coinciding with a fixed point is closer to the median plane, and on the extremities close to the trunk, proximal; attachment of muscles, coinciding with a moving point is further away from the middle, and on the limbs is farther away from the torso, the distal.

Punctum fixum and punctum mobile may be reversed in the case of strengthening the movable point and a fixed release. For example, when standing the movable point of the rectus abdominis muscle will be the top end (bending the upper body) while the vis of the body with the hands on the bar, the lower end (bending the lower part of the torso).

As the movement occurs in two opposite directions (flexion-extension, adduction-abduction, etc.) for movement around a single axis, you need two muscles, located on opposite sides. These muscles acting in mutually opposite directions, are called antagonists. Whenever the flexion is not only a flexor, but be sure and extensor, which gradually gives way to the flexor and keeps it from excessive reduction. Therefore, the antagonism of the muscles for a smooth and proportional movements. Every movement, therefore, is the result of the actions of the antagonists.

In contrast to the antagonist muscle, the resultant of which (i.e. the line connecting the center of the muscle with the center of the attachment it) is in the same direction, are called synergists. Depending on the nature of the movement and functional combinations of muscles involved in it, the same muscle can act as synergists, as antagonists.

In addition to the basic muscle functions, defined anatomical attitude of the axis of rotation of the joint, it is necessary to consider changes in the functional state of the muscles observed in vivo and associated with preservation of position of a body and its individual 1астей and ever-changing static and dynamic load on the machine movement. So the same muscle depending on the position of the body or part thereof, in which it operates as well as the phases of the corresponding motor act often changes its function. For example, the trapezius muscle in different ways involved their upper and lower parts when lifting the arm above a horizontal position. Thus, when movement of an arm, both named parts of the trapezius muscle is equally actively involved in this movement, and then (after rising above 120°) the activity of the lower part of the muscle ceases, and the upper one continues to the vertical position of the hands. When the bending of the arms, i.e. lifting it forward, the lower part of the trapezius muscle inactive, and after upper arm elevation above 120°, on the contrary, it revealed a significant activity.

Such a more deep and accurate data about the functional state of individual muscles of the living organism are obtained using the method of electromyography.

Distribution patterns of the muscles.

1. Accordingly, the structure of the body on the principle of bilateral symmetry of the muscles are paired or consist of two symmetrical halves (for example, m. trapezius).

2. In the torso, having a segmental structure, many muscles are segmental (intercostal, short muscles of the vertebrae) or retain traces of metamerism (the rectus abdominis). A broad abdominal muscles merged into solid beds of segmental intercostal due to the reduction of bone segments of the ribs.

3. As produced by muscle movement occurs in a straight line being the shortest distance between two points (punctum fixum and punctum mobile), then the muscles are placed along the shortest distance between these points. Therefore, knowing the point of attachment of a muscle, and that the movable point when the muscle contraction is attracted to stationary, you can always tell in advance which direction will be the movement produced by the muscle, and determine its function.

4. Muscles exchanging through a joint, have some relevance to the axes of rotation, and this is due to the function of muscles. Usually muscles their fibres or their resultant force is always in the crosshairs approximately at a right angle the axis in the joint, around which they make the move. If a uniaxial joint with front axle (ginglymoid joint) muscle lies vertically, i.e. perpendicular to the axis, and on the flexor side of her, it produces flexion, flexio (reducing the angle between the moving links). If a muscle lies vertically, but on the extensor side, it produces extension, extensio (increasing the angle up to 180° at full extension). When a joint in the other horizontal axis (sagittal) the resultant force of the two muscles-antagonists must be similar,

crossing over the sagittal axis on the sides of the joint (e.g., wrist joint). Thus, if the muscle or the resultant is perpendicular to the sagittal axis, and medial from it, they produce a cast to the middle line, adductio, and if lateral, it is the abstraction from it, abductio. Finally, if the joint has a vertical axis, the muscles crossing it perpendicularly or obliquely and produce rotation, rotation inwards (on the extremities - pronatio) and laterally (on the extremities-supinatio). Thus, knowing how many axes of rotation a in this joint, it is possible to tell, what will be the muscles in their function and how they will be placed around the joint. Knowledge of the location of the muscle, respectively, axes of rotation has a practical value. For example, if a muscle-flexor, lying ahead of the front axle, move back, she will act as the extensor, which is used during surgeries to transplant tendons to recover the function of the paralyzed muscles.

Classification of muscles.

Numerous muscles (they number up to 400) are classified in different ways. The shape distinguish muscles long, short and wide. Long muscles correspond with the long levers of the movement, and therefore are found mainly on the limbs. They have a spindle shape where the middle part is called the abdomen, venter, one of the ends, corresponding to the beginning muscle is called the head, with a put, and the other the tail, cauda. Tendons, tendo, long muscles have the form of narrow ribbons.

Some long muscles starts with several heads (many-headed) on different bones, which strengthens their support. There are two-headed muscle, biceps, triceps, triceps, and quadriceps, quadriceps. In the case of a merger of the muscles of different origin or have developed from several myotomal between them remain an intermediate tendon, tendon jumpers, intersectiones sectiones. Such muscles (mnogoobraznye) are two of the abdomen (e.g., m. digastricus) or more (for example, m. rectus abdominis). Varies also the number of their tendons, which end of the muscle. Thus, the flexors and extensors of the fingers and feet have several joints (up to 4), whereby the contraction of one muscle of the abdomen give physical effect to several fingers, thus achieving a saving in the working muscles.

Wide muscles are located mainly on the trunk and have an expanded tendon, called the tendon stretching, or fascia aponeurosis.

There are also other forms of muscles: square (m. quadratus), triangular (m. triangularis), pyramidal (m. pyramidalis), round (m. teres), deltoid (m. deltoideus), gear (m. serratus), soleus (m. soleus), etc.

At the direction of the fibers, due to the functionally different muscles with straight parallel fibers (m. rectus) oblique fibers (m. obliquus), cross (m. transversus), circular (m. orbicularis). The last form army, or sphincters surrounding the hole. If the oblique fibers join the tendon on the one hand, it turns out the so-called ownoperate muscle, but if on both sides - duperest. The special relation of the fibres to the tendon is observed in polyoxazolines (m. semitendinosus) and preperitoneal (m. semimembranosus) muscles.

Function muscles are divided into flexors (flexores) extensors (extensores), resulting (adductores), the outlet (abductores), rotators (rotatores) inwards (pronatores) and laterally (supinatores).

In relation to the joints through which (one, two or a few) spread the muscles, they are called one-, two - or mnogocwetnye. Mnogocwetnye muscle how longer are superficial odnosemjannyj.

On the status there are superficial and deep, outer and inner, lateral and medial muscles.

The auxiliary apparatus of muscles.

In addition to the major muscles of her body and the tendons, there are accessories or otherwise facilitating the work of muscles. Muscle group (or the entire musculature of the known parts of the body) surrounded by shells composed of fibrous connective tissue called fascia (fascia bandage, bandage). Structural and functional features are the fascia of the superficial, deep and organ. Superficial (subcutaneous) fascia, fasciae superficiales s. subcutaneae, lie beneath the skin and represent a seal subcutaneous tissue surround the entire musculature of this region, associated morphologically and functionally with subcutaneous fat and skin, and together with them provide elastic support for the body.

Deep fascia, fasciae profundae, cover a group of synergist muscles (i.e., performing a homogenous function) or each separate muscle (fascia, fascia propria). If the damage is your own fascia muscles last in this place stuck out, forming a muscle hernia.

Fascia, separating one muscle group from another, give into the processes, intermuscular septum, septa intermuscularia infiltrating between adjacent muscle groups and are attached to the bones.

Covering the structure of the fascia. Superficial fascia forms a kind of pouch for the body as a whole. Own fascia are cases of individual muscles and organs. Casing structure of a fascial container characteristic of fascia all parts of the body (torso, head and limbs), and abdominal, thoracic and pelvic cavities; in particular, it has been studied in relation to limb N.And. Pirogov.

Each division of the limb has multiple boxes, or fascial sacs located around a single bone (shoulder and thigh) or two (forearm and calf). For example, in the proximal forearm can be distinguished 7-8 fascial sheaths, and distal -14.

Distinguish the basic case, formed by the fascia that goes around the entire limb, and cases of second order that contain muscles, vessels and nerves. Theory N. I. Pirogov about covering the structure of fasciae of the limbs is important for understanding the spread of purulent streaks, of blood in hemorrhage, and also for local (casing) anesthesia.

Surrounding muscles and separating them from each other, fascia contribute to their isolated reduction. Thus, fascia and separate, and connect muscle.

Deep fascia forming the coverings of bodies, in particular the own fascia of the muscles attached to the skeleton intermuscular fascial septa or nodes. With these fascias are constructed vagina neurovascular bundles. These education, as if continuing a skeleton, serve as a support for organs, muscles, vessels, nerves, and are intermediate between the fiber and aponeurosis, so we can consider them as soft skeleton of the human body.

In the area of certain joints of the limbs, the fascia thickens, forming the retinaculum of the tendons, retinaculum, consisting of dense fibres, thrown over here passing through the tendon. Under these fascial ligaments are formed of fibrous and bony-fibrous canals, vaginae fibrosae tendinum, through which tendons pass. As ligament, and beneath the fibrous the vagina to hold the tendons in their situation, not allowing them to move away from the bones, and in addition, eliminating the lateral displacement of the tendons, they contribute to a more accurate direction of muscle traction. Slide tendons fibrous sheaths is facilitated by the fact that the walls of the last is lined by a thin synovial membrane, which in the region of the ends of the channel is wrapped to the tendon, forming around it a closed synovial vagina of tendon, vagina synovialis tendinis. Part of the synovial sheath surrounds the tendon and fused with it, forming a visceral piece of paper, and the other part lines the inside of fibrous vagina and fused with its wall, forming a parietal, parietal, leaf. On the transition of visceral leaf of the parietal near the tendon produces a doubling of the synovial membrane, called the mesentery tendons, mesotendineum. In thickness it are nerves and blood vessels of the tendon, so damage mesotendineum and located in the nerves and vessels entails necrosis of the tendon. Mesentery tendon is strengthened with thin cords-vincula tendinis. In the synovial cavity of the vagina, between the visceral and parietal sheets of the synovial membrane, is a few drops of fluid similar to synovia, which serves as a lubricant to facilitate the gliding of the tendon when it moves to the vagina.

Equally important is the synovial Bursa, bursae synoviales, located in different places under the muscle and tendons, primarily near their attachment. Some of them, as mentioned in astrologie, are connected with the articular cavity. In those places where the direction of muscle tendon change, is usually formed the so-called block, trochlea, through which the tendon spreads like a belt over the pulley. Distinguish between bone blocks when the tendon spreads through the bone, and the bone surface in this location is lined with cartilage and between bone and tendon is synovium, and the fibrous blocks formed by fascial ligaments.

To the auxiliary apparatus of the muscles are also sesamoid bones, ossa sesamoidea. They are formed in the thickness of tendons in the places of their attachment to the bone where you want to increase shoulder muscle strength and to increase the moment of rotation.

The influence of environmental factors on the muscles.

In muscles vigorously, the processes of metabolism, the intensity of which is increased when increasing the intensity of muscle work. The blood flow to the muscle increases. Enhanced function of the muscles leads to improved nutrition and increased muscle mass (called hypertrophy of working muscle).

Physical exercise associated with different types of work and sports, cause the working hypertrophy of the muscles that are the most loaded.

The employee-professional determines a long stay of the body in any one position (e.g. bent when working at the bench) or permanent change of position of a body (e.g., flexion and extension of the body at the carpenters). Therefore, specialization induces intense activity is not all muscles, but only certain departments, which is why professional work is the reason for the strong development of certain parts of the body and a backlog of other.

Similarly, some special types of sports are developing only certain muscle groups. Hence, occupational health and sports requires universal gymnastics, which contributes to the harmonious development of the human body.

The correct physical exercises cause the proportional development of the muscles of the whole body. Since the strengthened muscles affects the metabolism of the whole organism, so far as physical culture is one of the most powerful factors a beneficial effect on its development. While the motor activity of skeletal muscle translates to more efficient and economical mode of self-service. In extreme conditions, which include sports, the skeletal muscles become supporting factor of blood circulation, because when they are working hypertrophy expands the lumen of the intramuscular blood vessels, is the working hyperemia of the muscles.

Lately (Arinchin N. And. 1988) discovered a new, pump, the ability of the skeletal muscles, the fibers of which the reduction is being driven blood intraorganic blood stream, helping your heart in the implementation of the circulation. Thus, skeletal muscle is a natural physiological vibrator and an independent pump in the circulatory system, how would the "peripheral heart"

The muscles of the back

The back muscles are numerous. A major part of their autochthonous forms the muscles arising from the dorsal divisions of myotomal body, which is layered muscles, move to the back of the head (visceral) and upper limb (Trincomalee), so that they are arranged in two layers - superficial and deep.

A. Superficial muscles.

1. Muscles are attached on the belt of upper limb and shoulder:

a) trapezius muscle, Gill origin, moved to the torso from the head and therefore is innervated by cranial nerve XI, n. accessorius;

b) latissimus dorsi - troscopically moved to the trunk with the upper limb is innervated by and because of the brachial plexus;

in) m. levator scapulae and m. rhomboideus, truncatellidae: moved from the torso to the belt of the upper limb are innervated by short branches of the brachial plexus.

2. The muscles attached to the ribs: mm. posteriores serratus superior et inferior; both muscles are derivatives of the ventral muscles of the body, protruding posteriorly. Their innervation comes from the anterior branches of the spinal nerves nn. intercostales.

B. Deep muscles. In the process of phylogenesis, the muscles serving for the axial skeleton, there are like a skeleton, first, therefore, in human ontogenesis they appear early and are deeper, keeping primitive metameric structure. In their origin they are divided as follows:

1) autochthonous muscles arising from the dorsal divisions of mitomo, so the rear innervated by branches of spinal nerves;

2) deep muscles of ventral origin, therefore, innervated by the front branches of the spinal nerves.

Superficial back muscles

I. Muscles attached to the belt of upper limb and shoulder, are arranged in two layers, of which the surface consists of two broad muscles: trapezius and latissimus dorsi.

1. The trapezius muscle, m. trapezius. It occupies the upper back up to nape and has a triangular shape. Both trapezius muscles taken together form a shape of a trapezoid, from which comes the name of the muscle. The muscle starts from the spinous processes of all thoracic vertebrae, lig. nuchae and from the lineae nuchae superior occipital bone. The upper muscle fibers down and attached to the acromial end of the clavicle, the middle going horizontally to the acromion, and the lower upwards and laterally to the spina scapulae.

Function. The upper fibers of the muscles lift up the belt of the upper limb, the scapula is rotated to its lower angle in the lateral direction, as happens, for example, when lifting the arm above horizontal. The lower fibers lower scapula downward. While reducing all of the fibers the muscle pulls the upper limb backwards to the middle, with both blades moving closer to each other, if this action occurs on both sides.

2. Latissimus dorsi, m. latissimus dorsi covers the whole lower back, approaching its upper portion to the lower end of the trapezius muscle. It originates from the spinous processes of the last four (and sometimes five or six) thoracic, all lumbar and sacral vertebrae and from the posterior part of the iliac crest and, finally, four teeth from four lower ribs. These teeth alternate with the rear teeth of the external oblique abdominal muscles. From its inception the fibers of the latissimus dorsi muscle going upwards and laterally in converging direction and are attached to the crista tuberculi minoris of the humerus. In the initial part, in the lumbar region of the latissimus dorsi on both sides, form a broad aponeurosis, joined with the fascia thoracolumbalis.

Function. Unbend and proniruet shoulder, the hand leads. Acting through the humerus, the muscle moves in the same direction and the belt of the upper limb. Owing to its attachment to the ribs of muscle with fixed arms can expand the rib cage, contributing to the breath and tighten the body to the hands, for example when climbing the rope. Pulling the torso, the monkeys throw the body from branch to branch (movement with hands-brachiaria), what explains the strong development of the broadest muscle of a monkey and a significant saving it (as an echo of phylogeny) in humans.

3. Rhomboid muscle, m. rhomboideus, lies under m. trapezius, having the form of rhombic plates. Starts from the spinous processes of two lower cervical and four upper thoracic vertebrae and attaches to the medial edge of the scapula downward from the spina scapulae.

Function. While reducing rhomboid muscle that draws the scapula towards the spine and upwards. Being an antagonist of m. serratus anterior, she, along with her locks the medial edge of the scapula to the rib cage.

4. Muscle, levator scapulae, m. levator scapulae. Starts from the transverse processes of four upper cervical vertebrae, goes down and laterally and is attached to the upper corner of the scapula.

The function is visible from the title.

II. Muscles., attached to the ribs, occur in the third layer of superficial muscles of the back in the form of two thin plates.

1. Rear upper serrated muscle, m. serratus posterior superior lies beneath the diamond-shaped muscle that begins from the spinous processes of two lower cervical and two upper thoracic vertebrae, directed downward and laterally and ends in a II-V ribs.

Function. Elevates ribs.

2. Rear lower serrated muscle, m. serratus posterior inferior, going from the spinous processes of the lower thoracic and upper lumbar vertebrae in the opposite direction to the IX-XII ribs.

Function. Lowers the lower ribs.

Deep back muscles (autochthonous back muscles).

Autochthonous back muscles form the lateral and medial longitudinal muscle tracts, two on each side, which lie in the grooves between the spinous and transverse processes and the angles of the ribs. Deep in its parts closest to the skeleton, they consist of short muscles, located in the segments between the vertebrae (medial tract); more superficially lie the long muscles (lateral tract). In the posterior cervical region, in addition, on top of both paths lies m. splenius.

All these muscles have the same origin of dorsal musculature, consisting of amphibians from a number of momirov, but beginning with the reptiles, only a part of the dorsal muscles keeps the metameric structure, connecting individual vertebrae (muscles medial-tion tract); part of the same interconnected for the formation of long muscle (lateral tract).

Belt muscle of the head and neck, m. splenius capitis et cervicis, starts from the spinous processes of the five lower cervical and upper six thoracic vertebrae: m. splenius capitis, is attached to the linea niichae and superior to the mastoid process, a m. splenius cervicis - transverse processes of II - III cervical vertebrae.

Function. With the reduction of one muscle rotates the head in the direction of contraction, and at the bilateral muscle contraction rejects the head back and straightening the cervical spine.

The lateral tract. Its characteristic is the attachment of the muscle to the transverse processes of the vertebrae and the ribs or their rudiments.

1. Muscle, straightening the spine, m. erector spinae (lat. spina, the spine), starts from the sacrum, spinous processes of the lumbar vertebrae, the crista illiaca and the fascia thoracolumbalis. Hence the muscle is pulled to the back and is divided into 3 parts corresponding to the attachment:

a) to the ribs - iliac rib muscle, m. iliocostalis (lateral part of m. erector spinae);

b) to the transverse processes longissimus, m. longissimus (middle part m. erector spinae) and processus mastoideus (headquarters);

b) to the spinous processes - spinous muscle, m. spinaIis (medial part of m. erector spinae).

To the lateral tract also includes the individual beams laid between the transverse processes of two adjacent vertebrae: they are expressed in the most moving sections of the spinal cord - in the neck (mm. inter-transversarii posteriores cervicis) and lumbar (mm. mediates lumborum intertransversarii).

The medial tract. The muscles that lie under the lateral tract and consist of separate beams traveling obliquely from the transverse processes of the underlying vertebrae to the spinous processes of the overlying, why get the common name m. transversospinalis. Than the superficial muscles, the steeper and longer the course of their fibres and the using a greater number of vertebrae they are moved. Accordingly, there are: surface layer, Polysticta muscle, m. semispina1is, its beams spread over 5-6 vertebrae; the middle layer, partitioned muscle, mm. multifidi, their beams burn through 3-4 vertebrae, and deep layer, rotators, mm. rotato res, they go through a single vertebra or to its neighbors.

The medial tract are also muscle bundles, located between the spinous processes of adjacent vertebrae - interspinal muscles, m. interspinales, which are expressed only in the most mobile sections of the spinal cord in the cervical and lumbar.

In the most moving place the spine in its joint with the occipital bone m. transversospinalis reaches a particular development; it is composed of four paired muscles, the two oblique and two straight lines, which are located under the m. and semispinalis m. longissimus.

Oblique muscles are divided into upper and lower. Top, m. obliquus capitis superior runs from the transverse process of Atlanta to the linea nuchae inferior. Bottom, m. obliquus capitis inferior, going from the spinous process II cervical vertebra to the transverse process of the I cervical. Direct muscles are divided into large and small. Big m. posterior rectus capitis major goes from the spinous process II cervical vertebrae to the linea nuchae inferior. Mala, m. rectus capitis posterior minor, is a line from the tuberculum posterius I cervical vertebra. When unilateral reduction they participate in the respective turns of the head, and in two-way - pull it back.

Deep back muscles (ventral origin).

1. Muscles, lifting the edges, mm. levatores costarum, the same muscle bundles of external intercostal muscles shifted toward the vertebral column. They exist only in the thoracic region and are under the m. erector spinae. Despite its name the action of these muscles podnimateli as the rib is unlikely that significant; they are mainly involved in the inclination of the vertebral column in the lateral direction. Innervation by nn. intercostales.

2. The remains of the intercostal muscles to form muscle bundles, located between the rudiments of the ribs (anterior tubercles) cervical vertebrae (mm. anteridres intertransversarii cervicis) and between the transverse processes of the lumbar (mm. intertransversarii laterales lumborum).

The fascia of the back

The outer surface of the m. trapezius and m. latissimus dorsi is covered by a thin superficial fascia, which is in the back of your neck seems to be more thickened (occipital fascia, fascia nuchae). In addition to the fascia, on the back there is another fascia, which lies deeper and separating the autochthonous muscles of the back from the surface of the underlying muscles (deep or your own, the fascia behind). It's called the fascia thoracolumbalis. There are two pieces: surface (rear) and deep (anterior). Surface sheet, extends from pelvis to head: medially it merges with the spinous process, and laterally moves to the edges. Deep fasciae thoracolumbalis piece starts from the transverse processes of the lumbar vertebrae and is only for between the XII rib and the iliac crest, where it is attached at the top and bottom. Heading in the lateral direction, the deep fasciae thoracolumbalis leaf covers the anterior surface of m. erector spinae and at the lateral edge of the latter merges with the surface sheet. Thus, the deep autochthonous muscles in the lower back are laid in a closed osteo-fibrous sheath, and the initial part of m. erector spinae - fibrous.

The muscles and fascia of the ventral side of the body

The ventral musculature in the lower vertebrates runs continuously on the ventral side of the body. In higher vertebrates it differentialsa on 4 regions: cervical, thoracic, abdominal and caudal.

The person of these four departments in connection with bipedalism develops particularly the abdominal muscles; in the tail section, it is reduced in connection with a reduction of the tail.

Autochthonous muscles of the body, developed from ventral outgrowths of mitomo, despite the various differentiation of selected areas, in General arranged in the same way. With the full development of the ventral muscles in it first of all possible to distinguish between lateral (lateral muscles) normally consists of three layers, and then the front (rectus muscles), located longitudinally from the pelvis to the head on the sides of the median connective tissue septum (white line).

In humans, this type is most pronounced in the belly area where there is a well-developed lateral wide (mm. obliqui et transversus abdominis) and the front straight muscle (m. rectus abdominis); in the thoracic front [straight) muscles do not exist due to the development of the sternum, whereas on the neck, they are available again (the muscles that attach to the hyoid bone).

The lateral musculature of the abdomen does not have segmentation, but in the ore region, were kept in the primary metamerism in explicit rime due to the presence of ribs located along the myosepta of myotomal (mm. intercostales). On the lateral neck muscles was transformed into three scalene muscle (mm. scaleni). As indicated earlier, the direct muscle retains traces of metamerism (tendon jumpers). (besides, some parts of the ventral musculature is displaced posteriorly on the middle surface of the vertebral column (predposlednii muscles) or the side (m. quadratus lumborum), or even go on the Dorsal surface of the spinal column, entering in the composition of the dorsal muscle, where they have already been discussed.

Predposlednii muscles are developed at the upper end of the body (on the neck), such as the muscle at the lower end the person went to education muscle of the pelvic floor (m. levator ani and m. coccygeus,). Part of the ventral musculature is a peculiar muscle, which exists only in mammals. This diaphragm-derived neck muscles, went down to the lower end of the ore cells, on the border of the abdominal cavity.

Finally, on top of the autochthonous ventral musculature in some places muscle-aliens - derivatives of Gill arches and part of the muscles of the limbs.

The muscles of the chest

Chest muscles are divided into the muscles that begin on the surface of the chest, and reaching from it to the belt of the upper limb and to a free upper extremity, and on their own (autochthonous) muscles of the chest, included in the walls of the chest cavity.

In addition, we will describe here the aperture diaphragm a, which limits the thoracic cavity from the bottom and separates it from the abdominal cavity. The diaphragm is developed in the neck, so its innervation mainly originates from the cervical plexus.

The muscles of the chest, related to the upper limbs.

1. The pectoralis major muscle, m.pectoralis major, starts from the medial half of the clavicle (pars clavicularis), from the anterior surface of the sternum and cartilage II-VII ber (pars stemocostalis), and finally from the front wall of the vagina straight uszy of the abdomen (pars abdominalis). Attaches to crista tuberculi majdris of the humerus. The lateral edge of the muscle adjacent to the edge of the deltoid muscle of the shoulder, delays from it a groove, sulcus deltoideopectoralis that expansion is up under the collarbone, causing a small here the subclavian fossa. Function. Leads the arm to the body, turns it inside (proniruet), uchicha part flexes the arm. While fixed upper extremities can raise ribs to the sternum and thereby contribute to breath, involved pulling the torso when climbing

2. Pectoralis minor, m. the pectoralis minor lies under the pectoralis major. It begins with four teeth from II to V rib and attaches to the processus coracoideus of the scapula.

Function. Delays in the reduction of the shoulder blade forward and down. With fixed arms acts as a muscle of inhalation.

3. Subclavian muscle, m. subclavius, extends between the clavicle and I edge. Function. Grudinoklyuchichno reinforces the joint, pulling the clavicle down and medially.

4. The serratus anterior muscle, m. serratus anterior lies on the surface of the chest in the side chest. The muscle usually begins nine teeth from the upper nine ribs and attaches to the medial edge of the scapula. Function. Together with the rhomboid muscle, also attaches to the medial edge of the scapula, forms a broad muscular loop, which covers the torso and presses to his shoulder. While reducing the whole simultaneously with the dorsal muscles (trapezius and

rhomboid) m. serratus anterior sets motionless blade, pulling it anteriorly. The lower part of the muscle turns the lower angle of the scapula anteriorly and laterally, as it happens when lifting the arm above the horizontal level. Upper teeth move the scapula together with the clavicle anteriorly, being antagonists of secondary fibers m. trapezius, at a fixed zone of raised ribs, contributing to breath.

Of the four muscles described the first two troscopically, the second - truncatellidae.

Autochthonous muscles of the chest.

1. External intercostal muscles, mm. intercostales externi, perform intercostal spaces from the vertebral column to the costal cartilages. Start from the bottom edge of each rib, and run obliquely downwards and back to front and are attached to the upper edge of the underlying rib. Between the cartilages of the ribs, muscles replaced by fibrous plate with the same fiber direction, membrana intercostalis externa.

2. The internal intercostal muscles, mm. intercostales interni, lying under the outer and have a relatively with the latest reverse the direction of fibres, intersecting them at an angle. Starting at the upper edge of the underlying ribs, they go upward and forward and attach to the overlying edge. In contrast, external internal intercostals reach the sternum, passing between the costal cartilages. Posteriorly mm. intercostales interni reach the angle of the ribs. Instead, between the rear ends of the ribs is membrana intercostalis interna.

3. Subcostal muscles, mm. subcostales, lie on the inner surface of the lower part of the thorax in the region of the corners of the ribs have the same fiber direction as the internal intercostal muscles, but spread over one or two ribs.

4. Transverse muscle of the chest, m. transversus thoracis, also located on the inner surface of the thorax in its anterior region, forming a continuation of the transverse abdominal muscles.

Function. Mm. intercostales externi raise the ribs and expand the chest in anteroposterior and transverse directions and are consequently muscles inhalation active during normal quiet breathing. The strong breath and take part the other muscles can raise the ribs upward (mm. scaleni, m. sternocleidomastoideus, mm. pectorales major et minor, m. serratas anterior, etc.) provided to the movable points of their attachments in other places, were fixed motionless, as, for example, instinctively make patients, suffering from shortness of breath. He's got a flail chest during expiration occurs mainly because of the elasticity of the lungs and chest.

According to some authors, relaxed exhalation also participate mm. intercostales interni. With increased exhalation participate more mm. subcostales, m. transversus thoracis and other muscles, lower ribs (stomach muscles).

Fascia of the breast

The front surface of the m. the pectoralis major is covered by the superficial leaf of the fascia of the breast, pectoralis fascia, which passes medial to the periosteum of the sternum, at the top - in the periosteum of the clavicle and lateral - fascia deltoidea. Under m. the pectoralis major is more pronounced deep fasciae leaf pectoralis, which is in the region of the trigonum clavipectorale (between clavicle and pectoralis minor muscle) has called fascia clavi-pectoralis. During the process of splitting and re-connecting, deep leaf fasciae surrounds the pectoralis m. and subclavius m. pectoralis minor. The superficial and deep fasciae of the pectoralis sheets are joined together in two places: 1) in the sulcus deltoideopectoralis and 2) at the lower edge m. pectoralis major, pectoralis fascia where it passes into the fascia axillaris. The last is the bottom of the fossa axillaris, axillary fossa, along the circumference which extends to the adjacent muscles, and in the middle greatly deepened along with covering her skin, making turns visible on the outside of the axillary fossa. In addition to the fascia on the surface of the chest, inner side of the latter is lined with the intrathoracic fascia, fascia endothoracica, which also switches on the diaphragm in the form of a very thin layer of fiber.

Aperture

Aperture, diaphragma, is a flat thin muscle, m. phrenicus, a dome-shaped curved, covered with top and bottom fascia and serous membrane. Her muscle fibers, beginning at the circumference of the lower aperture of the thorax converge in a tendon stretching, which occupies the middle of the diaphragm centrum tendineum. At the place of origin of the fibers in the muscle Department diaphragm distinguish lumbar, costal and sternal parts.

The lumbar part, pars lumbalis consists of two parts - the legs - right and left crus dextrum et sinistrum. Both feet leave the diaphragm between itself and the spinal column triangular gap, the hiatus aorticus, through which pass the aorta, lying behind her duictus thoracicus. The edge of this hole is bordered by a strip of tendon, thus reducing the aperture of the skylight of the Yurt is not changed. Lifting up the legs of the diaphragm converge in front of the aortic orifice and then a few left and up from it again apart, forming a hole, hiatus esophageus, through which pass the oesophagus and both accompanying nn. vagi. This hole is bordered by muscle bundles, which play the role of a pulp, regulating the promotion of food. Between the muscle bundles of each of the legs of the diaphragm are formed slots through which pass nn. splanchnici, v. azygos (left - v. hemiazygos) and sympathetic trunk.

Rib portion, pars costalis, starting from cartilage VII-XII ribs, which ascend in the direction of the tendon center.

Sternal part, pars sternalis, departs from the back surface of the xiphoid process of the sternum to a tendon center. Between the pars sternalis and pars costalis of the sternum in close proximity to a steam room a triangular slit, trigonum ternocostale, through which penetrates the lower end of a. thoracica interna a. epigastrica superior.

The other paired slit larger sizes lumbocostale trigonum, located between the pars costalis and pars lumbalis. This gap, corresponding cestoidea in fetal life, the communication between the thoracic and abdominal cavities, covered by the pleura and fascia endothoracica, a bottom-subperitonealis fascia, retroperitoneal cellular tissue and peritoneum. Through it can pass the so-called diaphragmatic hernia.

A few backwards and to the right of the middle line of the tendon in the center is a square hole, foramen venae cavae inferior, through which passes the inferior Vena cava. As mentioned, the diaphragm has a dome shape, but the height of the dome is uneven on both sides: the right part propped up by the bottom of a voluminous liver, is higher than the left.

Function. Aperture is reduced on inhalation, the dome flattens her, and she falls. Due to the omission of the diaphragm increases the chest cavity in a vertical direction that takes place when you inhale.

Abdominal muscles

The abdominal muscles occupy the space between the lower aperture of the thorax and the upper edge of the pelvis. They surround the abdominal cavity, forming its walls. Distinguish between side, front and back muscles. Abdominal muscles belong exclusively to autochthonous ventral musculature of this region and are innervated by intercostal nerves (V-XII) and the upper branches of the lumbar plexus.

The side abdominal muscles

The side abdominal muscles are three broad muscular layer, lying on each other, stretching the tendon which, forming the vagina for m. rectus abdominis, incorporate front of the abdomen on the so-called white line, the linea alba.

1. External oblique abdominis, m. obliquus externus abdominis, the most superficial of the three broad muscles of the abdomen. It begins on the lateral surface of the thorax from the lower eight ribs by eight teeth, and the fibres go downwards and medially. This broad area is the origin of the muscle and nevertheless lower in comparison with the four-legged arrangement due to the strengthening of the muscles of the upper limb that anthropomorphic monkeys serves as a means for throwing the body from tree to tree (brachiaria), and the human body work. The need for a large support for the muscles of the upper limb causes expansion and lengthening of the

chest and pushed off down affixed to her abdominal muscles, oblique and direct. Fibers of the external oblique muscle is like a continuation of the external intercostal muscles and going in the same direction obliquely downward and backward. This is because in the process of phylogenesis as the disappearance of the ribs the intercostal muscles are fused with each other and form a continuous muscle layers. Rear beams are attached to the iliac crest. The rest of the muscle fibers pass into a broad aponeurosis, which passes in front of m. rectus abdominis and the midline of the abdomen criss-cross with the aponeurosis of the other party. Its fibres take part in the formation of longitudinal strand - the white line of the abdomen.

The lower free edge of the aponeurosis of the external oblique muscle and burn between spina iliaca anterior superior and tuberculum pubicum, tucking into a gutter. This region is allocated conditionally is called the inguinal ligament, lig. inguinale. In primates, inguinal ligament supports the lower abdominal wall and the inguinal canal, and is also important for erection. In humans it stands out only as the bottom wall of the inguinal canal.

The place of the medial attachment of the inguinal ligament its fibrous fiber wrapped bottom, to the crest of the pubic bone, forming a so-called lacunar ligament, lig. lacunare. Over the medial division of the inguinal ligament to the aponeurosis of the external oblique muscle is a triangular slit - superficial inguinal ring, the annulus inguinalis superficialis. Behind the rear edge of the fleshy part m. obliquus abdominis externus, between it and the beginning of m. latissimi dorsi, forms a small triangular interval, trigonum lumbale, limited from below the iliac crest. The bottom of the triangle is the internal oblique muscle of the abdomen. The outer surface of the m. obliquus externus abdominis is covered by a thin fascial sheet, which continues in the aponeurosis of the muscle, closely with him when healing. On top of this piece in hypogastrium meets another fascia superficialis related to the deep layer of the subcutaneous tissue: it grows down to the inguinal ligament.

Function. External oblique abdominal muscle in unilateral contraction rotates the torso in the opposite direction. In bilateral contraction lowers the ribs, flexes the spine.

2. Internal oblique abdominis, m. intcrnus obliquus abdominis lies beneath the previous muscle. It originates from the rear fasciae thoracolumbalis, then from the iliac crest and from the lateral two thirds of inguinal ligament. The direction of the muscle fibers in General upward, fan-shaped. Rear muscle bundles, ascending upwards, are attached to the lower edge of the XII, XI and X of ribs. Extension between the ribs serve mm. intercostales interni. Front muscle bundles pass into a broad aponeurosis, which is on the lateral edge of m. rectus is split into two pieces, taking part in the education of the vagina called the muscles. Medial to the m. rectus, no linea alba, the aponeurosis is connected with the same fascia of the opposite side. M. obliquus internus abdominis from its outer and inner surfaces covered with a fascial plates. Function. Internal oblique abdominal muscle with a unilateral reduction together with the external oblique abdominal muscle of the opposite side rotate torso to his side. When bilateral reduction of the internal oblique muscles Flex the spine.

3. Transverse abdominis, m. the transversus abdominis, is the most profound and subtle of all the broad abdominal muscles. It starts from the inner surface of lower six ribs. Above the diaphragm a continuation of it is m. tranversus thoracis. Further inferiorly and posteriorly the muscle originates from the deep fasciae thoracolumbalis piece and finally at the very bottom - to the iliac crest and lateral two thirds of inguinal ligament. From its inception the muscle fibers are transversely anteriorly and medially and pass into a broad aponeurosis, which is sent to the linea alba, its upper part behind, and in the lower m ahead. rectus abdominis, and is connected with the aponeurosis of the opposite side. In many mammals this muscle is more developed, and may involve the testicle into the abdominal cavity from the scrotum. Of the internal oblique and transverse muscles towards the egg moves only a small muscle bundle is a vestigial muscle lifting egg, m. cremaster. On its internal surface, facing into the abdominal cavity, the transverse abdominal muscle is covered by fascia transversal! s, which is a plot of the total podbryushinnye

fascia, fascia subperitonealis. The last lines the entire inner surface of the abdominal wall and sometimes is a separate title accordingly the layout area: transversalis fascia, fascia iliaca, fascia pelvis etc Function. The transverse abdominal muscle in bilateral reduction reduces the volume of the abdominal cavity. Is the main part of the abdomen.

Front muscles. belly

Rectus abdominis, m. rectus abdominis lies on both sides of the side of the middle line and consists of longitudinal muscle bundles running in the vertical direction. It starts from the front surface of V, VI and VII costal cartilages and xiphoid process of the sternum, then gradually narrowing, is directed downward and is attached by a strong tendon to the pubic bone in the space between the symphysis and the tuberculum pubicum. Start low rectus muscle in comparison to animals, as already mentioned, due to the expansion from the anthropomorphic apes and man chest, which became a support for the developed muscles of the upper limb in connection with brachiaria (in monkeys) and labor (people). The path of the muscle is interrupted running transversely (three or four) tendon jumpers, intersectiones sectiones. Jumper fused with the anterior wall of the vagina, which is m. rectus. Intersectiones sectiones represent traces of the former segmental development of the ventral muscles. They have functional significance: separating the muscle segments, they allow each of them to contract on their own. Function. With the reduction of the rectus abdominis down the chest and flexes the spine.

2. The pyramidal muscle, m. pyramidalis, a small triangular muscle that lies beneath the front wall of the vagina straight muscle on the pubic symphysis. It is a vestige of the muscles that surrounds the monotremes and marsupials a pouch for carrying young. Function. The pyramidal muscle while reducing pulls the white line of the abdomen.

The vagina of the rectus abdominis muscle.

Each of the rectus abdominis is enclosed in the vagina, the vagina m. recti abdominis, formed by the tendon strain of the three broad abdominal muscles. The vagina is in the upper part, above the navel, constructed in such a way that the aponeurosis of the external oblique abdominal muscles passes in front of m. rectus and the aponeurosis of the transverse muscle in the back, the aponeurotic tension of the internal oblique muscle splits into two plates that cover! rectus front and rear, grow together with the aponeurosis of the external oblique and transverse muscles, and together with them forming the front and back of the vagina. In the lower part, 4-5 cm below the umbilicus, the structure of the vagina is different: here, the aponeurosis of all three abdominal muscles pass in front of the rectus, part of the front wall of her vagina, while the posterior vaginal wall is missing, replaced here transversalis fascia lining the abdominal wall from the inside. The rear wall aponeurotic vagina ends over the place more or less sharp concave bottom edge, called the linea arcuata. The lack of a back wall of the vagina straight muscles in the lower part, apparently, is connected with the filling of the bladder, which, rising over the edge of the pubic symphysis is shifted to this place. Thickening of the anterior wall in the lower part is connected with a vertical position of the human body, in which the lower part of the abdominal wall is a lot of pressure.

The white line of the abdomen.

The aponeurosis of the broad abdominal muscles, converging and connecting with each other in the midline, to form between the rectus muscles of the tendon strip is a white line, the linea alba stretches from the xiphoid process of the sternum to the pubic symphysis. At the top of the white line is quite wide (2-2. 5 cm at the umbilicus). On the ground at some distance from the navel it quickly narrows but thickens in the anteroposterior direction. Almost in the middle of the linea alba is the umbilical ring, annulus umbilicalis, formed by scar tissue, connecting with the skin of the navel. Light color lines is due to the decussation of the fibers of the tendon in the frontal plane (when moving from one side to the other) and sagittal (from the surface to depth), and a poverty of blood vessels. This fact is used by the surgeons when necessary in surgery (e.g., cesarean section) is widely open abdominal cavity.

The function of the abdominal muscles. Abdominal muscles narrows the abdominal cavity and put pressure on its inside, forming a so-called the abdominal press prelum abdominale, the effect of which manifests in the outward expulsion of the contents of these organs in the acts of defecation, urination and childbirth, coughing and vomiting. This action takes part and the diaphragm, which, being reduced under heavy breath, produces in its flattening down pressure on the abdominal viscera and the diaphragm of the pelvis and provides them with support. In addition, due to the tone of the abdominal muscles, the viscera are held in their position; in this case the musculo-aponeurotic wall of the abdomen plays a role like holding the abdominal belt. Next, the abdominal muscles Flex the spine and torso, being the antagonists of the muscles of the back, extending them. It produces direct muscles, bringing together between the chest and pelvis, as well as oblique when bilateral reduction. When unilateral contraction of the abdominal muscles together with m. erector spinae tilt your torso to one side. Obliques take part in the rotation of the spine to the rib cage, and on the side where there is a rotation, m is reduced. obliquus internus abdominis, and on the opposite side - m. obliquus externus abdominis. Finally, the abdominal muscles participate in breathing movements: attaching to the ribs, they pulled the last down, facilitating exhalation.

Back abdominal muscles.

Square loin muscle, m. quadratus lumborum, quadrangular muscle plate lying in front of m. erector spinae and separated from the last deep leaf of fascia thoracolumbalis. Starting from the iliac crest and lig. iliolumbale, it goes to the twelfth rib and transverse processes I to IV of the lumbar vertebrae. Function. Square loin muscle in unilateral your reduction along with other abdominal muscles and m. erector spinae tips towards the vertebral column with the rib cage. When the tonic contraction on both sides at the same time with the same muscles, it keeps the spine in a vertical position. Delaying the XII rib downwards, and can act as a muscle of exhalation.

The inguinal canal.

Inguinal canal, canalis inguinalis, is a slit through which passes the spermatic cord, funiculus spermaticus, men and the round ligament of the uterus, lig. teres uteri in women. It is placed in the lower part of the abdominal wall on the other side of the abdomen, immediately above the inguinal ligament, and goes from top to bottom, from outside to inside, from back to front. Its length is 4.5 cm. it is Formed to the outer two thirds of the inguinal ligament gutter grow internal oblique and transverse muscles, over the medial third of the ligament they are free to spread through the spermatic cord or round ligament. Thus, between the lower edges of internal oblique and transverse muscles on the top and the medial division of the inguinal ligament on the bottom turns triangular or oval slit, which is one of the mentioned formations. This gap is the so-called inguinal canal. From the lower edge of internal oblique and transverse muscles, overhanging the seminal cord to the last one departs a bundle of muscle fibers accompanying the cord into the scrotum, m. cremaster (the muscle, lifting the testicle).

Slit the inguinal canal is closed in front by the aponeurosis of the external oblique muscle of the abdomen, passing down to the inguinal ligament, and behind it is covered by fascia transversalis. Thus, in the inguinal canal it is possible to distinguish between four walls. The front wall is formed by aponeurosis of the external oblique abdominal muscles, and rear - fascia transversalis; the upper wall of the channel is represented by the lower edge of internal oblique and transverse muscles, and the lower - the inguinal ligament. In the front and rear walls of the inguinal canal has an opening called the inguinal ring, superficial and deep.

Superficial inguinal ring annulus inguinalis superficialis (anterior wall), formed by the diverging fibers of the aponeurosis of the external oblique muscle on two legs, one of which, crus laterale, is attached to the tuberculum plibicum, and the other, crus mediale,- to the pubic symphysis. In addition to these two legs, describes a third (rear) leg surface of the ring, lig. reflexum, lying in the inguinal canal behind the spermatic cord. This leg is formed by the lower fibres of the aponeurosis of the obliquus externus abdominis m the opposite side, which, crossing the middle line, passes behind the crus mediale and merge with the fibers of the inguinal ligament. Limited crus mediale and crus laterale superficial inguinal ring is in the form of oblique triangular slit. Acute lateral angle of the slit rounded curved tendinous fibers, fibrae intercrurales, originating from the fascia covering m obliquus externus abdominis. This fascia is in the form of a thin film down the edges on top of personal inguinal ring in the spermatic cord, accompanying the latter into the scrotum, called fascia cremasterica.

Deep inguinal ring annulus inguinalis profundus, is located in the posterior wall of the inguinal canal formed by the fascia transversalis, which from the edges of the rings continues in the spermatic cord, forming a sheath surrounding it together with the egg, fascia spermatica interna. In addition, the back wall of the inguinal canal reinforced in its medial division of the tendon with fibers extending from the aponeurotic stretching m. transversus abdominis and down on the edge of the rectus muscles down to the inguinal ligament. This so-called falx inguinalis. The peritoneum covering this wall, forms two inguinal fossa, fossae inguinales, separated from each other by the sheer folds of peritoneum, called the umbilical. These next folds: the lateral plica umbilicalis lateralis, formed by the raised peritoneum passing underneath a. epigastrica inferior; medial plica umbilicalis medialis, ligamentum mediale contains umbilicale, i.e. overgrown a. umbilicalis embryo; middle, plica umbilicalis mediana, covers lig. umbilicale medianum, overgrown bladder (urachus) of the embryo.

The lateral inguinal fossa, fossa inguinalis lateralis located laterally from the plicae umbilicalis lateralis, corresponds exactly to the deep inguinal ring, the medial fossa, fossa inguinalis medialis, which lies between the plica umbilicalis lateralis medialis and plica umbilicalis, corresponds to the weakest division of the rear wall of the inguinal canal and placed against the superficial inguinal ring. Through these holes in the inguinal canal can bulge inguinal hernias, and through the lateral fossa is lateral (external) oblique hernia, and in the medial - medial (internal) direct hernia. The origin of the inguinal canal is in connection with the so-called lowering of testicle descensus testis, and the formation in the embryonic period procesus vaginalis of the peritoneum.

Equipments of the lesson: posters, models, slides

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Lecture № 7. Muscles, fascia, topography of the neck and head.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. Superficial muscles of the neck - branchial arches derivatives 2. Middle neck muscles, or muscles of the hyoid bone 3. Deep muscles of the neck 4. Triangles of the neck 5. Fasciae of the neck 6. Muscles and fasciae of the head 7. Chewing muscles 8. Facial muscles
The purpose of the lesson: To acquaint students with the characteristics of the structure, topography, development, classification and function of the muscles and fasciae of neck and head.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation, cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience
Monitoring and control	1. What groups are divided into the muscles of the neck? 2. Superficial muscles of the neck. 3. Middle muscles of the neck. 4. Deep muscles of the neck. 5. What groups are divided into the muscles of the head? 6. Facial muscles. 7. Chewing muscles. 8. Fascia of the neck. 9. Triangles of the neck. 10. The development of the neck muscles. 11. The development of the muscles of the head.

Technological map of the lecture lesson

Stages, time	Teacher	Students
Preparatory stage (5minutes) Stage 1 Introduction (15 minutes)	Verification of student progress 1.1. Introduces the topic of the lecture, its purpose and expected results.	Preparation of training tools. Listen, write
2 stage Main part (50 minutes)	2.1. In order to attract students' attention and check the level of their knowledge, question answer. - What groups are divided into the muscles of the neck?	2.1. Listen. They think. Answer and listen to the right answers 2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights

	- What groups are divided into the muscles of the head? 2.2. Using visual materials, continues the presentation of the lecture material 2.3.–Superficial muscles of the neck. -The average muscle neck. -Deep muscles of the neck. -What groups are divided into the muscles of the head? -Facial muscles. -Muscles of mastication. -Fascia of the neck. -Triangles of the neck. -Development of the neck muscles. -Development of the muscles of the head. 2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	of the lecture 2.3. Remember, write, try to answer questions 2.4.Write, give examples
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "Triangles of the neck"	4. Write down the task

Theoretical part of the lecture:

The muscles of the neck

The composition of neck muscles includes muscles of different origin.

1. Derivatives of Gill arches:

a) derivatives I Gill arc - mylohyoid muscle, anterior belly digastric,

b) derivatives of the Gill arch II - chilopoda muscle, posterior belly digastric, subcutaneous muscle of the neck;

C) derivatives of the remaining Gill arches - grudinoklyuchichno-mastoid muscle,

2. Autochthonous muscles of the neck:

a) front: gradinitza muscle, glutinosity muscle, thyrohyoid muscle, and the scapular-hyoid muscles and chin-hyoid muscle;

b) lateral: scalene muscles - the front, middle and back;

in) long neck muscles, the long muscle of head, anterior rectus muscle of head, and lateral straight muscles of the head.

Autochthonous muscles of the neck are the remains of the ventral muscles, the distribution of which has been affected by two important circumstances: reduction of the edges and reduction of the body cavity. As a result, the human part of the autochthonous muscles of the neck disappeared, and only survived stair, predposlednii and chin-hyoid muscle. Accordingly, the development they are innervated by anterior branches of cervical spinal nerves.

As for the muscles located below the hyoid bone, they are associated with the hyoid apparatus and is innervated by the ansa cervicalis from the.

Topographically, the muscles of the neck are divided into the following groups.

1. The superficial muscles (platysma, m. sternocleidomastoideus).

2. Average muscles, or muscles of the hyoid bone:

a) muscle lying above it (mm. mylohyoideus, digastricus, stylohyoideus, geniohyoideus);

b) muscles that lie below it (mm. sternohyoideus, sternothyroideus, thyrohyoideus, omohyoideus).

3. Deep muscles:

a) lateral, attached to the ribs (mm. scaleni anteriores, posteriores mediales et);

b) (m. colli longus, m. longus capitis, m. capili rectus anterior et lateralis).

Superficial muscles - derivatives of Gill arches

1. Subcutaneous muscle of the neck, m. platysma lies directly under the skin on the fascia in the form of a thin plate. It starts at the level of the II rib from fasciae pectoralis et deltoidea and is attached to the edge of the lower jaw and fascia parotidea and fascia masseterica, part continuing in the muscles of the mouth. Function. Pulling the skin of the neck, the muscle prevents compression of the saphenous vein; in addition, it can pull down the corner of the mouth, which is important for facial expressions.

2. Grudinoklyuchichno-mastoid muscle, m. sternocleidomastoideus, lies immediately under the previous one, separated from her cervical fascia. Starts from the handle of the sternum and the sternal end of the clavicle and attaches to the mastoid process and to the linea nuchae superior occipital bone. The origin of the muscle is a separated part of the m. trapezius and so has this one muscle innervation. Function. In unilateral contraction, the muscle produces a tilt to his side of the cervical spine; at the same time lifting the head with the rotation of the face in the opposite direction.

At the bilateral muscle contraction to hold the head upright so the muscle and the place of its attachment (processus mastoideus), the most developed person in connection with bipedalism. When bilateral reduction may also be flexion of the cervical spine while lifting the face. When the recording head it is possible lifting of the thorax during breathing (accessory muscle of inhalation).

Average muscles, or muscles of the hyoid bone

The muscles lying above the hyoid bone, the derivatives of Gill arches that lie between the lower jaw and the hyoid bone.

1. Mylohyoid muscle, m. mylohyoideus, starting from the linea mylohyoidea lower jaw ends in a tendon suture, raphe, which extends from the inner side of the chin to the body of the hyoid bone in the midline along the border between the two mm. mylohyoidei. The back part of the muscle is attached to the body of the hyoid bone. Both mm. mylohyoidei, converging together, form a muscular bottom of his mouth, diaphragma oris, which closes the bottom of the Horny cavity.

2. Digastric m. digastricus consists of two bellies connected by an intermediate round tendon. The anterior belly, venter anterior, originates in the fossa of the lower jaw digastrica and sent back to the hyoid bone. Rear abdomen, venter posterior, starts at the incisura mastoidea of the temporal bone and goes to the tendon, through which it connects with the front abdomen. The intermediate tendon is attached to the body and a large horn of the hyoid bone.

3. Chilopoda muscle, m. stylohyoideus, down from proccesus styloideus of the temporal bone to the body of the hyoid bone, covering the two beams of the intermediate tendon of the digastric.

4. Chin-lingual muscle, m. geniohyoideus, is a derivative of the anterior longitudinal muscles lying over m. mylohyoideus on the side of the raphe extends from spinae mentalis of the mandible to the body of the hyoid bone.

Function. All four of the muscles lift the hyoid bone upwards. When it is fixed, the three muscles (mm. mylohyoideus, geniohyoideus, digastricus) lower jaw, being, thus, antagonists of the masticatory muscles. Fixation of the hyoid bone exercise the muscles located below it (mm. sternohyoideus, omohyoideus, etc.). Without this fixation is impossible, the lowering of the lower jaw, as doing so will raise more lightweight and mobile than a jaw, the hyoid bone. The same three muscles, especially m. mylohyoideus, with its reduction during the act of swallowing raise the tongue, pressing it into the sky, making the food lump is pushed into the throat.

The muscles located above the hyoid bone, part of a complex apparatus, including the mandible, hyoid bone, larynx, trachea, and which plays an important role in the act of articulate speech. In the process of human evolution occurred morphological changes in those muscles associated, on the one hand, with the reduction in the grasping function of the jaws, which acquired arms, and with another - with the advent of articulatory movements. Therefore, when comparing skulls of Neanderthal man and modern man can see the following changes the attachment of the respective muscles:

a) the place of attachment of the rear of the abdomen m. digastricus - incisura mastoidea, flat at the Neanderthal, gets deep in modern man;

b) the place of attachment of the anterior belly of the same muscle-fossa digastrica - moves the modern man of the medial;

C) the place of attachment m. mylohyoideus - linea mylohyoidea becomes more pronounced and is located below, so that the diaphragm of the mouth the modern man is below;

g) the place of attachment m. geniohyoideus - spina mentalis-Neanderthals almost non-existent and occurs only in modern man, who appears and chin projection. All these changes on the bones caused by the development of these muscles involved in the characteristic only of man the act of articulate speech.

Muscles lying below the hyoid bone, the derivatives of the anterior longitudinal muscles of the trunk - refer to the system of the ventral straight muscles of the neck and are located on the sides of the middle line immediately beneath the skin in front of the larynx and trachea, stretching between the hyoid bone and the sternum, with the exception of m. omohyoideus, which goes to the shoulder blade and in its origin is a muscle, has shifted from the torso to the belt of the upper limb (trancopal).

1. Gradinitza muscle, m. sternohyoideus, starting from the rear surface of the handle of the sternum, grudinoklyuchichno articulation and the sternal end of the clavicle, goes upward and is attached to the lower edge of the hyoid bone. Between the medial edges of mm. sternohyoidei is narrow vertical interval, closed the fascia, the so - called white line of the neck. Function. Pulls down the hyoid bone.

2. Glutinosity muscle, m. sternothyroideus, lies under the previous one. Originates from the posterior surface of the arm of the sternum and cartilage of rib I and attaches on the lateral surface of the thyroid cartilage (to its linea obliqua). Function. Lowers down the throat.

3. Thyrohyoid muscle, m. thyrohyoideus, is like a continuation of the previous muscle, and lineae obliqua extends from the thyroid cartilage to the body and a large horn of the hyoid bone. Function. With a fixed hyoid bone pulls up the larynx.

4. Scapular-hyoid muscle, m. omohyoideus, consists of two bellies. Lower abdomen, beginning on the medial incisura scapulae, fits grudinoklyuchichno-mastoid muscle, where by means of an intermediate tendon continues in the upper abdomen which goes to the body of the hyoid bone. Function. M. omohyoideus lies in the thickness of the cervical fascia, which pulls in its decline, contributing to the expansion of large venous trunks, under the fascia. In addition, the muscle pulls the hyoid bone downwards.

Deep muscles

Side fixed to the edges, stair, mm. scaleni, are based on a modified intercostal muscles; hence attaching them to the ribs.

1. Anterior scalene muscle, m. scalenus anterior, starts from the anterior tubercles of the transverse processes of the III-VI of the cervical vertebrae and attaches to the tuberculum m. scaleni anterioris I fin ahead of a sulcus. subclaviae.

2. The middle scalene muscle, m. scalenus medius originates from the anterior tubercles of the transverse processes of all cervical vertebrae and attaches to the first rib, posterior to sulcus a. sub-claviae.

3. Back scalene muscle, m. scalenus posterior, starts from the posterior tubercles of the three lower cervical vertebrae and is attached to the outer surface of the rib II.

Function. Mm. scaleni raise the top edge, acting as a muscle of inhalation. For fixed edges, cutting on both sides, they Flex the cervical part of the spinal column anteriorly, and with a unilateral reduction bend and rotate-vayut her to his side.

1. Long neck muscles, m. 1опдиs Solli has the shape of a triangle, lying on the anterior surface of the vertebral column and with the other parties for all cervical and three thoracic vertebrae.

2. The long muscle of head, m. longus capitis, closes the upper part of the previous muscle. Originates from the transverse processes of the III-VI of the cervical vertebrae and attaches to the pars basilaris of the occipital bone.

3 and 4. Front and lateral straight muscles of the head, mm. recti capitis anterior et lateralis, extends from the lateral masses of Atlanta (front) and transverse process (lateral) to the occipital bone.

Function. M. rectus capitis anterior and m. longus capitis anteriorly tilted his head. M. longus colli, by subtracting all fiber on both sides, flexes cervical portion of vertebral column, with the reduction on one side makes it tilt in their favor; the slant beams are involved in the rotation, head tilt to the side; it helps m. rectus capitis lateralis.

Topography of the neck

The neck, the cervix, is divided into four regions: posterior, lateral, the region grudinoklyuchichno-mastoid muscle and the anterior.

Rear area, regio cervicalis posterior, located behind the outer edge of the m. trapezius and represents the back of the head or neck, Pisa.

Lateral area, regio cervicalis lateralis (trigonum colli laterale), lies behind the m. sternocleidomastoideus and limited front called the muscle, below the collarbone and behind-m. trapezius. Regio sternocleidomastoidea corresponds to the projection of this muscle.

Front area, regio cervicalis anterior, lies anterior to the m. siernocleidomastoideus and limited back muscle called the front - middle line of the neck and top edge of the lower jaw. A small area behind the mandibular angle and in front of the mastoid process is called the fossa retromandibularis. It is placed posterior part of the parotid gland, nerves and blood vessels.

Front and side region are divided into a number of triangles by m. omohyoideus, passing obliquely downward and backward, and crossing m. sternocleidomastoideus.

Regio cervicalis lateralis there are two triangle:

1) omoclaviculare trigonum, which is bounded by m. sternocleidomastoideus (front), lower abdomen m. omohyoideus (top), and clavicle (below);

2) trigonum omotrapezoideum formed the lower abdomen m. omohyoideus, m. traptezius and m. sternocleidomastoideus.

Regio cervicalis anterior, there are three triangle:

1) trigonum caroticum (it is a. carotis) is formed m. sternocleidomastoideus (rear), rear abdomen m. digastricus (front and top) and upper abdomen m. omohyoideus (front and bottom); 2) trigonum submandibulare (it is submandibular gland) formed by the lower edge of the

mandibulae (top) and the two bellies of m. digastricus; it is for practical purposes a dedicated Pirogov triangle bounded by the rear edge m. mylohyoideus (front), rear abdomen m. digastricus (rear) and n. hypogldssus (above); it passes a. lingualis; 3) trigonum omotracheale formed m the upper abdomen. omohyoideus, the middle line of the neck and m. sternocleidomastoideus. Between the scalene muscles have a triangular gap or space through which the nerves and vessels of the upper extremity: 1) between mm. anteior et scaleni medius - spatium interscalenum I limited the bottom rib, where the subclavian artery and the brachial plexus; 2) m ahead. scalenus anterior -spatium antescalenum covered front mm. sternothyroideus and sternohyoideus (there are subclavian Vienna, a. suprascapularis and m. omohyoideus).

Fasciae of the neck

Fasciae of the neck reflect the topography of the organs located in the cervical region. Therefore, in textbooks of topographic anatomy is the most convenient for surgical purposes, the description of the fasciae according V. N. Shevkunenko, which distinguishes 5 fascial sheets.

The first fascia, or superficial neck fascia, fascia colli superficialis, is part of the common superficial (subcutaneous) fascia of the body and moves without a break from the neck to the next area. From the subcutaneous fascia of other departments of the body it differs in that it contains the subcutaneous muscle (m. platysma), which is perimysium.

The second fascia, or the superficial fascia own piece neck, lamina superficialis fasciae colli propriae, covers the whole neck, like a collar and covers the muscles above and below the hyoid bone, salivary glands, blood vessels and nerves. At the top it attaches to the mandible and processus mastoideus and goes on the face in the fasciae parotidea et masseterica, which cover the parotid salivary gland and masticatory muscle. The bottom surface of the fascia own piece neck is attached to the front edge of the manubrium sterni and the clavicle. In the front, in the midline, it fuses with the deep fascia own piece neck, forming the so-called white line of the neck (width 2-3 mm). The surface sheet on each side of the neck goes from the white line back to the spinous processes of the cervical vertebrae. Met on his journey with m. et sternocleidomastoideus trapezius, it slots covers them on both sides and again fused, forming a fascial vagina separately for each of these muscles.

Where the superficial fascia own piece neck passes over the transverse processes, it is attached to them, which gives fascial spur in front standing plate, which divides all fascial space of the neck into 2 divisions: the front and rear. This division certain suppurative processes occur in both parts of the fascial spaces of the neck independently of each other.

The third fascia, or deep fascia own piece neck, lamina profunda fasciae colli propriae, is expressed only in the middle section of the neck behind m. stemocleidomastoideus, where he was in the form of a trapezoid is stretched in the triangular space bounded at the top of the hyoid bone, laterally - both mm. omohyoidei and below the collarbone and the breastbone. As the deep fascia own piece neck attached at the bottom to the rear edge of the handle of the sternum and clavicle and superficial to the anterior margin of them, between the superficial and deep sheets of the own fascia of the neck forms a slit-like space, spatium suprasternale interaponeuroticum where are loose tissue and superficial veins of the neck, arcus venosus juguli (jugular venous arch), damage which is dangerous. The sides of this space communicates with the recessus lateralis, a blind pocket behind the lower end of the m. stemocleidomastoideus where can numb pus. Deep leaf bisecting and again grow together, forms a fascial vaginal muscles lying below the hyoid bone (mm. sternohyoideus, sternothyroideus et thyrohyoideus). It combines named muscles in a tight soedinitelnotkannoj the muscle-plate and is for them like the aponeurosis, the aponeurosis omoclavicularis that is rolled at reduction of mm. omohyoidei and promotes venous outflow passing through it and fused with it cervical veins. This tension and triangular shape served as the basis for the figurative name of the fascia - cervical sail.

The fourth fascia, or internal fascia of neck fascia endocervicalis, hugs cervical viscera (larynx, trachea, thyroid, pharynx, esophagus and major blood vessels). It consists of two sheets of the visceral, which, covering each of these bodies forms a capsule for them, and parietal, which covers all these bodies together and forms the vagina for important vessels. carotis communis and V. jugularis interna.

The space between the parietal and the visceral fasciae sheets endocervicalis positioned in front of the intestines and is therefore called spatium previscerale, in particular in front of the trachea - spatium pretracheale. The latter contains, in addition to tissue and lymph nodes, the isthmus of the thyroid gland and blood vessels (a. thyroidea ima et plexus thyroideus impar), which may be damaged during tracheotomy. Spatium pretracheale continues in the anterior mediastinum. Covering the inside of the neck, the parietal leaf is at the front and sides from them and at the same time, behind the muscles located below the hyoid bone (mm. sternohyoidei, sternothyroidei, thyrohyoidei and omohyoidei).

The fifth fascia, predpolagaetsya, prevertebralis fascia covers the front lying on the spinal column predposlednii and scalene muscle and grow together with the transverse processes of the vertebrae forms for these vaginal muscles.

Top predpolagaetsya fascia starting from the base of the skull behind the pharynx, descends through the neck and goes to the posterior mediastinum, merging with the fascia endothoracica.

Between the fourth and fifth fascia, behind the pharynx and esophagus is filled with loose fiber narrow slit - spatium retropharyngeale, continued down into the posterior mediastinum.

Its origin is described 5 fasciae of the neck are different: some are reduced muscles (the first fascia - perimysium, m. platysmae and the third is the reduced m. cleidohyoideus), the other is a product seal surrounding the organs tissue (parietal and visceral brushing of the fourth fascia), and still others have the usual fascia origin (second and fifth fascia).

According to the Paris anatomical nomenclature, all fasciae of the neck are United under the name fascia cervicalis, which is divided into 3 albums:

1) surface plate, lamina superficialis, corresponds to the first fascia, fascia colli superficialis (for V. I. Shevkunenko);

2) pretracheal plate, lamina pretrachealis, covers salivary glands, muscles, and other entities in front of the trachea, whence it receives its name; it corresponds to the second and third fasciae (3. N. Shevkunenko);

3) predpolagaetsya plate, lamina prevertebralis corresponds to the fifth fascia (for V. N. Shevkunenko).

The fourth fascia, fascia endocervicalis, no PNA is not described. Cervical fascia is firmly in contact with the walls of the veins by connective tissue strands and promote venous outflow.

Muscles and fasciae of the head

If you don't count voluntary muscles related to the senses of sight and hearing and to the upper part of the digestive system, which were written in the appropriate departments, all the muscles of the head are divided as follows:

1)muscles of mastication-derivatives I Gill (mandibular) arc

2) facial muscles, or the muscles of the face derived II Gill (goodnoe) arc;

3) muscles of the cranial vault.

Chewing muscles

Four muscles of mastication on each side are connected to each other genetically (they come from the same Gill arch - mandibular), morphologically (they are all attached to the lower jaw, which move at their reductions) and functional (they make chewing movements of the mandible, which determines their location).

1. The masseter, m. masseter, starts from the lower edge of the zygomatic bone and the zygomatic arch and attaches to tuberositas masseterica and the outer side of the Ramus mandibulae.

2. The temporal muscle, m. temporalis, its wide beginning occupies the entire space of the temporal fossa of the skull, reaching the top to linea temporalis. Muscle bundles converge fan-shaped and form a strong tendon, which fits under the zygomatic arch and attaches to the processus coronoideus of the lower jaw.

3. The lateral pterygoid muscle, m. pterygoideus lateralis starts from the lower surface of the greater wing of the sphenoid and from the pterygoid process and attaches to the neck of the condylar process of the mandible and the capsule and the discus articularis of the temporomandibular joint.

4. Medial pterygoid muscle, m. pterygoideus medialis, originates in the fossa pterygoidea of the pterygoid bone and attaches on the medial surface of the angle of the mandible symmetrically m. masseter, to the same tuberosity.

Function. M. masseter, m. temporalis and m. pterygoideus medialis with an open mouth, attracting the lower jaw to the upper, otherwise closed mouth. While reducing both mm. pterygoidei laterales lower jaw is pushed forward. The reverse movement produces the most posterior fibers of m. temporalis, extending almost horizontally backward. If m. pterygoideus lateralis is reduced only on one side, the lower jaw shifts sideways in the direction opposite to the cutting muscle. M. temporalis carries out the movements of the lower jaw and is essential for articulate speech.

The muscles of the face

The visceral musculature of the head, previously had a relation to the viscera laid in the head and neck, part has progressively become cutaneous muscles of the neck, and from it by differentiation into separate thin bundles in mimic muscles of the face. This explains the close relationship of facial muscles with the skin, which they set in motion. This also explains other features of the structure and function of these muscles.

So, facial muscles, unlike skeletal, do not have a double attachment on the bones, but be sure the two or one end are woven into the skin or mucosa. As a result, they do not have the fasces, and, by subtracting, result in movement of the skin. With the relaxation of their skin because of its elasticity returns to its previous status, so the role of the antagonist is much less than that of skeletal muscle.

The facial muscles are thin and small muscle bundles, which are grouped around the natural orifices: mouth, nose, palpebral fissure and ear - taking somehow participate in closing or Vice versa, the extension of these openings.

Contactors (sphincters) are usually located around the holes Annularly, and the extenders (dilatatory) - radial. Changing the shape of the holes and moving the skin with the formation of wrinkles, facial muscles give the face a certain expression that matches a particular experience. Such changes of the face are called facial expressions, hence the name muscles. In addition to the main functions: to Express feelings,- the facial muscles involved in speech, chewing, etc.

The shortening of the jaw apparatus and the participation of the lips in articulate speech led to a special development of the facial muscles around the mouth, and, conversely, well-developed animals have ear muscles in humans, reduced and survived only in vestigial muscles.

Muscles of the cranial vault.

1. Almost the entire cranial vault is covered with a thin naharani muscle, m. epicranius with extensive tendinous part in the form of the tendon helmet, or noderange aponeurosis, a gale aponeurotica (aponeurosis epicranialis), and muscle, breaking up into three separate muscle of the abdomen: 1) the anterior or frontal, abdomen, venter frontalis, starts from the skin of the eyebrows; 2) the posterior, or occipital, abdomen, venter occipitalis, starts from the linea nuchae superior; 3) the lateral abdomen is divided into three small muscles that are appropriate for the ear: the front - m. auricularis anterior, top - m. auricularis superior and rear - m. auricularis posterior. Bee named muscles are woven into the fascia. Galea aponeurotica gives the middle part of the cranial vault, making the Central Department of epicranius m.

Function. Being loosely connected with the periosteum of the skull bones, naharani the fascia is closely fused with the skin of the head, so she can move with him under the influence of a reduction of the frontal and occipital bellies. When naharani aponeurosis fortified occipital belly of the muscle, venter frontalis lifts the eyebrow up, making it curved, and forms transverse folds on the forehead .

The remains of the ear muscle man - a classic example of vestigial organs. As you know, people that can move their ears very rare.

The muscles of the circumference of the eye.

2. Muscle proud m. procerus, starts from the bone of the nose and the aponeurosis m. nasalis and ends in the skin area glabellae, connecting with the frontal muscle. Omitting the skin named region downward, causes the formation of transverse folds above the nose bridge.

3. Circular muscle of the eye, m. orbicularis oculi surrounds the eye, the slit being located in its peripheral part, pars orbitalis, on bony edge of the orbit, and the inner, pars palpebralis,-on the eyelids. Distinguish between another and a third small part, the pars lacrimalis, which arises from the wall of the lacrimal SAC and, expanding it, affect the absorption of lacrimal fluid through lacrimal canaliculi. Pars palpebralis closes his eyelids. Orbital part, pars orbitalis, with a strong reduction produces zazhmurivaet eyes.

M. orbicularis oculi allocate a small portion that lies beneath the pars orbitalis and bearing the name of corsewall eyebrows, m. corrugator supercilii. This part of the circular muscle of the eye brings the eyebrows and causes the formation of vertical wrinkles in the glabellar gap above the nose bridge Often, but the vertical folds above the nose bridge are formed by a short transverse wrinkles in the middle third of the forehead, due to the simultaneous action by the venter frontalis. This state of eyebrows happens when suffering and pain is typical of hard feelings.

Muscle circumference of the mouth

4. Muscle lifting the upper lip, m. levator labii superioris, starts from the infraorbital region of the maxilla and ends mainly in the skin of the nasolabial folds. It split from the beam, reaching to the wing of the nose and therefore received its own name - the muscle that raises upper lip and wing of nose, m levator labii superioris alaeque nasi. With the reduction raises the upper lip, deepening the sulcus nasolabialis, pulls the wing nose up, nostrils expanding.

5. Small zygomatic muscle, m zygomaticus minor, starts from the zygomatic bone, woven into the nasolabial folds, which deepens with the reduction.

6. Great zygomatic muscle, m. zygomaticus major, is from facies lateralis of the zygomatic bone to the corner of the mouth and partly to the upper lip. Pulls angle of the mouth upwards and laterally, and the nasolabial folds deepened greatly. In this action the muscles of the face is laughing, so m. zygomaticus is essentially a muscle laughing.

7. Muscle of laughter, m. risorius, a small transverse beam going to the corner of the mouth, is often missing. Stretches your mouth with laughter, in some individuals, due to the attachment of the muscle to the skin of the cheeks in its reduction forms a small dimple on the side of the corner of his mouth.

8. Muscle, lowering the angle of the mouth, m. depressor anguli oris, begins at the lower edge of the mandible lateral tuberculum mentale and attached to the skin of corner of mouth and upper lip. Pulls down the corner of the mouth and makes the nasolabial folds straight. Lowering the corners of the mouth gives the face an expression of sadness.

9. Muscle lifting the corner of the mouth, m. levator anguli oris lies beneath m. superidris levator labii and m. zygomaticus major originates from the canine fossa, fossae caninae (what was previously called m. caninus) below the foramen infraorbitale and attached to the corner of his mouth. Pull up the corner of the mouth

10. Muscle, lowering the lower lip, m. depressor labii inferioris. Begins at the edge of the lower jaw and attached to the skin of the entire lower lip Pulls the lower lip down and somewhat laterally as it is, by the way, is observed in the expression of disgust on her face.

11. Mentalis, m. mentalis, departs from the juga alveolaria of the lower incisors and canine, attached to the skin of the chin. Lifts up the skin of the chin, and it formed small dimples, and takes up the lower lip, pressing her to the top.

12. Buccal muscle, m. buccinator forms the lateral wall of the oral cavity. On the upper level of the second large molar tooth muscle runs through the parotid duct, diictus parotideus. The outer surface of the m. buccinator is covered by fascia buccopharyngea, on top of which lies a bundle of fat cheeks. It is the beginning - the alveolar process of the maxilla, the buccal ridge and the alveolar part of the mandible, krylonizhnechelyustnogo seam. Attaching to the skin or mucous membranes fragile mouth, where it enters the circular muscle of the mouth. Pulls the corners of the mouth to the side, presses cheeks to the teeth, compresses the cheek and protects the mucosa of the oral cavity from prokusyvanie when chewing.

13. Circular muscle of the mouth m. orbicularis oris, which lies in the thickness of the lips around the mouth slit. While reducing the peripheral part of the m. dris orbicularis of the lips pulled together and pushed forward, as in the kiss when downsizing the part, lying under a red border of lips, lips, tight bonding between them, wrapped inside, resulting in the red fringe disappears. M. orbicularis oris, located around the mouth, functions as a sphincter (the sphincter), i.e., the muscle that closes the opening of the mouth. In this respect, he is the antagonist of the radial muscles of the mouth, i.e. the muscles radiating from him along the radii and opening mouth (mm. levatores labii superiores and anguli oris .depressores labii inferiores and anguli oris, etc.).

Muscle circumference of the nose

14. Actually nasal muscle, m. nasalis, poorly developed, partially covered by the muscle that lifts the upper lip, compresses the cartilaginous part of the nose. Her pars alaris lowers the wing of the nose, and m. depressor septi (nasi) down the cartilaginous part of the nasal septum.

Fasciae of the head

Naharani aponeurosis covering, as mentioned above, the cranial vault in the lateral parts of the latter is much thinner to the extent rychlovarnou plate, under which there lies a strong, tendinous shiny temporal fascia, temporalis fascia covering the muscle and starting at the top of the linea temporalis. At the bottom it attaches to the zygomatic arch, dividing into two plates, of which surface adheres to the outer surface of the arc, and the deep - to its inner side. Between the two plates is a space filled with fatty tissue. Fascia temporalis and the temporal fossa of the skull limit the osteo-fibrous receptacle, which lies the temporal muscle. M. masseter is covered with fascia masseterica, which, putting on muscle, is attached at the top to the zygomatic arch down to the edge of the lower jaw, and behind and in front - to its branches. Posteriorly and partly from its outer surface called fascia is connected with the fascia of the parotid gland, fascia parotidea, which forms around her last capsule. In the face of fascia is not, as chemical muscles lie directly under the skin. The only exception is m. buccinator, it is covered at its rear end tight fascia buccopharyngea, which loosened at the front, merging with the tissue of the cheek and the back fused with the raphe pterygomandibularis, and continues in the connective tissue covering the muscles of the pharynx.

Equipments of the lesson: posters, models, slides

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Lecture № 8. Muscles and fascia of the shoulder girdle, upper and lower extremities.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. The muscles and fascia of the upper limb 2. Muscle belt upper extremities 3. The muscles of the shoulder 4. The muscles of the forearm 5. Muscles of the hand 6. The muscles and fasciae of the lower limb 7. Muscle belt of the lower extremity 8. Thigh muscles 9. The calf muscles 10. The muscles of the foot
The purpose of the lesson: To acquaint students with the structural features of muscles of the limbs, their classification, topography and practical value.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation, cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience
Monitoring and control	1.What groups are divided into upper limb muscles? 2.Muscles of the shoulder girdle, upper arm, forearm, wrist 3.What groups are divided into the muscles of the lower limbs? 4.Muscles of the thigh, leg, foot.

Technological map of the lecture lesson

Stages, time	Teacher	Students
Preparatory stage (5minutes) Stage 1 Introduction	Verification of student progress 1.1. Introduces the topic of the lecture, its purpose and	Preparation of training tools. Listen, write

(15 minutes)	expected results.	
2 stage Main part (50 minutes)	2.1. In order to attract students' attention and check the level of their knowledge, question answer. 2.2. Using visual materials, continues the presentation of the lecture material 2.3.-The structure and topography of muscles of the upper and lower extremities. 2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	2.1. Listen. They think. Answer and listen to the right answers 2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights of the lecture 2.3. Remember, write, try to answer questions 2.4.Write, give examples
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "the femoral canal "	4. Write down the task

Theoretical part of the lecture:

The muscles and fascia of the upper limb

The muscles of the upper limbs carry out the hand movements necessary to perform its functions as an organ of labour. Muscle belt upper extremities attach it to the skeleton of the body, forming muscle connection bone – synsarcosis, and leads the movement of the bones of the girdle, mainly the scapula and the whole upper limb. Muscle belt upper extremities to the bones of his flock as to the center on all sides - from the head, back and chest and are of different origin:

1) derivatives of the ventral muscles of the trunk, found a point of attachment on the bones of the belt, i.e. truncatellidae muscle - m. rhomboideus, levator scapulae m.., m. serratus anterior, m. subclavius m. omohyoideus, as well as moved from the head of derivatives of branchial arches - m.. trapezius, 2), trunco-pechalnye muscle - m. latissimus dorsi, mm. pectorales major et minor.

The position and function of all these muscles have already been discussed earlier in the description of the muscles of the back, chest and neck. The rest of the muscles of the upper vechnosti originate from the ventral part of myotomal and can be divided into 1ышцы belt of the upper limb, muscles of shoulder, forearm and hand. They nerverous from the branches of the brachial plexus, plexus brachialis.

Muscle belt upper extremities

Accordingly, the spherical shape of the shoulder joint and its movements in all directions (multi-joint) muscle that serve it, attaching to the humerus, are located on all sides. They are topographically on the back and the front of the group.

The back panel

1. The deltoid muscle, m. deltoideus, covers a proximal end of the humerus. It starts from the lateral third of the clavicle and acromion, and from the spina scapulae in its entirety. Front and rear muscle bundles are almost in a straight line downward and laterally; average, leaning

over the head of the humerus, heading straight down. All the beams converge and are attached to the tuberositas deltoidea in the middle of the humerus. Between the inner surface of muscle and a large tubercle of the humerus is found bursa subdeltoidea.

Function. With the reduction of the anterior (clavicular) part of deltoid muscle flexion of arm, flexio, the reduction of the back (shoulder) part produces the opposite movement is extension, extensio. The reduction of the average (acromion) part or all of the deltoid muscle causes the movement of an arm from the body to the horizontal level a b d ii t i O. All of these movements occur in the shoulder joint.

2. Supraspinatus muscle, m. supraspinatus lies in the fossa supraspinata scapula and attaches to the top of the greater tubercle of the humerus. The muscle is covered with strong fascia, fascia supraspinata.

Function. Removes his hand, as a synergist m. deltoideus

3. Infraspinatus muscle, m. infraspinatus, fills most of nfraspinata fossa and attaches to the greater tubercle of the humerus. Function. Spinneret, supinatio, shoulder

4. Small round muscle, m. teres minor, starts from the margo lateralis of the scapula and attaches to the greater tubercle of the humerus below the tendon m. the infraspinatus.

Function. The muscles

5. A large round muscle, m. teres major, starts from the back of the lower angle of the scapula and is attached together with m. latissimus dorsi to the crista tuberculi minoris. The person she is separated from the subscapularis muscle, keeping, however, a common innervation with it.

Function. Pulls arm backward and downward, leading her to the body and rotates inside.

6. Subscapularis muscle, m. subscapularis occupies the entire facies costalis of the scapula and attaches to the tuberculum minus of the humerus.

Function. Rotates the shoulder inward (proniruet), and can also stretch the joint capsule, protecting it from infringement. The last property is possessed due to its fusion with the capsule and above the muscles that attach to the greater tubercle of the humerus.

7. Latissimus dorsi, m. latissimus dorsi .

Front group

1. The pectoralis major muscle, m. pectoralis major.

2. Pectoralis minor, m. pectoralis minor.

3. Coracobrachialis muscle, m. coracobrachialis, starts from the coracoid process of the scapula along with short head m. biceps brachii and m. pectoralis minor and attaches to the medial surface of the humerus from the distal cristae tuberculi minoris.

Function. Flexes and leads the shoulder.

The muscles of the shoulder

Shoulder muscles remain in the most simple form of the initial location of the muscles of the extremities and are separated by a classically simple pattern: two flexor (m. biceps and m. brachialis) on the front surface (front panel) and two extensor (m. triceps and m. anconeus) — rear (rear group). They act on the elbow joint, making movement around the frontal axis, and therefore are located on the front and back surfaces of the shoulder, attaching to the bones of the forearm. Both groups of muscles are separated from each other by two connective tissue septa, septa intermuscularia portion extending to the lateral and medial edges of the humerus from the General fascia of the shoulder, puts all the muscles of the latter.

The front shoulder muscles

1. Two-headed muscle of a shoulder, m. biceps brachii, a large muscle, the reduction of which is very clearly noticeable under the skin, making her know even people who are unfamiliar with anatomy. Proximal muscle consists of two heads; one (long, caput longum) starts from the tuberculum supraglenoidale blades long tendon that passes through the cavity of the shoulder joint and then rests in the sulcus intertubercularis the humerus surrounded by the vagina

synovialis intertubercularis, the other head (short, caput breve) takes origin from the processus coracoideus of the scapula. Both heads combine to pass into elongated, spindle-shaped abdomen, which ends in a tendon to the tuberositas radii. Between the tendon and tuberositas radii is constant synovium, bursa bicipitoradialis. From this tendon the tendon moves medially flat beam, the aponeurosis m. bicipitis brachii, woven into the fascia of the forearm.

Function. Flexes the shoulder in the shoulder joint and the forearm at the elbow joint, due to the point of its attachment on the radius it also acts as a supinator when the forearm was previously bronirovania. The biceps muscle is spread not only through the elbow joint and through the shoulder and can act on it, flexing the shoulder, but only if the elbow joint is reinforced by the reduction of m. triceps.

2. The shoulder muscle, m. brachialis lies deeper than the biceps muscle originates from the anterior surface of the humerus, and also from both septa and intermuscularia brachii attaches to the tuberositas ulnae.

Function. Pure flexor of the forearm.

Rear shoulder muscles

1. The triceps brachii, m. triceps brachii, is the entire rear side of the shoulder consists of three heads, turning into one common tendon. Long head, caput longum, starts from the tuberculum infraglenoidale of the scapula descends, passing between the mm. teres major et minor. The lateral head, caput lateral e, originates on the posterior surface of the shoulder, upwards and laterally from the sulcus nervi radialis, and below the septum intermusculare brachii laterale. The medial head, caput medial e, starts from the posterior surface of the humerus from the distal sulcus n. radialis and both intermuscular septa. The broad common tendon attached to the olecranon of the ulna. Behind the tendon between it and the skin in the area 1алегает olecranon synovium, bursa olecrani.

Function. Extends forearm at elbow, long head extends and the shoulder.

2. Elbow muscle, m. anconeus, a small, triangular-shaped, adjacent to its proximal edge to the triceps muscle. Starting from the epicondylus lateralis of the humerus and lig. collaterale radiale, is attached to the rear surface of the ulna in its proximal quarter.

Function. The same as at m. triceps brachii.

The muscles of the forearm

In their function they are divided into flexors and extensors, and most of them are megosztani because they operate at multiple joints: elbow, radioulnar, wrist and joints of the hand and fingers. In addition, there are predatory and insoles producing corresponding movements of the radius. The position of these muscles)badaude into two groups: the anterior, composed of the flexor and pronator, and back, consisting of the extensors and supinators. Each group is composed of superficial and deep layers. Superficial layer of muscles of the anterior group originated in the region of the medial epicondyle of the shoulder, the same layer of the rear group in the region of the lateral epicondyle. The deep layer of both groups in the main parts do not finds the point of attachment on notmyself, and originates on the bones of the forearm and the interosseous membrane. The final attachment of the flexor and extensor of the brush are at the bases of the metacarpal bones and the same muscles going to the toes attach to the phalanges, with the exception of the long abductor thumb muscles that attach to the metacarpal I bones. Predatory and foot support are attached on the radius. The muscles of the forearm closer to the shoulder consist of the fleshy parts, while the direction of the brush, they pass into a long tendon, resulting forearm has the shape of a cone, flattened from front to back.

Front group

The surface layer consists of the following muscles.

1. Round pronator, m. pronator teres, starts from the medial epicondyle of the shoulder and tuberositas ulnae and attaches to the lateral surface of the radius immediately above her middle.

Function. Proniruet forearm and participates in its flexion

2. Radial flexor of wrist, m. flexor carpi radialis lies along the medial edge of the pronator teres. It starts from the medial epicondyle of the shoulder and attaches to the base of II metacarpal bone.

Function. Produces flexing the wrist and can also take latter in the radial direction in combination with other muscles.

3. Long Palmar muscle, m. palmaris longus lies medially from the previous one and starts from the medial epicondyle of the shoulder. Short spindle-shaped abdomen it very much goes into long thin tendon, which passes over the retinaculum flexorum in the Palmar aponeurosis, palmaris aponeurdsis. This muscle is often absent.

Function. Tightens Palmar aponeurosis and flexes the wrist.

4. Ulnar flexor of the wrist, m. flexor carpi u1naris, is located on the ulnar edge of the forearm, taking origin from the medial epicondyle of the shoulder and attaches to the pisiform bone, which are the sesamoid, and further to the os hamatum (lig. pisohamatum) and V metacarpal bones (in the form of lig. pisometacarpeum).

Function. Together with m. flexor carpi radialis flexes the brush, and leads her (along with m. extensor carpi ulnaris).

5. Superficial flexor of fingers m. flexor digitorum superficialis, lies deeper described four muscles. It starts from the medial epicondyle of the humerus, processus coronoideus of ulna and the upper part of the radius. The muscle is divided into four long tendons, which descend from the forearm through the canalis carpalis on the palm, which are on the Palmar surface of the II—V fingers.

At the body level of the proximal phalanx each tendon divides into two legs which diverge and form a gap, hiatus tendinous, passes the tendon of the deep flexor, from which they cross (chiasma tendinum), and are attached on the Palmar surface of base of middle phalanx.

Function. Flexes the proximal and middle phalanges (except for thumb), as well as the whole hand.

The deep layer consists of the following muscles:

6. Long flexor of the thumb, m. flexor pollicis 1ongus, starts from the anterior surface of the radius distal from the tuberositas radii and a part from the medial epicondyle of the humerus. The long tendon passes under the retinaculum flexorum in the palm and goes in the groove between the two heads of m. flexor pollicis brevis to the base of the distal phalanx of the thumb.

Function. Bend the nail Phalange of the thumb and wrist.

7. Deep flexor of fingers m. flexor digitorum profundus, originates from the ulna and interosseous membrane. Its four tendons extending from the muscles of the body in the middle of the forearm, pass through the canalis carpalis on the palm, lying under the tendons of the superficial flexor, and then sent to the II—V fingers, and each of these tendons penetrates the tendinous hiatus between the legs of the tendon m. flexor digitorum superficialis, forming with it the optic chiasm and is attached to the distal phalanx.

Function. Flexes middle and distal phalanges II—V fingers, and is also involved in flexing the wrist.

8. Square pronator, m. pronator quadratus is a flat quadrangular muscle, located directly on both bones of the forearm and the interosseous membrane, immediately above the wrist. Starting from the Palmar surface of the ulna is attached to the Palmar side of the radius.

Function. Is the chief pronator of the forearm, and round support.

The back panel

Superficial layer of back muscles can be divided into two secondary groups: radius and ulna. The first of them occupies the anterolateral surface of the forearm, and the second lies on his back side.

Beam group of the surface layer

1. The brachioradialis muscle, m. brachioradialis that lies on the anterolateral surface of the forearm, along its side edges. This muscle starts from the lateral edge of the humerus, passing between m. brachialis and m. triceps. Then her abdomen down the front of the radial bone and in the middle of the forearm ended in a long tendon, which is attached to the radius above the styloid process. The medial muscle is bordered by m. pronator teres and m. flexor carpi radialis.

Function. Flexes forearm at the elbow joint and sets the radius in position, average between Michaud and supination. This situation usually takes forearm and at freely lowered hands.

2. Long radial extensor muscle of wrist, m. extensor carpi radialis longus, located on the posterolateral surface of the forearm, posterior to the previous muscle, and originates from the lateral edge and the lateral epicondyle of the shoulder. In the middle of the forearm the muscle turns into tendon. that goes on the lateral surface of the radius, and then fit the retinaculum extensorum and attaches to the dorsum of the base of II metacarpal bone.

Function. Produces straightening of the brush, and allocating it in the radial direction, with m. flexor carpi radialis.

3. Short radial extensor muscle of wrist, m. extensor carpi radialis brevis lies posterior to the long radial extensor of the wrist .starting from the lateral epicondyle of the humerus, goes along with the tendon of the extensor carpi radialis longus, both of which are in the distal third of the forearm cross with m. abductor pollicis longus and m. extensor pollicis brevis and in the area of the brush with the tendon of the long extensor of the thumb, where they pass through a common (second) fibrous canal under rednaculum tensorum, after which the tendon short radial extensor of the brush fastened to the rear surface of the base of metacarpal III. This place is located underneath a small synovial purse.

Function. the same as that of the long radial extensor of the brush.

Ulnar group of the surface layer.

4. Extensor digitorum, m. extensor digitorum, lies quite on the posterior surface of the forearm, taking the beginning together with m. extensor carpi radialis brevis from the epicondylus lateralis. In the middle of the forearm, the muscle divides into four the abdomen, each of which gives a long tendon. The tendons down the back of the hand, pass under the retinaculum extensorum through the fourth of the channels, and then diverge to the four fingers (II—V). On the back of the hand near the metacarpal-phalangeal joints the tendons are connected by oblique fibrous jumpers, connexus intertendineus, resulting in bending two middle fingers is only possible together; the index finger and the little finger partially retain independence because of the existence of a private extensors. Each of the tendons of the common extensor on the back side of the corresponding finger moves in a triangular tendon stretching, is divided into three beams, of which the middle is attached to the base of the middle phalanx, and lateral — to the base of the distal phalanx.

The function Unbend II—V fingers and produces extension brush.

5. The extensor of the little finger, m. extensor digiti minimi is separated from the common extensor of the fingers with its ulnar side. Its long tendon passes through the fifth channel under the retinaculum extensorum to the back of the hand to the pinky connects to the common extensor tendon going to that finger.

The function is visible from the title .

6. Ulnar wrist extensor, m. extensor carpi ulnaris adjacent its lateral edge to the common extensor and extensor of zinets, starts with these muscles from the lateral epicondyle of the humerus and from the posterior edge of the ulna. Tendon muscle tendon passes through the sixth channel under the retinaculum extensdrum and sealed to the base of metacarpal V

Function. Extends the brush and leads her to the ulnar side, with m. flexor carpi ulnaris.

Deep layer

7. Supinator, m. supinator is located in verhaltener the part of the forearm it is covered with m. brachioradialis and the two radial extensors of the wrist. Starting from the lateral epicondyle of the humerus, lig. collaterale radiale elbow joint and from the upper end of the ulna, it covers the proximal end of the radius above and below the tuberositas radii.

Function. Pure supinator of the forearm.

8 and 9. Long muscle, abductor thumb brushes m. abductor pollicis longus short extensor of the thumb, m. extensor pollicis brevis, start next from the rear surface of the radius, the interosseous membrane and partly from the ulnae of the first muscle above the second. Hence, they are distal and in the lateral direction, beyond the radial edge of the common extensor of the fingers and passing through the first channel under the retinaculum extenorum, heading to the big toe, where the tendon m. abductor pollicis longus is attached toward the base of the I metacarpal bones, part of the tendon to the beginning of m. abductor pollicis brevis, and the tendon m. extensor pollicis brevis to the base of the proximal phalanx of the thumb.

Function. M. abductor pollicis longus attaches the thumb and produces radial retraction of the brush m. extensor pollicis brevis extends the proximal phalanx of the thumb.

10. Long extensor of the thumb, m. extensor pollicis longus, starting from the middle third of the posterior surface of the ulna, its tendon goes under the common extensor of the fingers below the previous two muscle crosses obliquely the tendons of both the radial extensors of the brush, passes under the retinaculum extensorum in the third channel and then goes to the back of the thumb where it attaches to the base of the distal phalanx. With the radial side of the radiocarpal joint, between the tendons m. extensor pollicis longus on the one hand, and mm. extensor pollicis brevis and abductor pollicis longus on the other, a recess is formed, called the anatomical snuffbox.

Function. Unbend your thumb, and pulling it rear side.

11. The extensor digitorum communis, m. extensor indicis, originates from the distal third of the posterior surface of the ulna. Its tendon passes with the tendon of the common extensor digitorum through fourth channel under the retinaculum extensorum and joins ulnar side of tendon of common extensor muscle going to the index finger, moving to the back of the tendon tension of the thumb.

The function corresponds to the name.

Muscles of the hand

In addition to the tendons of forearm muscles passing on the dorsal and Palmar sides of the hand, on the latest there are perfect muscle that starts and ends in this Department of the upper limb. They are divided into three groups. Two of them, located at the radial and ulnar side of the palm, forming the Eminence of the thumb, thenar, and the rise of the little finger, hypothenar, third (middle) group respectively overlying the Palmar depression, palma manus. In humans, the muscles of the hand represents the most important part of the upper limb — on work, reach the highest perfection. In the process of human evolution and development compared to anthropoids made up muscles of the big toe, so that the person has the ability to maximum opposition to it. This is expressed by the ability when Hey fist hand to get the end of the thumb joints of the V finger. Topeka reaches maximum development and extensors, and each finger 1aeт the possibility of a total rectification. As a result, the brush, and each finger to acquire the ability to maximum flexion and extension for work.

The muscles of the thenar

1. Short muscle, abductor thumb brushes m. abductor pollicis brevis lies superficial to all, starts from the retinaculum flexorum and tuberculum ossis scaphoidei and attached to the radial surface of the base of the proximal phalanx of the thumb.

Function. Withdrawal of the thumb carpometacarpal joint .

Short flexor of the thumb, m. flexor pollicis brevis, consists of two heads. Surface head starts from the retinaculum flexorum, goes along the ulnar edge of the thenar and narrowing is attached to the radial sesamoid bone in the region of the metacarpophalangeal tion of the thumb. Deep head starts from the ossa trapezium, trapezoideum and os capitatum, the main ground is attached to the base of the proximal phalanx of the big finger and a thin beam to the radial sesamoid bone. In the groove formed between the two heads of the muscle, tendon passes m. flexor pollicis longus.

Function. Flexes the proximal phalanx of the thumb and opposes it in part .

3. Muscle that opposes the thumb, m. opponens pollicis, lies along the radial edge of the thenar under m. abductor pollicis brevis. Starting from the retinaculum flexorum and from the tubercle of the os trapezium, it is attached at the radial edge of the I metacarpal bone.

Function. Opposes the thumb to the little finger, drawing to the palm of his metacarpal bone

4. The muscle that leads the thumb, m. adductor pollicis lies deep in the palm. Starting from the III metacarpal bone, she runs ahead of II metacarpal bone and is attached to the ulnar sesamoid bone and the base of the proximal phalanx of the thumb.

Function. Leads and partly opposes thumb

The muscles of hypothenar

1. Short Palmar muscle, m. palmaris brevis, located superficially under the skin. Starts from the Palmar aponeurosis and ends in the skin on the ulnar edge of the palm.

Function. Tightens Palmar aponeurosis.

2. Muscle, abductor little finger, m. adductor minimi digiti lies along the ulnar surface of the hypothenar region. Starts from the retinaculum flexorum and os pisiforme, is attached to the ulnar edge of the base of the proximal phalanx of the V finger.

Function. Takes a little finger.

3. Short flexor of the little finger, m. flexor digiti minimi brevis lies along the radial edge of the previous muscle. Starting from the retinaculum flexorum and the hook os hamatum, he is attached to the base of the proximal phalanx of the little finger.

Function. Flexion of the proximal phalanx of the V finger.

4. Muscle that opposes the little finger of the thumb, m. opponens digiti minimi, almost completely covered by the two preceding muscles. Originates from the retinaculum flexorum and the hook os hamatum; attached on the ulnar edge of V metacarpal bones.

Function. Draws the little finger towards the thumb (opposition).

Muscle Palmar depression. 1. Worm-like muscles, mm. lumbricales, four narrow muscle bundle between the tendon of the deep flexor of the fingers from which they originate. Heading to the fingers, worm-like muscles envelop the heads of the metacarpal bones with radial sides and are attached at the rear of the proximal phalanges to a tendon stretching of the common extensor of the fingers.

Function. Muscles bend and straighten the proximal middle and distal phalanges II—V fingers.

2. Interosseous muscles, mm. interossei occupy the intervals between the metacarpal bones and are divided into the palm and back. Performing mainly the function of abstraction and bring the fingers to the midline, they naturally clustered around the middle finger. So, three Palmar, mm. interossei palmaris, as adductors located in diverging from the middle line, i.e. from the third metacarpal bone, direction and therefore are attached to the back of the tendon tension of the m. extensor digitorum II, IV and V fingers. I finger m is its own. adductor pollicis, how would replacing the fourth Palmar interosseous muscle. Four detailed mm. interossei dorsales, as abductors, are located in species to the III metacarpal direction and attached to the II, III and GU fingers. Edge fingers (I and V) have their abductor. All of the interosseous muscles also Flex the proximal phalanx and unbend middle and the rest like a worm. Thus, each phalanx of each finger has one or even two separate muscles, setting it in motion, for example, proximal phalanx of each of II—V fingers bend mm. lumbricales and interossei palmares, middle—m. flexor

digitorum superficialis and the distal — m. flexor digitorum profundus. The functional individuality of the muscles and their tendons in the monkey are less pronounced than in humans.

The muscles and fasciae of the lower limb

The muscles of the lower limb are divided into the muscles of the girdle of the lower limb, muscles of the thigh, leg and foot. Muscles are innervated by the lower limbs from lumbar and sacral plexus, plexus lumbalis et sacralis.

Muscle belt of the lower extremity

Muscle belt of the lower extremity from the pelvis to the upper end of the femur and produce movement in the hip joint around all three major axes. They are located on all sides of the joint and perform all kinds of movements. The attachment points on the thigh and the main functions are divided into front and rear groups.

Anterior group (flexors) is attaching on the trochanter minor; it includes m. iliopsoas (m. psoas major and m. iliacus) and m. psoas minor.

Posterior group (extensors, rotators and abductor muscle) is attached to the trochanter major, or of its circumference. It includes: m. gluteus maximus m. gluteus medius, m. tensor fasciae latae, m. gluteus minimus, m. piriformis, m. with the obturator internus mm. gemelli, m. quadratus femoris and m. obturator externus.

The front group.

1. Ilio-psoas muscle, m. iliopsdas, consists of two heads. One big lumbar muscle, m. psdas major originates from the lateral surfaces of the bodies and intervertebral discs of the XII thoracic and four upper lumbar vertebrae and from the transverse processes of the lumbar vertebrae. Going down and somewhat laterally, suitable for m. iliacus. Second - iliac muscle, m. iliacus, starts from the fossae iliacae of the Ilium, and spinae iliacae anterior superior et inferior. With the medial side it is covered by a few m. psdas, and between the edge of the latter and it formed a deep groove in which lies the femoral nerve. Fiber iliac muscles, converging downwards, to join m. psoas major, grow together in a single m. iliopsoas; the latter is located on the anterior surface of the hip joint, exits from under the inguinal ligament through the lacuna musculorum and is attached to the trochanter minor.

Function. Produces flexion and supination of the thigh in the hip joint. In strengthening the lower limbs can bend the lumbar spine .

2. Lumbar small muscle, m. psoas minor, adjacent to m. the psoas major. It goes into the fascia iliaca, ending at eminentia iliopubica. Found not always

Function. Stretches the fascia and can bend the lumbar part of the spine.

The rear group.

1. The gluteus Maximus, m. gluteus maximus, is a massive layer of muscle lying directly under the skin and fascia in the region of the buttocks. Starting from the outer surface of the Ilium, from the fascia thoracolumbalis, from the lateral parts of the sacrum and coccyx, and from the lig. sacrotuberale, descends obliquely downward and laterally in parallel muscle bundles separated soedinitelnotkannoj thin partitions extending from the fascia covering the muscle. The front part of the muscle bundles by going to a wide flat tendon, greater trochanter wrapping around the side and continues in the broad fascia of the thigh (tractus iliotibialis it). The back part of the muscle attaches to the tuberositas glutea of the femur. Between the tendon of the muscle and the great trochanter lies a synovium, bursa trochanterica m. glutei maxim i.

Function. Being an antagonist of m. iliopsdas, extends the leg in the hip joint, turning it somewhat outward, and in strengthening the legs produces straightening bent forward trunk. When standing, if the resultant of gravity is projected ahead of the transverse axis of the hip joints ("military" posture), muscle tension maintains the equilibrium of the pelvis together with the body, not allowing him to zaprokidyvaya anteriorly .

2. Gluteus Medius, m. gluteus medius, in its rear part covered with m. gluteus maximus, and the front is superficial. Starting from the outer surface of the Ilium, fan-shaped abdomen and ends in a flat tendon from the lateral surface of the greater trochanter near the top.

Function. With the reduction removes the thigh. Front of its beams, by subtracting separately, rotate the thigh inward and the rear outward; when the support body on one leg she tilts the pelvis at its side .

3. The tensor of the broad fascia, m. tensor fasciae latae, embryologically represents the removal of the middle gluteal muscle and is located immediately ahead of the last on the lateral side of the thigh between two sheets of the femoral fascia, when healing with the beginning of m. gluteus medius and its distal end passes into the thicker band of the broad fascia of the thigh called the tractus iliotibialis. This band extends along the lateral surface of the femur and attaches to the lateral condyle of the tibia.

Function. Pulls tractus iliotibialis, and through it acts on the knee joint and flexes the thigh. By linking to m. large tensor fasciae latae and gluteus Medius muscles contribute to movement in the knee joint in terms of flexion and rotation outwards.

4. Small gluteal muscle, m. gluteus minimus lies under the gluteus Medius. Starting from the outer surface of the Ilium and attaches to the anterior surface of the greater trochanter flat tendon. Tendon lies under the bag, burs a trochanterica m. glutei minimi.

Function. The same as m. gluteus medius

5. The piriformis muscle, m. piriformis starts on the pelvis surface of the sacrum lateral anterior sacral holes, goes through the foramen ischiadicum majus from the cavity of the pelvis, passes transversely along the rear side of the hip joint and attaches to greater trochanter. The muscle is not fully foramen ischiadicum majus, leaving the top and bottom edges of this peep hole for the passage of vessels and nerves.

Function. Rotates thigh laterally and partly removes it; in strengthening the leg can tilt the pelvis to its side.

6. The internal obturator muscle, m. obturatorius internus takes origin from the inner surface of the circumference of the foramen obturatum and the membrana obturatoria, passes through a bony foramen ischiadicum minus edge and is attached to the fossa trochanterica of the femur. On the break through the bone under the muscle lies a synovium, bursa ischiadica m. obturatorii interni. At the edges of the tendon m. obturatorius internus, lying outside of the cavity of the pelvis, on the posterior side of the hip, grow two flat and narrow muscle bundle, the so—called muscle-twins, mm. gemelli, of which the upper (t gemellus superior) begins at the spina ischiadica, a lower (m. gemellus inferior) from the point of buttock. Both of these small muscles together with the tendon of the m. obturatorius attached in the fossa trochanterica being covered with the surface of the gluteus Maximus.

Function. Rotates the thigh outwards.

7. Square thigh muscle, m. quadratus femoris, lying downward from m. gemellus inferior below the lower edge of the gluteus Maximus muscles. Muscle fibers located in the transverse direction from the buttock to the cristae intertrochantericae of the femur.

Function. Rotates the thigh outwards.

8. The outer sphincter muscle, m. obturatorius externus, starting from the outer surface of the pelvis at the medial circumference of the obturator foramen, and also from membranae obturatoriae, around the bottom and back of the capsule of the hip joint and is attached by a narrow tendon to the fossa trochanterica and the articular capsule.

Function. Produces hip rotation outwards.

Thigh muscles

The thigh muscles involved in walking upright and keeping my body in a vertical position, driving the long bone levers. In this regard, they become long and grow into a powerful mass with one common tendon, forming a many-headed muscle (e.g., biceps and quadriceps).

The thigh muscles are divided into 3 groups: anterior (mainly extensor), posterior (flexors) and the medial (adductor). The last group acts on the hip joint, and the first two also, and mainly, on the knee, producing motion mainly around its frontal axis, that is determined by their position on the front and back surfaces of the femur and attaching on the tibia.

With the lateral side of the front and rear groups of muscles are separated from each other the lateral intermuscular septum, lateral septum intermusculare e, the femoral fascia attaches to the lateral lip of the lineae asperae femoris, and the medial side is wedged between layer of adductors.

Front group

1. Quadriceps femoris, m. the quadriceps femoris occupies the entire front and partially lateral surface of the thigh and consists of four interconnected heads:

1) rectus femoris, m. rectus femoris, is the surface and starts from the spinae iliacae anterior and inferior from the upper edge of the acetabulum, being covered from its beginning the m. tensor fasciae latae and m. sartorius; rectus muscle runs along the mid-thigh and above the patellae is connected to the common tendon of the quadriceps muscle throughout;

2) lateral broad muscle, m. vastus lateraIis, surrounds the femur with the lateral side, taking the beginning of lineae intertrochantericae, from the lateral surface of the greater trochanter and lateral lip lineae asperae femoris; muscle fibers run obliquely downward and ends above the patellae;

3) medial broad muscle, m. vastus media1is lies medially relative to the femur, starting from the labium mediate lineae asperae femoris; its muscular bundles run in an oblique direction from the medial side laterally and downward;

4) intermediate wide muscle, m. vastus intermedius lies directly on the anterior surface of the femur, from which it receives the beginning, reaching almost to the proximal lineae intertrochantericae. Its fibers are parallel in the vertical direction to the common tendon. The edges of the intermediate wide muscle is covered by m. vastus lateralis and vastus medialis, with which it fused here. Ahead of her lies m. rectus femoris. All these parts of the quadriceps muscle above the knee joint to form a common tendon, which, fixing to the base and side edges patellae, continues in lig. patellae attaches to tuberositas tibiae. Part of the tendon fibers mm. vastus lateralis et medialis on the sides of the patellae are going down to the sides, forming retinacula patellae mentioned in astrologie. Patella, inserted, in frame, into the tendon of the quadriceps muscle, increases the action of the shoulder muscle strength, which increases the moment of rotation.

Function. Extends the tibia in the knee joint. M. rectus femoris, thrown over through the hip joint, flexes it.

2. The Sartorius muscle, m. sartorius, starting from the spinae iliacae anterior superior, descends in the form of a long tape down and the medial side I attached to the fascia of the leg and tuberositas tibiae.

Function. Flexes the lower limb in the knee joint, and when the latter is bent, rotates the tibia medially, acting along with other muscles that attach to the tibia just where it is. Can also bend and supinate your thigh in the hip joint, supporting this action m. iliopsoas and m. rectus femoris.

The back panel

1. Poluchila muscle, m. semitendinosus, called so because of its long tendon, which occupies nearly the whole of its distal half. Starts on the ischial tuberosity and is attached behind m. gracilis to the tuberositas tibiae and fascia of the lower leg. Tendon m. semitendinosus from their places of attachment along with the tendon of the m. gracilis and m. sartorius forms a triangle, connecting with the fasciae cruris tendon tension, the so-called surface houndstooth pes anserinus superficialis, under which lies a synovium, bursa apega.

2. Paliperidonesee muscle, m. semimembranosus lies under the previous one. It begins on the ischial tuberosity by a tendon plate, which is nearly the entire proximal half of the muscle, hence its name. Ultimate tendon is divided at the point of attachment to beam three, pes anserinus profundus of which one is attached to the medial condyle of the tibiae, the other to the fascia covering it with the medial side of m. popliteus, and the third is wrapped to the back surface of the knee joint, passing in lig. cruris popliteum obliquum.

3. Biceps femoris, m. biceps femoris, placed closer to the lateral edge of the femur, being separated from the vastus lateralis of the lateral intermuscular septum. The muscle consists of two heads. Long, caput Idngum, begins with m. semitenoinosus on the ischial tuberosity; short head, caput breve, departs from the middle third of the lateral lip lineae asperae femoris and the septum intermusculare femoris laterale. Both heads joining together attached to the head of the fibula.

4. Popliteal muscle, m. popliteus, a triangular shape, lies on the posterior surface of the knee joint. Starting from epicdnoylus lateralis of the femur and from the capsule of the knee joint (lig. popliteum obliquum), grows to proximal division of the posterior surface of the tibia

Function. As mm. semitenoinosus, semimembranosus and biceps femoris thrown through two joint, with a fixed pelvis, they, acting together, bend the drumstick at the knee joint, bend the thigh, and reinforced lower leg produces extension of the body together with the gluteus Maximus. When the knee is bent, the same muscles exercised by the rotation of the tibia, by subtracting separately on one side or the other. Laterally rotates the tibia biceps muscle, and inside — m. semitendinosus and semimembranosus. M. popliteus acts only on one knee, bending the latter and turning the lower leg inward.

Medial group

1. Comb-like muscle, m. pectineus, starting from the upper branch and the crest of the pubic bones and lig. pubicum superius, goes down and a few to the side and attaches to the linea pectinea of the femur. His lateral edge of the comb in contact with the muscle m. iliopsoas. Both of these muscles, converging with each other to form the fossa triangular fossa iliopectinea,B which are placed in the femoral vessels immediately upon their exit from the pelvis.

2. Long adductor muscle, m. adductor longus, originates on the anterior surface of the upper branch of the pubic bone and attaches to the medial lip of the lineae asperae femoris in the middle trimester.

3. Short adductor muscle, m. adductor brevis lies under the previous muscles. Starts from the anterior surface of the pubic bone and attaches to the medial lip of the lineae asperae femoris at the top.

4. A large adductor muscle, m. adductor magnus, the most powerful of all the adductors. She lies furthest posteriorly and covered his front in the proximal part of mm. adductores brevis et longus. Starting from the branches of the pubic and ischial bones and from the tuber ischiadicum, m. adductor magnus is directed in the lateral direction and is attached to the medial lip of the lineae asperae femoris along its entire length to the medial condyle of the femur. The upper fibers of the muscles go from the pubic bone to the attachment site almost transversely and are described separately under the name of little adductor muscle, m. adductor minimus.

5. Thin muscle, m. gracilis, a long and narrow muscular ribbon, passing superficial to the medial edge of the total mass of the adductors. It starts on the lower branches of the pubic bone near the pubic symphysis. Attaches to the fascia of the tibia at the tuberositas tibiae.

Function. All the adductor muscles, according to their name, produce a cast of the thigh, rotating it somewhat outwards. The ones that cross the transverse axis of the hip joint from the front (mm. pectineus, adductor brevis et Idngus), can also produce flexion at this joint, a m. adductor magnus, located posterior to this axis, on the contrary, it produces extension. M. gracilis as the two thrown over the joint, in addition to bringing the hip performs flexion of the tibia in the knee joint and rotates it medially.

The calf muscles

The calf muscles result in movement of the distal part of the limb — the foot — and adapted as your thigh muscles to keep the body upright and moving him along the ground. Therefore, there is no subtle specialization of individual muscles, as is seen on the forearm in connection with the function of the hand as the organ of labor, but rather large muscle mass grow together and get a common tendon, combining their efforts to produce more powerful and larger movements necessary to keep a vertical position when standing erect. Accordingly, the movement around the frontal axis of the ankle joint and finger joints most of the muscles located on the anterior and posterior surfaces of the tibia, between the two Shin bones at the front (front muscles) and back (posterior). Accordingly, the movement of the foot around a sagittal axis of the muscle and lie on the side, along the fibula (the lateral muscles).

In its origin the first and third group belong to dorsally the muscles of the lower limbs and ventral. Back other group is more developed and consists of two layers: surface (calf muscle) and deep. All calf muscles are in the longitudinal direction and attached to the foot, and some of them have points of attachment on the bones of the Tarsus and on the bases of the metatarsal bones, and others in the phalanges. The fleshy part of the muscles are placed in the proximal tibia, distal the same direction to the foot muscles turn into tendons; as a result, the shank has a conical shape. As for the function, then the front muscles produce extension of the foot, and those that go to the fingers, bend of the latter. Flexion of the foot making a back and lateral muscles, tendons which are suitable to stop back or side of the sole. In addition, some of the back muscles bend the fingers. Pronation and supination of the foot are mainly manufactured by those leg muscles that have attachment on the medial or lateral edge of the foot.

Front group

1. Anterior tibial muscle, m. tibialis anterior, the most medial in this group. Begins on the lateral myselt and the lateral surface of the tibia in its proximal two thirds, and from the interosseous membrane and fascia cruris. Going down along the tibia, it passes into a strong tendon, running through the most medial fibrous channel under the retinaculum mm. extensorum superius et inferius to medial edge of the back of the foot where it attaches to the os cuneiforme mediale and the base I metatarsal bone.

Function. Extends foot and lifts its medial edge (supination), together with m. tibialis posterior leads stop. When the foot is strengthened, the muscle inclines the tibia anteriorly, bringing it closer to the rear of the foot.

2. Long extensor digitorum, m. extensor digitorum longus, originates from the lateral condyle of the tibiae, from the head and anterior surface of fibula, interosseous membrane and fascia of lower leg, down, the muscle goes into a tendon, which is divided into four parts, going through the lateral channel on the back of the foot, where the tendons diverge fan-shaped and attached to a tendon sprain on the dorsum of II—V fingers. From distal part of m. extensor digitorum longus from the lateral side separated by a small muscle bundle, giving the fifth tendon, which, passing under the retinaculum mm. extensorum inferius is attached to the base V metatarsal bone. This beam is called m. peroneus (fibularis) lertius. In it one can see a first stage of isolation of new human muscle (it's not monkeys) is a pronator of the foot necessary for walking upright.

Function. Together with m. tertius peroneus extends the foot, raises her lateral edge (pronation) and puts the foot. Reinforced foot action Alt. tibialis anterior. In addition, extends the four fingers (II—V).

3. Long extensor of the big toe, m. extensor hallucis longus lies more deeply between the described two muscles, originates from the medial side of the fibula and interosseous membrane, descends through the middle channel under the retinaculum mm. extensorum inferius on the back of the foot to the big toe where it attaches to the distal phalanx, giving beam to the proximal phalanx.

Function. Extends the foot, raises its medial edge and extends the thumb. A fixed stop, together with other front muscles tips KPE-Redi leg.

Lateral group

1. Long peroneal muscle, m. peroneus (fibularis) longus lies superficial and originates from the head and proximal third of the lateral surface of the fibula, and from the front and rear intermuscular septa and fascia of the lower leg. The tendon passes behind and below the lateral malleolus, lying in the synovial vagina under the retinaculum mm. peroneorum superius. and attaches to the medial wedge and I metatarsal bones. Here, at the medial edge of the rear foot is attached by a strong tendon m. tibialis anterior. Together these muscles form a stirrup like to support the transverse arch of the foot. Attachment to the medial cuneiform bones is peculiar to man.

2. The short peroneal muscle, m. peroneus (fibularis) brevis lies under the previous one. Its tendon goes behind lateral malleolus in a common vagina with the previous muscle and attaches to the tuberositas ossis metatarsi V. Sometimes it gives a thin beam to the tendon of the extensor of the V finger.

Function. Both peroneal muscles Flex, paniruyut stop, lowering its medial edge and the lateral lifting, and assign the foot.

The rear group.

The surface layer (calf muscle).

1. Triceps muscle of calf, m. triceps surae, forms the main mass of the elevation of the calf. It consists of two muscles — m. gastrocnemius, superficial, and m. soleus, which lies beneath it; both muscles below have one common tendon.

Calf, m. the gastrocnemius, starts from the facies poplitea of the femur back over both condyles of the two heads that its the beginning of the tendon fuse with the capsule of the knee joint (under each head is the synovial bag, bursa subtendinea m. gastrocnemii lateralis et medialis).

Head pass into a tendon, which, joining with the tendon m. soleus, continues in massive calcaneal (Achilles) tendon, tendo calcaneus (Achillis), attached to the rear surface of the tuber calcaneus. At the point of attachment between the tendon and the bone is laid very constant synovium, bursa tendinis calcanei.

Soleus, m. soleus, thick and fleshy. Lies under the calf muscle, has a large stretch on the bones of the lower leg. Its start line is located on the head and upper third of the posterior surface of the fibula and descends in the tibia almost to the border of the middle third of the leg from the bottom. In the place where the muscle burn from the fibula to the tibia, forms a tendinous arch, arcus tendineus m. solei, which are suitable popliteal artery and n. tibialis. Tendon stretching m. solei blends with the calcaneal tendon.

2. Plantar muscle, m. plantaris. Originates from the facies poplitea above lateral condyles of femur and capsule of the knee joint, soon turns into a very long and thin tendon, which stretches the front of m. the gastrocnemius and attaches from the heel of the hill. This muscle undergoes a reduction in humans is rudimentary education, owing to what may be missing.

Function. All muscles m. triceps surae (including m. plantaris) produces flexion at the ankle joint as when the free leg, and by relying on the end stops. As the line pull of the muscle passes medial to the axis of the subtalar joint, she still leads and Spinneret stop. On standing m. triceps surae (especially m. soleus) prevents the overturning of the body anteriorly in the ankle joint. The muscle has to work mainly with the burdening weight of the whole body, but because it has strength and has the largest physiological cross-section; m. gastrocnemius, as dvoastra muscle, can also bend the knee reinforced Shin and foot.

Deep layers, separated from the superficial to the deep fascia of the leg, consists of three flexors, three namesake who oppose the extensors, lying on the anterior surface of the tibia.

3. Flexor digitorum longus, m. flexor digitorum longus, the most medial of the muscles of the deep layer. Lies on the posterior surface of the tibia, from which it originates. The tendon of the muscle descends behind the medial malleolus, on the mid-sole is divided into four secondary tendons that go to the four fingers (II—V), pierce, like the deep flexor on the brush of the tendon m. flexor digitorum brevis and attached to the distal phalanges.

Function in the sense of flexion of the toes small; the muscle primarily acts on the foot as a whole, producing under free leg flexion and supination of it. She also, along with m. triceps surae is involved in setting the foot on the toes (tiptoeing). When standing muscle along with the long plantar ligament, lig. plantare longum, actively promotes the strengthening of the longitudinal arch of the foot. When walking pushes the fingers to the support.

4. The posterior tibial muscle, m. tibialis posterior occupies the space between the bones of the lower leg, lying on the interosseous membrane and partly on the tibial and fibular bones. This muscle receives its primary fiber, then its tendon curves around the medial ankle and went out on the sole attaches to the tuberositas ossis navicularis, and then several beams to the three cuneiform bones and bases of II—IV metatarsal bones.

Function. Flex the foot and brings it together with m. tibialis anterior. Together with other muscles, is also fixed on the medial edge of the foot (m. tibialis anterior and m. peroneus longus), m. tibialis posterior also involved in the formation of "stapes", which strengthens the transverse arch of the foot. Stretching your tendon through lig. calcaneonaviculare, muscle support along with this bundle the head of the talus.

5. Long flexor of the big toe, m. flexor hallucis longus, the lateral muscles of the deep layer. Lies on the posterior surface of the fibula, from which it originates, the tendon is in the groove on the processus posterior of the talus, sustentaculum tali fit to the thumb, where it attaches to the distal phalanx.

Function. Bends the thumb, and also due to possible Association with tendon m. flexor digitorum longus can act in the same sense at the II and even III and IV fingers. Like the rest of the rear muscles of the calf m. flexor hallucis longus produces flexion, adduction and supination of the foot and strengthens the longitudinal arch of the foot.

Pathological changes in the ligaments and tendons of the foot lead to ptosis (flattening) of its arches and flat feet.

The muscles of the foot

Stop, as well as brush in addition to tendons belonging down at her long calf muscles, has its own short muscles, these muscles are separated on the back (dorsal) and bottom.

The back muscles

Short extensor digitorum, m. extensor digitorum brevis, is located on the back of the foot under the tendons of the long extensor and originates on the calcaneus in front of the entrance to the sinus tarsi. Going forward, divided into four thin tendons to the I—IV fingers, which are attached to the lateral edge of the tendon m. extensor digitorum longus and m. extensor hallucis longus, and together with them form the back tendon stretching fingers. Medial abdomen, running obliquely down along with his tendon to the big toe, is even a special name— m. extensor hallucis brevis.

Function. Performs extension I—IV of the fingers together with a light diverting them in the lateral direction

Plantar muscles.

Form three groups: medial muscles of the thumb), lateral (muscles of the little finger) and the average lying in the middle of the sole.

Muscles of the medial group of three.

1. Muscle, abductor hallucis, m. abductor hallucis,)raspolagetsya most superficially on the medial edge of the sole; originates from the processus medialis calcaneal tuber, the

retinaculum mm. flexorum and tuberositas ossis navicularis; attaches to the medial sesamoid bone and the base of the proximal phalanx.

2. Short flexor of the big toe, m. flexor hallucis brevis, adjacent to the lateral edge of the previous muscle begins on the medial cuneiform bone and lig. calcaneocuboideum plantare. Heading straight ahead is divided into two heads, between which passes the tendon of m. flexor hallucis longus. Both heads are attached to the sesamoid bones in the region of the first metatarsophalangeal joint and the base of the proximal phalanx of the thumb.

3. Muscle, adductor hallucis, m. adductor hallucis, lies deep and consists of two heads. One of them (oblique head, caput obliquum) takes origin from the cuboid bone and lig. plantare longum, as well as from the lateral cuneiform and bases of II—IV metatarsal bones, and then passes obliquely forwards and somewhat medially. The other head (lateral, caput transversum) starts from joint of bags II—V metatarsophalangeal joints and the plantar ligaments; it is transversely to the longitudinal axis of the foot together with the oblique head attaches to the lateral sesamoid bone of the thumb.

Function. Muscles of the medial group of the sole, in addition to the actions specified in the titles, participate in strengthening of the arch of the foot on its medial side.

Muscles of the lateral group:

1. Muscle, abductor little finger of the foot, m. abductor minimi digiti lies along the lateral edge of the sole, superficial to other muscles. Starts from the calcaneus and attaches to the base of the proximal phalanx of the little finger.

2. Short flexor of the little finger of the foot, m. flexor digiti minimi brevis, starting from the base V metatarsal bone and attaches to the base of the proximal phalanx of the little finger.

The function of the muscles of the lateral group of the midsole in terms of the impact of each one on the little finger of the minor. Their main role is to strengthen the lateral edge of the arch of the foot.

The muscles of the middle group.

1. Short flexor of fingers m. flexor digitorum brevis, is the surface under the plantar aponeurosis. Starts from calcaneal tuberosity and divides into four flat tendons that attach to the middle phalanges II—V fingers. Before his attachment of the tendon are split each in two legs, between which the tendon of the m. Pehov digitorum longus. Muscle holds the arch of the foot in the longitudinal direction, and flexes the fingers (II—V).

2. Square muscle sole, m. quadratus plantae (m. flexor accessorius), lies beneath the previous muscle, starts from the heel bone and then attaches to the lateral edge of the tendon m. flexor digitorum longus. The beam that regulates the action of flexor digitorum longus, giving it a thrust the forward direction relative to the fingers.

3. Worm-like muscles, mm. lumbricales, four of them. As on the hand, they depart from the four tendons of flexor digitorum longus and attach to the medial edge of the proximal phalanx II—V fingers, They can bend the proximal phalanx; extending the action to other phalanges are very weak or absent. They can still attract the other four fingers in the direction of the thumb.

4. Interosseous muscles, mm. interossei, are most deeply from the soles, respectively, in the intervals between the metatarsal bones. Separated, and namesake of the muscles of the hand into two groups: three plantar, mm. interossei plantares and the back four, mm. interossei dorsales, they however differ in their location. In the brush in connection with its prehensile function, they are grouped around the III finger, foot in her supporting role, they are grouped around the second finger, i.e., the II metatarsal bone.

Functions: lead and spread my fingers, but in a very limited scope.

Equipments of the lesson: posters, models, slides

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Lecture № 9. Topography of the upper extremity. Topography of lower extremities.

Model of teaching technology

Class time - 2 hours	Number of students: 36-48
Form of lesson	Introduction, visual lecture
The plan of the lecture	1. Fascia of the upper limb and tendon sheath 2. The topography of the upper limb 3. Fascia of the lower limb and tendon sheath 4. The topography of the lower limb
The purpose of the lesson: To acquaint students with the structural features of muscles of the limbs, their classification, topography and practical value.	
Method and technique of teaching	Visual lecture, blitz-inquiry, presentation, cluster, "yes-no" technique
Form of training	Collective, group
Means of education	Textbook, lecture material, projector, graphic organizers
Teaching conditions	Technically equipped audience
Monitoring and control	1.Femoral triangle 2. Femoral canal. 3.Popliteal fossa 4. Canalis cruro-popliteus

Technological map of the lecture lesson

Stages, time	Teacher	Students
Preparatory stage (5minutes) Stage 1 Introduction	Verification of student progress 1.1. Introduces the topic of the lecture, its purpose and	Preparation of training tools. Listen, write

(15 minutes)	expected results.	
2 stage Main part (50 minutes)	2.1. In order to attract students' attention and check the level of their knowledge, question answer. 2.2. Using visual materials, continues the presentation of the lecture material 2.3.-The structure and topography of muscles of the upper and lower extremities. 2.4. Draws the attention of students to the basic concepts of the lecture and asks them to write down	2.1. Listen. They think. Answer and listen to the right answers 2.2. Discuss the essence of schemes, graphs, slides. Ask questions, write the highlights of the lecture 2.3. Remember, write, try to answer questions 2.4.Write, give examples
Stage 3 Final (5 min.)	3.1. Draws conclusions and draws students' attention to the main points. Encourages actively participating students	3.1. Listen, concretize.
4 stage Tasks of independent work (5 minutes)	4.1. Task of independent work: make a cluster for the word "the femoral canal "	4. Write down the task

Theoretical part of the lecture:

Fascia of the upper limb and tendon sheath

The deltoid muscle lying in the deltoid region, covered by a thin fascia deltoidea, which gives processes that penetrate between the bundles 1ышцы. The front of this fascia passes into the breast fascia, rear — superficial fascia of the back, it merges with the brachial fascia. Fascia of shoulder, fascia brachii clothing around the shoulder muscles, quite thin. On the sides of her into one of the fibrous intermuscular septum, septa intermuscularia brachii, a muscle which separates the front from the back . The medial septum, the septum intermusulare brachii mediale, is between the m. brachialis and triceps muscle adheres to the bone crest over epicdondylus medialis shoulder. The lateral septum, the septum intcrmusculare brachii laterale, is at the other edge of the shoulder between the shoulder and triceps muscles, and the distal between the latter and the m. brachioradialis and fused with the lateral scallop of Paradise on the humerus epicondylus lateralis. The elbow the fascia of the shoulder goes into the fascia of forearm, fascia antebrachii, and here has the thicker stripes, which is the superficial part of the tendon of the biceps muscle of the shoulder - the aponeurosis m. bicipitis brachii. Fascia antebrachii, covering the muscles of the forearm, giving between them a fibrous septum. It also adheres to namiseom shoulder and to the rear edge of the ulna. On the border with brush fascia of the forearm forms the rear transverse thickening in the form of the extensor retinaculum, retinaculum extensorum. The latter by processes of the fused dorsal surface of the radius and ulna. Between these processes under the retinaculum are six part of the osteo-fibrous, the fibrous part of the only channels through which pass the tendons of the extensors of the fingers. In the first channel (counting from the radial edge) pass the tendon m. abductor pollicis Idngus and m. extensor pollicis brevis, the second (sometimes double) — tendons of the mm. extensores carpi radiales longus et brevis; the third, crisscrossing obliquely— tendon m. extensor pollicis Iongus in the fourth — tendon m. extensor digitorum and m. extensor indicis; the fifth, located more superficially, the tendon m. extensor digiti minimi and, finally, in the sixth — tendon m. extensor carpi ulnaris. The duct walls are lined with synovial membrane, which above and below the retinaculum extensorum is wrapped on the tendons and covers them, forming a tendon sheath, vaginae tendinum, the back muscles. The number of sheaths corresponds to the number of channels. From under the retinaculum extensorum the vagina face back of the hand. On the Palmar surface of the fascia in the middle of the palm is much thickened and forming a strong Palmar aponeurosis, the aponeurosis palmaris, which is a continuation of the tendon of the m. palmaris longus. The Palmar aponeurosis is triangular in shape, the apex of which lies on the retinaculum flexorum, the base directed to the toes where the fascia at odds on four flat beam between which extend transverse of the fibres, fasciculi transversi. Under the aponeurosis is a flat fibrous ligament that holds the tendons of the flexors and therefore called the retinaculum of the flexor tendons, retinaculum flexorum. On both sides of the Palmar aponeurosis, where it turns into thin plates, clothing thenar and hypothenar him depart deep fascial sheets, which are fused with the deep fascia of the palm covering mm. interossei. Thus, in the middle of the palm is formed as a receptacle for flexor tendons and mm. lumbricales. There is another fascia which covers the interosseous muscles on the back of the hand, grow together with the periosteum of the metacarpal bones, fascia dorsalis manus.

The topography of the upper limb

The topography of the armpit (regio axillaris), or fossa (fossa axillaris). In the abduction hands clearly revealed axillary region. Border it (when designated hand) front — the lower edge m. pectoralis major, behind — the lower edge m. latissimus dorsi and m. teres major, medial — an imaginary line connecting the edges of these muscles on the chest, outside the line connecting the same edge on the inner surface of the shoulder. On removing the fascia, forming together with the bottom skin of the axillary fossa, axillary open cavity, cavitas axillaris. Walls of the axillary cavity: front — mm. pectorales major et minor, rear — mm. latissimus dorsi, teres major et subscapularis, medial ~ mm. serratus anterior and lateral humerus with its covering m. coracobrachialis and short head of m. biceps brachii.

Downwards of the axillary cavity is opened a hole, and tapers upwardly and communicates with the neck area. The cavity is filled with fatty tissue, which contains nerves, vessels and lymph nodes. For a more precise description of the topography of vessels and nerves of the anterior wall of the axillary cavity is divided into 3 triangles, arranged in series one above the other. The top is formed by the clavicle and the upper edge of the m. pectoralis minor — trigonum clavipectorale. The average corresponds to m. pectoralis minor —trigonum pectorale. Lower restricted lower edge m. pectoralis minor, the lower edge of the m. pectoralis major and m. deltoideus —trigonum subpectorale.

On the back wall of cavitas axillaris is a triangular space formed by the surgical neck of the shoulder (lateral), m. teres major (lower) and m. subscapularis (above), which is divided vertically long head m. triceps on two holes .

1. Lateral, quadrilateral, foramen quadrilaterum formed called the muscle and bone (it is a. circumflexa humeri posterior and p. axillaris).

2. The medial, triangular, foramen trilaterum (it is a. circumflexa scapulae), which is limited only to named muscles.

Between the muscles, fascia and bones of the upper limb are the spaces, channels and furrows, in which lie the vessels and nerves. Their knowledge is important for surgery. P. Sulcus radialis humerus, being covered with a three-headed muscle of a shoulder, turns in the channel, and n a 1 i s humeromuscularis (there are called the nerve accompanied. and v. profundae brachii and deep lymphatic vessels).

On the front surface of the shoulder, between m. brachialis and m edges. biceps brachii has two sulcus: sulcus bicipitalis medialis et lateralis. One is more deep medial sulcus bicipitalis medialis, is the bed of the neurovascular bundle of the shoulder. Ahead of the elbow, in the elbow of the bend, lies the cubital fossa, fossa cubitalis, and m limited. brachioradialis (lateral) and m. pronator teres (medial). The bottom of the pit and the upper bound formed by the m. brachialis. Between the muscles of the forearm are three furrows:

1) medial, elbow, sulcus ulnaris — m. flexor carpi ulnaris (medially) and m. flexor digitorum superficialis (laterally); in it are the ulnar nerve, artery, vein and deep lymphatic vessels;

2) the lateral, radial, sulcus radialis— between m. brachioradialis (lateral) and m. flexor carpi radialis (medial). There are namesake nerve, artery, vein and deep lymphatic vessels;

3) median, us median sulcus between m. flexor carpi radialis (lateral) and m. flexor digitorum superficialis (medial). It runs n. medianus.

In the area of the wrist joint are the three channels, the resulting due to the presence here of the retinaculum flexorum. Exchanging in the form of bridge from the eminentia carpi ulnaris to the eminentia carpi radialis, he turns a gutter between these hills, sulcus carpi, canal, canalis carpalis, a bending in the radial and ulnar sides, respectively, forms the canalis canalis carpi radialis and carpi ulnaris. Channel in the elbow are the ulnar nerve and vessels, which proceed here from the sulcus ulnaris of the forearm. In the canalis carpi radialis lies the tendon of m. flexor carpi radialis, is surrounded by a synovial sheath. Finally, canalis carpalis are 2 separate synovial vagina: 1) for the tendons of the mm. flexores digitorum superficialis et profundus, and 2) tendon m. flexoris pollicis longus. First, the vagina synovialis communis mm. flexorum, is a medial voluminous bag covering eight tendons of deep and superficial digital flexor. He stands at the top 1-2 cm proximal to the retinaculum flexorum and the bottom of insulate! until the middle of the palm. On the side of the little finger, he continues along the tendons flexing his long muscles surrounding them and achieving with them the Foundation of the distal phalanx of the V finger.

The second vagina, vagina tendinis m. flexoris pollicis longi, situated laterally, is long and narrow channel, in which lies the tendon of the long flexor of the thumb. At the top of the vagina also acts 1-2 cm proximal to the retinaculum flexorum, and continues down along the tendon to the base of the distal phalanx of the I toe. The other 3 fingers have separate vagina, vaginae synoviales tendinum digitorum (manus) covering the tendons of the flexors of the appropriate finger. These vagina extends from the line of the metacarpophalangeal joints to the base of the nail phalanges. Therefore, the II—IV fingers on a Palmar side have an insulated vagina for their common tendons of the flexors, and on the segment corresponding to the distal half of the metacarpal bones, they are denied them.

Vagina synovialis communis mm. flexorum, covering the tendons of the V finger, at the same time not surrounded on all sides of the tendons of the II—IV fingers. I believe that it forms three protrusions, one of which is located in front of the tendons of the superficial flexor, and the other between them and the tendons of the deep flexor, and the third—behind these tendons. Thus, the elbow synovial vagina is a true synovial sheath of the tendons only of the V finger.

Tendon sheath on the Palmar side of fingers covered with a dense fibrous plate which, in the form of the scallops on the edges of the phalanges, forming on each finger of bone-fibrous canal surrounding the tendons along with their vagina. The fibrous wall of the channel is very dense in the region of the bodies of the phalangeal bones, where they form a transverse thickenings of the pars annularis vaginae fibrosae. In the joints they are much weaker and are reinforced by obliquely intersecting connective tissue bundles, pars cruciformis vaginae fibrosae. Inside the vagina of the tendon connected to their walls by a thin mesentery, mesotendineum carrying blood and lymph vessels and nerves.

Fascia of the lower limb and tendon sheath

Iliac-psoas muscle within the belly covered iliac fascia, which, constituting a part of the overall podbryushinnye fascia, fascia subperitonealis, attached to the skeleton at the edges of the whole of the area occupied by m. iliopsoas, forming for this muscle closed vessel. Below the inguinal ligament fascia iliaca descends on the thigh, moving in the broad fascia of the thigh, fascia lata surrounding the thigh muscles. Immediately below the inguinal ligament within the femoral triangle is the fatty tissue, and in it lie the superficial inguinal lymph nodes. Fascia is here split into two pieces: deep and superficial. The first goes behind the femoral vessels. The surface of the piece passes in front of the femoral vessels and the side of the femoral vein, which ends in a free crescentic edge, margo falciformis.

The edge of this limit an indentation, called subcutaneous gap, hiatus saphenus. In margo falciformis there are two so-called horns. Through the lower horn, corn u inferius, merging with deep leaf fasciae latae, and burn vena saphena magna, which flows into the femoral vein. The upper horn, cornu iregi, is attached to the inguinal ligament and, tucking it under, fused with the lig. lacunare. Hiatus saphenus covered with fascia cribrosa (subcutaneous tissue of the thigh, a bullet passing through the lymphatic vessels), which grows to the margo falciformis. Fascia lata surrounding the thigh muscles, provides deep branches between the muscles that attach to bones. Of these shoots one is on the side of the thigh called the lateral intermuscular septum, the septum intermusculare femoris laterale. It is attached along the lateral lip linea aspera femoris, separating m. vastus laterals from the rear thigh muscles (especially m. biceps femoris). Another intermuscular septum, the septum intermusculare femoris mediale, is located on the medial side of the thigh and is attached to the labium mediale linea aspera in front of the adductors.

In addition to intermuscular septa, fascia lata, laminating on the edge of some of the muscles on the two plates, forms for closed vagina. Fascia lata has significant density, especially on the lateral surface of the femur where the capsule is interwoven with the tendon fibers. Here it forms a thicker strip, the tractus iliotibialis, running the whole length of the thigh. This band plays the role of the tendon of the m. tensor fasciae latae and m. gluteus maximus. The distal fascia lata covers the anterior surface of the knee joint and then into the fascia of the leg; she continues in the rear fascia poplitea, covering the fossa poplitea and representing an intermediate area between the fascia of the femur and tibia. Thus, the fascia Lata in different places has a different structure: together with very strong stations (for example, tractus iliotibialis) and weak (fascia cribrosa).

Fascia of leg, fascia cruris, surrounds the tibia grow together with the bones, where they are not covered by muscles. On the back of the Shin it consists of superficial and deep leaves. Surface sheet covers m. triceps surae and deep is between this muscle and the deep layer of back muscles, attaching the sides to the tibia bone. With the lateral side of fascia cruris gives two deep intermuscular septum attaches to fibula. Front of them, the septum intermusculare cruris anterius, is coming from the front mm. peronei and the posterior, the septum intermusculare cruris posterius, behind them. On the anterior surface of the tibia above the ankle to the fascia is a fibrous woven fiber in the form of transverse strips between the two Shin bones, forming the upper retinaculum of extensor tendons, retinaculum mm. extensorum superius. This bunch of presses to bone tendons of anterior crural muscles. The same importance is located in more distal ankle joint ahead of the lower retinaculum tendons of extensor tendons, retinaculum mm. extensorum inferius, which usually has the form of the letter V. This retinaculum, starting from the lateral surface of the calcaneus, and its deep layer in the sinus tarsi, divided then into two legs, of which the top goes to the medial malleolus, and the lower is attached to the navicular and medial cuneiform bones. Sometimes it is divided into plates, superficial and deep, covering the tendons of the extensors, resulting in the passage last formed of four fibrous channel (three vascular and one tendon). The lateral and the wide channel under the overall authority of the retinaculum mm. extensorum inferius, passes the tendon of m. extensor digitorum longus and m. peroneus tertius. Following the canal transmits the tendon of m. extensor hallucis longus, and the third, the medial— tendon of m. tibialis anterior. The tendons passing through the channels, are surrounded by synovial sheaths. The fourth channel behind the middle contains blood vessels (and. and v. dorsales pedis and lymphatic vessels) and nerve (n. peroneus profundus).

Behind the other ankle is also thickening of the fascia, clamping the tendon to the bones. Thickening on the medial side forms the retinaculum of the flexor tendons, retinaculum mm. flexorum, thrown over to the medial malleolus (the exact bone through the tendon m. tibialis posterior, m. flexor digitorum longus m. flexor hallucis longus. He gives into the septum and forms for the passage of the aforesaid three tendons of a bone-fibrous channel, one fibrous, more superficial lying channel for a. tibialis posterior, deep lymphatic vessels and n. tibialis. The tendons in the channels of the bundle are enclosed in three separate vagina. Behind the lateral malleolus is a thickening of the fascia — upper retinaculum of peroneal muscle tendons, retinaculum mm. peroneorum superius, extending from the ankle to the heel bone over the tendon of mm. peronei longus et brevis, which lie underneath in one bone-fibrous channel. Distal and several down both tendons pass under the lower retinaculum of peroneal muscle tendons, retinaculum mm. peroneorum inferius, which is attached to the lateral surface of the calcaneus. The space under the retinaculum m. peronedrum inferius is divided by a partition into two channels, passing each tendon separately. Tendons mm. peronei are enclosed in a common synovial vagina, which bottom is divided into two parts corresponding to the two channels under the retinaculum mm. peroneorum inferius.

The rear fascia of the foot, fascia dorsalis pedis, distal from the retinaculum mm. extensorum inferius is quite thin. Fascia of the sole, like the fascia of the palm, strongly thickened and forms in the middle of the plantar aponeurosis, the aponeurosis plantaris, stretching from the calcaneal tuber to the base of the fingers and fused in its proximal part with m. flexor digitorum brevis, which it covers. Towards the toes the fascia becomes wider and is divided into five beams, between which the transverse fibers. These bundles end in the fibrous sheaths of the tendons on the fingers. At the edges of the plantar aponeurosis deep between the muscles depart two vertical partitions that attach to the deep fascia covering the interosseous muscles. These septa divide the sole into three not entirely closed container, which in General correspond to the three groups of muscles of the sole: the lateral, medial, and intermediate, as reflected in ways of distribution of pus on the sole. The sole is some of the sheaths surrounding tendons (Fig. 102). One of them, vagina tendinis m. peronei longi plantaris, lies in the depth of the sole around the tendon m. peroneus longus where the latter passes in the sulcus of the cuboid bone, under lig. plantare longum. Five other vaginas, vaginae tendinum digitales pedis, are surrounded by the flexor tendons on the plantar side of the toes, stretching of the heads of the metatarsal bones to the distal phalanges.

The topography of the lower limb

The channels and openings containing blood vessels and nerves. Through the foramen ischiadicum majus is m. piriformis, above and below which are slit suprapiriforme foramen and foramen infrapiriforme; through them pass the gluteal vessels and nerves.

Sulcus obturatorius of the pubic bone, supplemented by a bottom of the obturator membrane, becomes canal, canalis obturatorius, through which namesake vessels and nerves.

Above the pelvic bone from the spinae iliacae anterior superior to the tuberculum lig puibicum spreads. inguinale, which limits, thus the space between these bones and ligament. Passing in this space fascia iliaca lateral to his Department merged with the lig. inguinale, and in the medial departs from it, thickens and attaches to the eminentia iliopubica. This thickened strip fasciae iliacae in the area between the lig. inguinale and eminentia iliopubica artificially allocated under the name of arcus iliopectineus.

Arcus iliopectineus divides the space under the inguinal ligament into two gaps: the lateral, muscle, lacuna musculorum, where lie m. iliopsoas and p. femoralis and medial vascular lacuna vasorum, through which the femoral artery, lymphatics and Vienna (the last medial). Of the lacunae vasorum vessels pass to the thigh, Shin and foot. Vessels and nerves are in the grooves into the channels and opening again in furrows. There are the following furrows and channels.

Iliopectineus Sulcus, which passes lacuna vasorum, lies between the m. iliopsoas (laterally) and m. pectineus (medial), and then continues, in turn, in the sulcus femoralis anterior; the last formed m. vastus medialis (lateral) and mm. adductores longus et magnus (medial). Both grooves lie in the femoral triangle, trigonum femorale, limited lig. inguinale (top—base of the triangle), m. sartorius (lateral) and m. adductor longus (medial). The bottom triangle, called the fossa iliopectinea, formed mm. iliopsoas pectineus et. At the top of the triangle facing down, sulcus femoralis anterior goes between the muscles, turning the channel, canalis adductorius going over the lower third of the thigh in the popliteal fossa. Channel m is formed. vastus medialis (lateral side), m. adductor magnus (medial side) and thrown over between tendinous lamina, lamina vastoadductoria (front); its distal opening is hiatus tendineus (adductorius), formed by the divergence of the beams m. adductor magnus.

Canalis adductorius at the bottom opens into the popliteal fossa, fossa poplitea, diamond-shaped. The upper corner of a rhombus formed with the lateral side of m. biceps femoris and medial mm. semimembranosus et semitendinosus, the bottom angle is limited by both heads of m. gastrocnemius. The bottom of the pit formed by facies poplitea femoris and the rear of the knee joint. In the popliteal fossa is fatty tissue from the popliteal lymph nodes and lymphatic vessels. From the upper corner to the lower pass of the sciatic nerve (or its two branches, into which it is divided), and popliteal artery and vein, which lie in this order (if viewed from surface to depth): nerve, vein, artery.

From the popliteal fossa canalis cruropopliteus starts running between the superficial and deep layers of back muscles of the leg and formed mainly m. tibialis posterior (front) and m. soleus (rear). There are p. tibialis, and. and v. tibiales posteriores. The breakout of this channel, respectively, the go and. regimea is the canalis musculo-peroneus inferior, educated middle third fibulae and mm. flexor hallucis longus tibialis posterior et. In the upper third of the leg between the fibula and m. peroneus longus is canalis musculoperoneus superior, which is p. peroneus superficialis. On the sole, respectively, during the plantar vessels and nerves there are two furrows on the edges m. flexor digitorum brevis: 1) medial sulcus plantaris medialis, between these muscles and m. abductor hallucis and 2) the lateral, sulcus plantaris lateral! s, between the flexor and m. abductor digiti minimi. In each of the furrows are also the neurovascular bundles.

The femoral canal. In norm there is a gap in the medial corner of the lacuna vasorum, called the femoral ring, annulus femoralis. The femoral ring is formed with the lateral side of the femoral vein, front and top — lig. inguinale, the medial side is a continuation of the inguinal ligament, lig. lacunare, rear — lig. pectineale; the latter is a continuation of lig. lacunare at the os pubis.

Crack is made by connective tissue, the femoral septum e, which is loosened in this place transversalia fascia, and covered the outside of the lymph node and side of the abdominal cavity — the peritoneum, which forms a fossa, fossa femoralis. Through the femoral ring can get femoral hernias, and women more often than men, as the first due to the greater width of the pelvis it is broader than the second, With the passage of the hernia called a crack develops in the channel with inlet and outlet openings.

Input or internal hole is described above the femoral ring, annulus femoralis. The output, or outside, the hole is hiatus saphenus, limited margo falciformis and its cornua superius et inferius. The space between the holes is the femoral canal has 3 walls: lateral, formed by the femoral vein, the posterior formed by the deep leaf of wide fascia of the thigh, and the front formed by lig. inguinale and cornu superius of the Crescent edges of the fasciae latae. Latest for hiatus saphenus loosened and penetrated the lymph vessels and v. saphena magna, as a result acquires the form of a lattice plate fascia cribrosa. Loosening of the broad fascia of the thigh in hiatus saphenus, and leads to the emergence of femoral hernia in this place.

Equipments of the lesson: posters, models, slides

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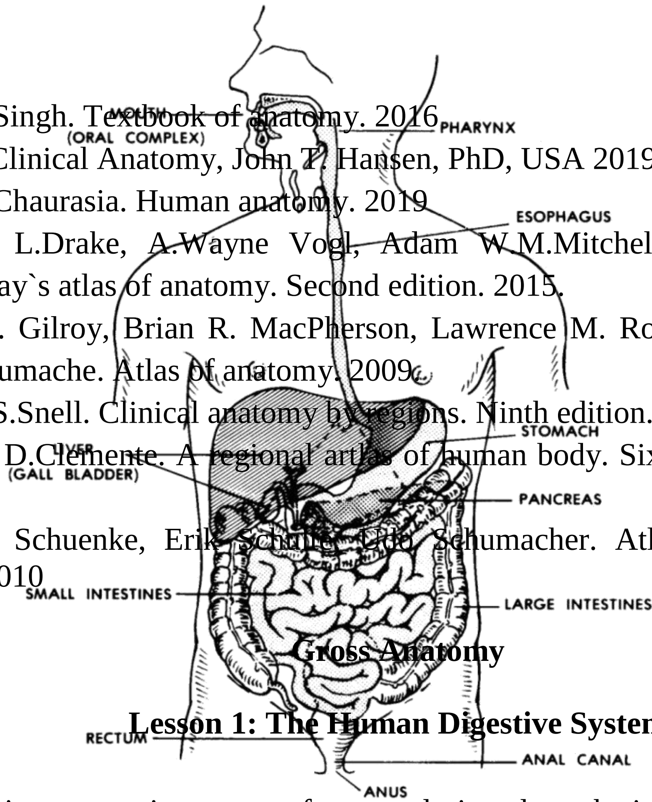


Gross Anatomy

Lesson 1: The Human Digestive System

The human digestive system is a group of organs designed to take in foods, initially process foods, digest the foods, and eliminate unused materials of food items. It is a hollow tubular system from one end of the body to the other end.

Figure 1. The human digestive system.

Major Organs. There are eight major organs involved in the human digestive systemand I'lldiscuss each of them later in this lesson. The eight are:

- Mouth or oral complex.
- Pharynx.
- Esophagus.
- Stomach.
- Small intestines and associated glands.
- Large intestines.
- Rectum.
- Anal canal and anus.

Digestive Enzymes. A catalyst is a substance that accelerates (speeds up) a chemical reactionwithout being permanently changed or consumed itself. A digestive enzyme serves as a catalyst, aiding in digestion. Digestion is a chemical process by which food is converted into simpler substances that can be absorbed or assimilated by the body. Enzymes are manufactured in the salivary glands of the mouth, in the lining of the stomach, in the pancreas, and in the walls of the small intestine.

FOODS AND FOODSTUFFS

Examples of food items are a piece of bread, a pork chop, and a tomato. Food items contain varying proportions of foodstuffs. Foodstuffs are the classes of chemical compounds which make up food items. The three major types of foodstuffs are carbohydrates, lipids (fats and oils), and proteins. Food items also contain water, minerals, and vitamins.

THE SUPRAGASTRIC STRUCTURES

Supragastric means those structures above the level of the stomach.

ORAL COMPLEX

The oral complex consists of the structures commonly known together as the mouth. It takes in and initially processes food items. See figure 2.

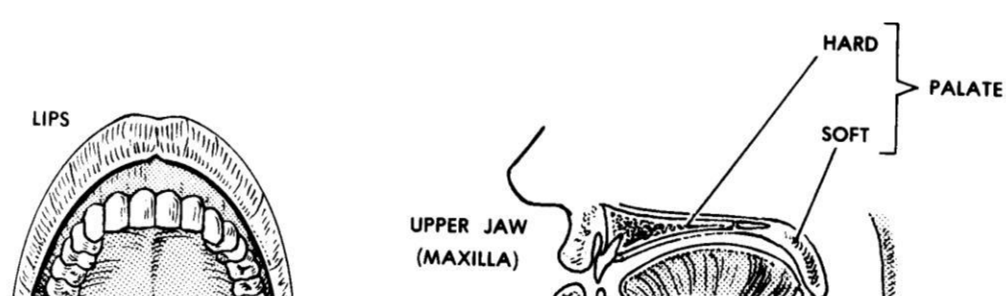


Figure 2. Anatomy of the oral complex.

Teeth.A tooth has two main parts--the crown and the root. A root canal passes up through the central part of the tooth. The root is suspended within a socket (called the alveolus) of one of the jaws of the mouth. The crown extends up above the surface of the jaw. The root and inner part of the crown are made of a substance called dentin. The outer portion of the crown is covered with a substance known as enamel. Enamel is the hardest substance of the humanbody. The nerves and blood vessels of the tooth pass up into the root canal from the jaw substance.

There are two kinds of teeth-- anterior and posterior. The anterior teeth are also known as incisors and canine teeth. The anterior teeth serve as choppers. They chop off mouth-size bites of food items. The posterior teeth are called molars. They are grinders. They increase the surface area of food materials by breaking them into smaller and smaller particles.

Humans have two sets of teeth--deciduous and permanent. Initially, the deciduous set includes 20 baby teeth.

DECIDUOUS = to be shed

These are eventually replaced by a permanent set of 32.

Jaws. There are two jaws--the upper and the lower. The upper is called the maxilla. The lower iscalled the mandible.

In each jaw, there are sockets for the teeth. These sockets are known as alveoli. The bony parts of the jaws holding the teeth are known as alveolar ridges.

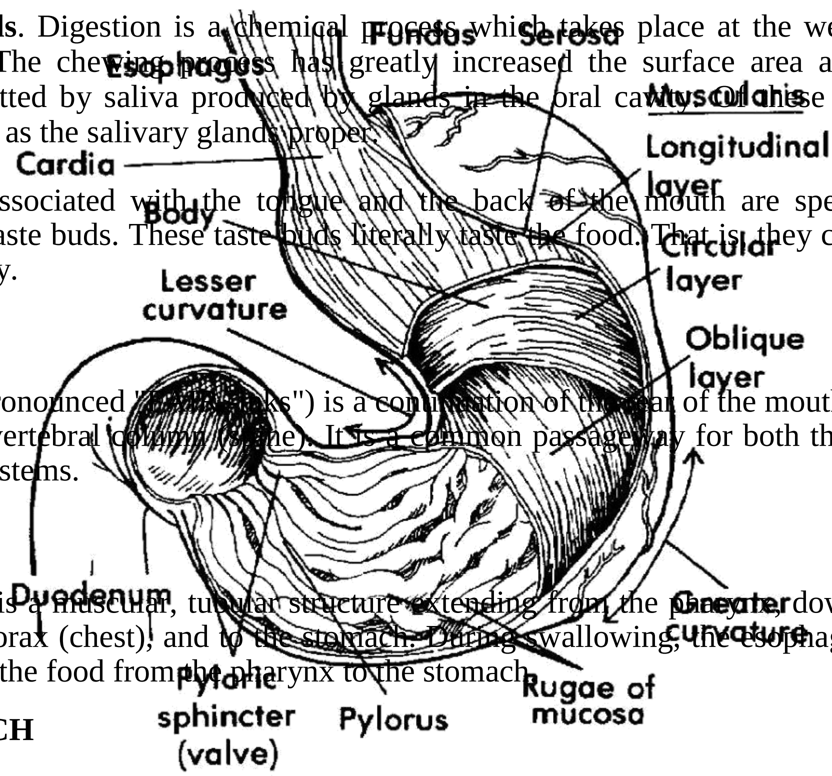
The upper jaw is fixed to the base of the cranium. The lower jaw is movable. There is a special articulation (T-MJ--temporo-mandibular joint) with muscles to bring the upper and lower teeth together to perform their functions.

Palate. The palate serves as the roof of the mouth and the floor of the nasal chamber above.Since the anterior two-thirds is bony, it is called the hard palate. The posterior one-third is musculo-membranous and is called the soft palate. The soft palate serves as a trap door to close off the upper respiratory passageway during swallowing.

Lips and Cheeks. The oral cavity is closed by a fleshy structure around the opening. Forming theopening are the lips. On the sides are the cheeks.

Tongue. The tongue is a muscular organ. The tongue is capable of internal movement to shapeits body. It is moved as a whole by muscles outside the tongue. Interaction between the tongue and cheeks keeps the food between the molar teeth during the chewing process. When the food is properly processed, the tongue also initiates the swallowing process.

Salivary Glands. Digestion is a chemical process which takes place at the wet surfaces of foodmaterials. The chewing process has greatly increased the surface area available. The surfaces are wetted by saliva produced by glands in the oral cavity. Of these glands, three pairs are known as the salivary glands proper.



Taste Buds. Associated with the tongue and the back of the mouth are special clumps of cellsknown as taste buds. These taste buds literally taste the food. That is, they check its quality and acceptability.

PHARYNX

The pharynx (pronounced "FAIR-inks") is a continuation of the rear of the mouth region, just anterior to the vertebral column (spine). It is a common passageway for both the respiratory and digestive systems.

ESOPHAGUS

The esophagus is a muscular, tubular structure extending from the pharynx, down through the neck and the thorax (chest), and to the stomach. During swallowing, the esophagus serves as a passageway for the food from the pharynx to the stomach.

THE STOMACH

STORAGE FUNCTION

The stomach is a sac-like enlargement of the digestive tract specialized for the storage of food. Since food is stored, a person does not have to eat continuously all day. One is freed to do other things. The presence of valves at each end prevents the stored food from leaving the stomach before it is ready. The pyloric valve prevents the food from going further. The inner lining of the stomach is in folds to allow expansion.

DIGESTIVE FUNCTION

While the food is in the stomach, the digestive processes are initiated by juices from the wall of the stomach. The musculature of the walls thoroughly mixes the food and juices while the food is being held in the stomach. In fact, the stomach has an extra layer of muscle fibers for this purpose.

When the pyloric valve of the stomach opens, a portion of the stomach contents moves into the small intestine.

THE SMALL INTESTINES AND ASSOCIATED GLANDS

Digestion is a chemical process. This process is facilitated by special chemicals called digestive enzymes. The end products of digestion are absorbed through the wall of the gut into the blood vessels. These end products are then distributed to body parts that need them for growth, repair, or energy.

There are associated glands--the liver and the pancreas--which produce additional enzymes to further the process.

Most digestion and absorption takes place in the small intestines.

ANATOMY OF THE SMALL INTESTINES

The small intestines are classically divided into three areas-- the duodenum, the jejunum, and the ileum. The duodenum is C-shaped, about 10 inches long in the adult. The duodenum is looped around the pancreas.

DUODENUM = 12 fingers (length equal to width of 12 fingers)

The jejunum is approximately eight feet long and connects the duodenum and ileum.

The ileum is about 12 feet long. The jejunum and ileum are attached to the rear wall of the abdomen with a membrane called a mesentery. This membrane allows mobility and serves as a passageway for nerves and vessels (NAVL) to the small intestines.

JEJUNUM = empty

ILEUM = lying next to the ilium (bone of the pelvic girdle; PELVIS = basin)

The small intestine is tubular. It has muscular walls which produce a wave-like motion called peristalsis moving the contents along. The small intestine is just the right length to allow the processes of digestion and absorption to take place completely.

The inner surface of the small intestine is NOT smooth like the inside of new plumbing pipes. Rather, the inner surface has folds (plicae). On the surface of these plicae are finger-like projections called villi (villus, singular). This folding and the presence of villi increase the surface area available for absorption.

LIVER AND GALLBLADDER

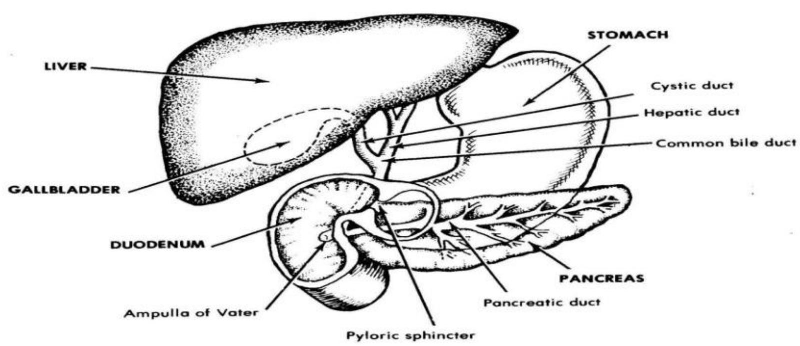


Figure 1-2. Stomach, duodenum, and the accessory organs.

Liver Anatomy. The liver is a large and complex organ. Most of its mass is on the right side ofthe body and within the lower portion of the rib cage. Its upper surface is in contact with the diaphragm.

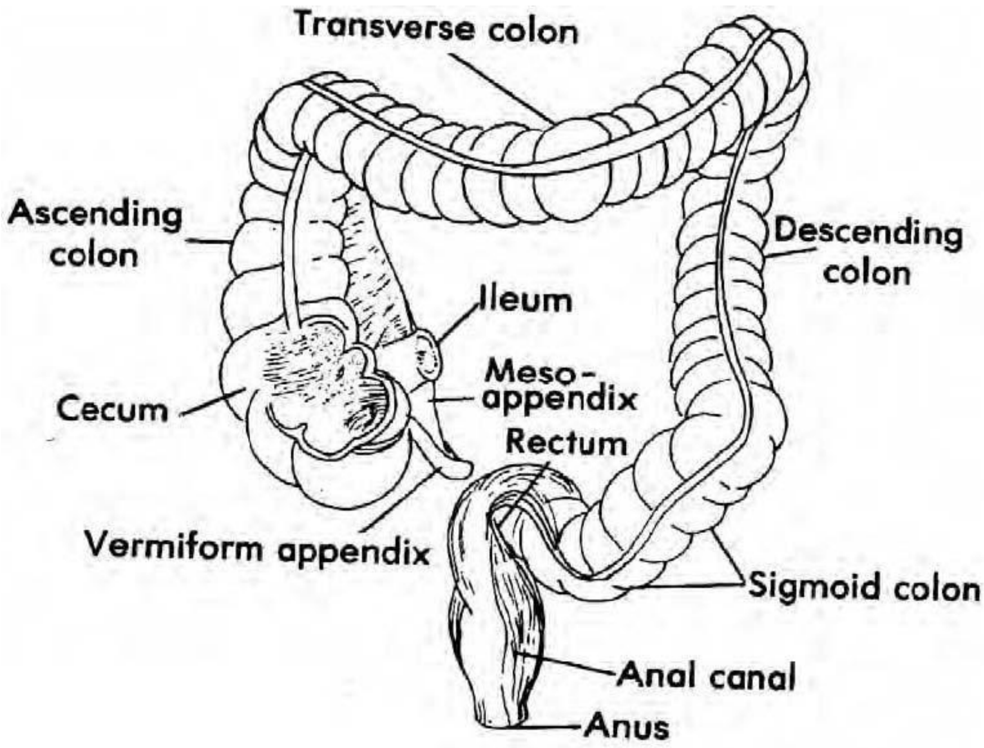
Liver Functions. The liver is a complex chemical factory with many functions. These includeaspects of carbohydrate, protein, lipid, and vitamin metabolism and processes related to blood clotting and red blood cell destruction. Its digestive function is to produce a fluid called bile or gall.

Gallbladder. Until needed, the bile is stored and concentrated in the gallbladder, a sac on theinferior surface of the liver. Fluid from the gallbladder flows through the cystic duct, which joins the common hepatic duct from the liver to form the common bile duct. The common bile duct then usually joins with the duct of the pancreas as the fluid enters the duodenum.

PANCREAS

The pancreas is a soft, pliable organ stretched across the posterior wall of the abdomen. When called upon, it secretes its powerful digestive fluid, known as pancreatic juice, into the duodenum. Its duct joins the common bile duct.

THE LARGE INTESTINES



The primary function of the large intestines is the salvaging of water and electrolytes (salts). Most of the end products of digestion have already been absorbed in the small intestines. Within the large intestines, the contents are first a watery fluid. Thus, the large intestines are important in the conservation of water for use by the body.

The large intestines remove water until a nearly solid mass is formed before defecation, the evacuation of feces.

MAJOR SUBDIVISIONS

The major subdivisions of the large intestines are the cecum (with vermiform or "worm-shaped" appendix), the ascending colon, the transverse colon, the descending colon, and the sigmoid colon. The fecal mass is stored in the sigmoid colon until passed into the rectum.

RECTUM, ANAL CANAL, AND ANUS

Rectum means "straight." However, this six-inch tubular structure would actually look a bit wave-like from the front. From the side, one would see that it was curved to conform the sacrum (at the lower end of the spinal column). The final storage of feces is in the rectum. The rectum terminates in the narrow anal canal, which is about one and one-half inches long in the adult. At the end of the anal canal is the opening called the anus. Muscles called the anal sphincters aid in the retention of feces until defecation.

ASSOCIATED PROTECTIVE STRUCTURES

Within the body, there are many structures that aid in protection from bacteria, viruses, and other foreign substances. These structures include cells that can phagocytize (engulf) foreign particles or manufacture antibodies (which help to inactivate foreign substances). Collectively, such cells make up the reticuloendothelial system (RES). Such cells are found in bone marrow, the spleen, the liver, and lymph nodes.

STRUCTURES WITHIN THE DIGESTIVE SYSTEM

Lymphoid structures make up the largest part of the RES. Lymphoid structures are collections of cells associated with circulatory systems (to be discussed in lesson 9).

- Tonsils are associated with the posterior portions of the respiratory and digestive areas in the head, primarily in the region of the pharynx. The tonsils are masses of lymphoid tissue.
- Other lymphoid aggregations are found in the walls of the small intestines.
- The vermiform appendix, attached to the cecum of the large intestine, is also a mass of lymphoid tissue. It is the "tonsil" of the intestines.

Lesson 2 A: Respiratory System

INTRODUCTION

a. **Respiration**. Respiration is the exchange of gases between the atmosphere and the cells of the body. It is a physiological process. There are two types of respiration--external and internal. External respiration is the exchange of gases between the air in the lungs and blood. Internal respiration is the exchange of gases between the blood and the individual cells of the body.

b. **Breathing**. Breathing is the process that moves air into and out of the lungs. It is a mechanical process. There are two types of breathing in humans—costal (thoracic) and diaphragmatic (abdominal). In costal breathing, the major structure causing the movement of the air is the rib cage. In diaphragmatic breathing, interaction between the diaphragm and the abdominal wall causes the air to move into and out of the lungs.

COMPONENTS AND SUBDIVISIONS OF THE HUMAN RESPIRATORY SYSTEM

a. **Components**. The components of the human respiratory system consist of air passageways and two lungs. Air moves from the outside of the body into tiny sacs in the lungs called alveoli (pronounced al-VE-oh-lie).

b. **Main Subdivisions**. The main subdivisions of the respiratory system may be identified by their relationship to the voice box or larynx. Thus, the main subdivisions are as listed in table 7-1.

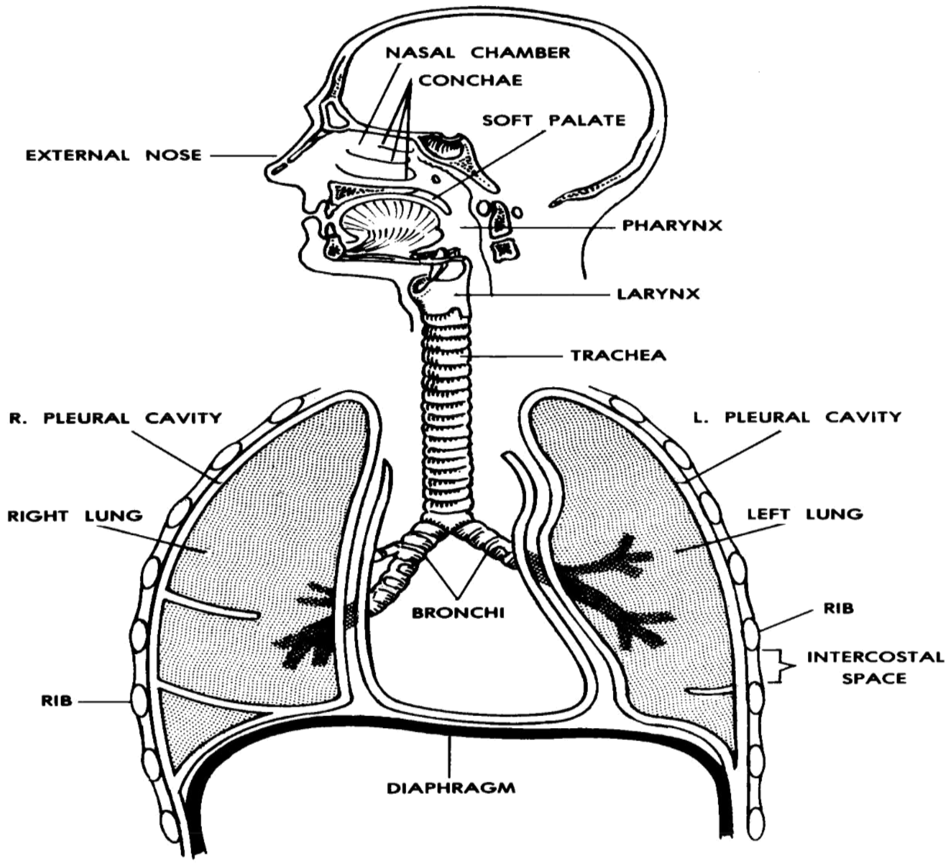


Figure 7-1. The human respiratory system.

SUBDIVISION	**FUNCTION**
SUPRALARYNGEAL STRUCTURES (su-prah-lah-RIN-je-al)	Cleanse, warm, moisten, and test inflowing air
LARYNX (voice box) (LARE-inks)	Controls the volume of inflowing air; produces selected pitch(vibration frequency) in the moving column of air
INFRALARYNGEAL STRUCTURES (in-frah-lah-RIN-je-al)	Distribute air to the alveoli of the lung where the actual external respiration takes place

Table 7-1. The main subdivisions of the respiratory system.

SUPRALARYNGEAL STRUCTURES

a. **External Nose**. The external nose is the portion projecting from the face. It is supported primarily by cartilages. It has a midline divider called the nasal septum, which extends from the internal nose. Paired openings (nostrils) lead to paired paces (vestibules). Guard hairs in the nostrils filter inflowing air.

b. **Nasal Chambers (Internal Nose)**. Behind each vestibule of the external nose is a nasal chamber. The two nasal chambers together form the internal nose. These chambers too are separated by the nasal septum.

 Mucoperiosteum. The walls of the nasal chambers are lined with a thick mucous-type membrane known as the mucoperiosteum. It has a ciliated epithelial surface and a rich blood supply, which provides warmth and moisture. At times, it may become quite swollen.
CILIATED = provided with cilia (hairlike projections which move fluids to the rear)

(2) Conchae. The lateral wall of each chamber has three scroll- like extensions into the nasal chamber which help to increase the surface area exposed to the inflowing air. These scroll-like extensions are known as conchae.

CONCHA (pronounced KON-kah) = sea shell
CONCHA (singular), CONCHAE (plural)

(3) Olfactory epithelium. The sense of smell is due to special nerve endings located in the upper areas of the nasal chambers. The epithelium containing the sensory endings is known as the olfactory epithelium.

(4) Paranasal sinuses. There are air "cells" or cavities in the skull known as paranasal sinuses. The paranasal sinuses are connected with the nasal

chambers and are lined with the same ciliated mucoperiosteum. Thus, these sinuses are extensions of the nasal chambers into the skull bones. For this reason, they are known as paranasal sinuses.

c. **Pharynx**. The pharynx (FAIR-inks) is the common posterior space for therespiratory and digestive systems.

(1) Nasopharynx. That portion of the pharynx specifically related to the respiratory system is the nasopharynx. It is the portion of the pharynx above the soft palate. The two posterior openings (nares) of the nasal chambers lead into the single space of the nasopharynx. The auditory (eustachian) tubes also open into the nasopharynx. The auditory tubes connect the nasopharynx with the middle ears (to equalize the pressure between the outside and inside of the eardrum). Lying in the upper posterior wall of the nasopharynx are the pharyngeal tonsils (adenoids). The soft palate floor of the nasopharynx is a trapdoor which closes off the upper respiratory passageways during swallowing.

(2) Oropharynx. The portion of the pharynx closely related to the digestive system is the oropharynx. It is the portion of the pharynx below the soft palate and above the upper edge of the epiglottis. (The epiglottis is the flap that prevents food from entering the larynx (discussed below) during swallowing.)

(3) Laryngopharynx. That portion of the pharynx which is common to the respiratory and digestive systems is the laryngopharynx. It is the portion of the pharynx below the upper edge of the epiglottis. Thus, the digestive and respiratory systems lead into it from above and lead off from it below.

LARYNX

The larynx, also called the Adam's apple or voice box, connects the pharynx with the trachea. The larynx, located in the anterior neck region, has a box-like shape. See figure 7-3 for an illustration. Since the voice box of the male becomes larger and heavier during puberty, the voice deepens. The adult male's voice box tends to be located lower in the neck; in the female, the larynx remains higher and smaller and the voice is of a higher pitch.

a. **Parts and Spaces**. The larynx has a vestibule ("entrance hallway") which can be covered over by the epiglottis. The glottis itself is the hole between the vocal cords. Through the glottis, air passes from the vestibule into the main chamber of the larynx (below the cords) and then into the trachea. The skeleton of the larynx is made up of a series of cartilages.

b. **Muscles**. The larynx serves two functions and there are two sets of muscles-- one for each function.

(1) One set controls the size of the glottis. Thus, it regulates the volume of air passing through the trachea.

(2) The other set controls the tension of the vocal cords. Thus, it produces vibrations of selected frequencies (variations in pitch) of the moving air to be used in the process of speaking.

a. **Trachea and Bronchi**. The respiratory tree (figure 7-4) is the set of tubularstructures which carry the air from the larynx to the alveoli of the lungs. Looking at a person UPSIDE DOWN, the trachea is the trunk of the tree and the bronchi are the branches. These tubular parts are held open (made patent) by rings of cartilage. Their lining is ciliated to remove mucus and other materials that get into the passageway.

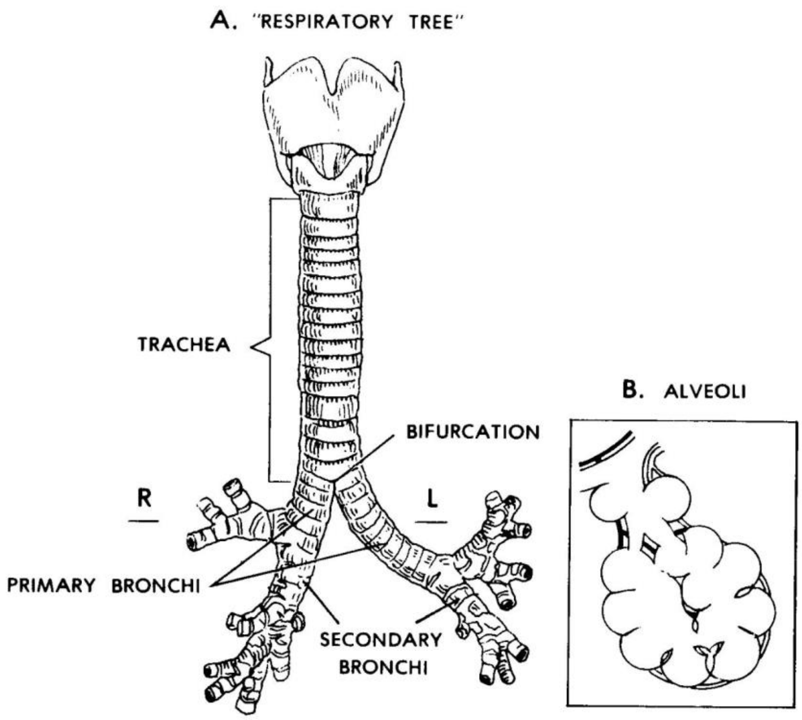


Figure 7-4. Infralaryngeal structures ("respiratory tree").

b. **Alveoli**. The alveoli (alveolus, singular) are tiny spherical (balloon-like) sacswhich are connected to the larger tubes of the lungs by tiny tubes known as alveolar ducts and bronchioles. The alveoli are so small that there are billions in the adult lungs. This very small size produces a maximum surface area through which external respiration takes place. External respiration is the actual exchange of gases between the air in the alveolar spaces and the adjacent blood capillaries through their walls.

c. **Lungs**. A lung is an individual organ composed of tubular structures and alveolibound together by fibrous connective tissue (FCT). In the human, there are two lungs--right and left. Each lung is supplied by a primary or mainstem bronchus leading off of the trachea. The right lung is larger in volume than the left lung. The left lung must leave room for the heart. The right lung is divided into three pulmonary lobes (upper, middle, and lower) and 10 bronchopulmonary segments (2 + 3 + 5). The left lung is divided into two pulmonary lobes (upper and lower) and eight bronchopulmonary segments (4 + 4). A pulmonary lobe is a major subdivision of a lung marked by fissures (deep folds). Each lobe is further partitioned into bronchopulmonary segments. Each lobe is supplied by a secondary or lobar bronchus. Each segment is supplied by a tertiary or segmental bronchus, a branch of the lobar bronchus.

d. **Pleural Cavities**. See Lesson 3 to review a description of pleural cavities. ThatLesson indicates that each serous cavity has inner and outer membranes. In the case of the lungs, the inner membrane is known as the visceral pleura which very closely covers the surface of the lungs. The outer membrane is known as the parietal pleura, forming the outer wall of the cavity. The pleural cavities are the potential spaces between the inner and outer membranes. The pleural cavities allow the lungs to move freely with a minimum of friction during the expansion and contraction of breathing.

BREATHING AND BREATHING MECHANISMS IN HUMANS

INTRODUCTION

a. Boyle's law tells us that as the volume (V) of a gas-filled container increases, the pressure (P) inside decreases; as the volume (V) of a closed container decreases, the pressure (P) inside increases. When two connected spaces of air have different pressures, the air moves from the space with greater pressure to the one with lesser pressure. In regard to breathing, we can consider the air pressure around the human body to be constant. The pressure inside the lungs may be greater or less than the pressure outside the body. Thus, a greater internal pressure causes air to flow out; a greater external pressure causes air to flow in.
b. We can compare the human trunk to a hollow cylinder. This cylinder is divided into upper and lower cavities by the diaphragm. The upper is the thoracic cavity and is essentially gas-filled. The lower is the abdominopelvic cavity and is essentially water-filled.

COSTAL (THORACIC) BREATHING

a. **Inhalation**. Muscles attached to the thoracic cage raise the rib cage. A typical rib might be compared to a bucket handle, attached at one end to the sternum (breastbone) and at the other end to the vertebral column. The "bucket handle" is lifted by the overall movement upward and outward of the rib cage. These movements increase the thoracic diameters from right to left (transverse) and from front to back (A-P). Thus, the intrathoracic volume increases. Recalling Boyle's law, the increase in volume leads to a decrease in pressure. The air pressure outside the body then forces air into the lungs and inflates them.

Exhalation. The rib cage movements and pressure relationships are reversed for exhalation. Thus, intrathoracic volume decreases. The intrathoracic pressure increases and forces air outside the body.

DIAPHRAGMATIC (ABDOMINAL) BREATHING

The diaphragm is a thin, but strong, dome-shaped muscular membrane that separates the abdominal and thoracic cavities. The abdominal wall is elastic in nature. The abdominal cavity is filled with soft, watery tissues.

a. **Inhalation**. As the diaphragm contracts, the dome flattens and the diaphragm descends. This increases the depth (vertical diameter) of the thoracic cavity and thus increases its volume. This decreases air pressure within the thoracic cavity. The greater air pressure outside the body then forces air into the lungs.

b. **Exhalation**. As the diaphragm relaxes, the elastic abdominal wall forces the diaphragm back up by pushing the watery tissues of the abdomen against the underside of the relaxed diaphragm. The dome extends upward. The process of inhalation is thus reversed.

Basic Human Anatomy
Lesson 2B: Endocrine System

- Define endocrine glands, hormones, target organs, and feedback mechanism.
- Briefly describe three different control systems of the human body.
- Briefly describe the endocrine system and name six better known endocrine organs.
- Describe the pituitary body, including its location, its major subdivisions, and the origins and hormones of each subdivision.
- Describe the location, structure, and hormone(s) for each of the following:

  The thyroid gland.

  The parathyroid glands.

  The pancreatic islets.

  The suprarenal glands.

  Name the primary sex organs and the sex hormones for each gender.

INTRODUCTION

DEFINITIONS
ENDO = internal
CRINE = secrete
a. The endocrine glands are glands of internal secretion (rather than external, as seen with the sweat glands and digestive glands).
b. This internal secretion results from the fact that these glands have no ducts.
Thus, they are often referred to as the ductless glands.
c. The secretions produced by the endocrine glands are called hormones.

d. Hormones are carried by the bloodstream to specific organs or tissues, which are then called the target organs.
e. The activity of the target organ, in turn, affects the activity of the endocrine organ. Thus, it is a reverse or feedback mechanism.
GENERAL
a. **Control "Systems" of the Human Body**. The structure and function of the human body is controlled and organized by several different "systems."

 Heredity/environment. The interaction of heredity and environment is the fundamental control "system." Genes determine the range of potentiality and environment develops it. For example, good nutrition will allow a person to attain his full body height and weight within the limits of his genetic determination. Genetics is the study of heredity.

Hormones. The hormones of the endocrine system serve to control the tissues and organs in general. (Vitamins have a similar role.) Both hormones and vitamins are chemical substances required only in small quantities.

Nervous system. More precise and immediate control of the structures of the body is carried out by the nervous system.

(5)**The Endocrine System**. In the human body, the endocrine system consists of anumber of ductless glands producing their specific hormones. Because these hormones are carried to their target organs by the bloodstream, the endocrine organs (glands) are richly supplied with blood vessels.

(6) **Better Known Endocrine Organs of Humans**. The better known endocrineorgans are the:

Pituitary body.
Thyroid gland.
Parathyroid glands.
Pancreatic islets (islands of Langerhans).
Suprarenal (adrenal) glands.
Gonads (female--ovaries; male--testes).

In addition, there are several other endocrine organs, less well understood, and other organs suspected to be of the endocrine type. See figure 10-1, which shows the better known endocrine glands and their locations.

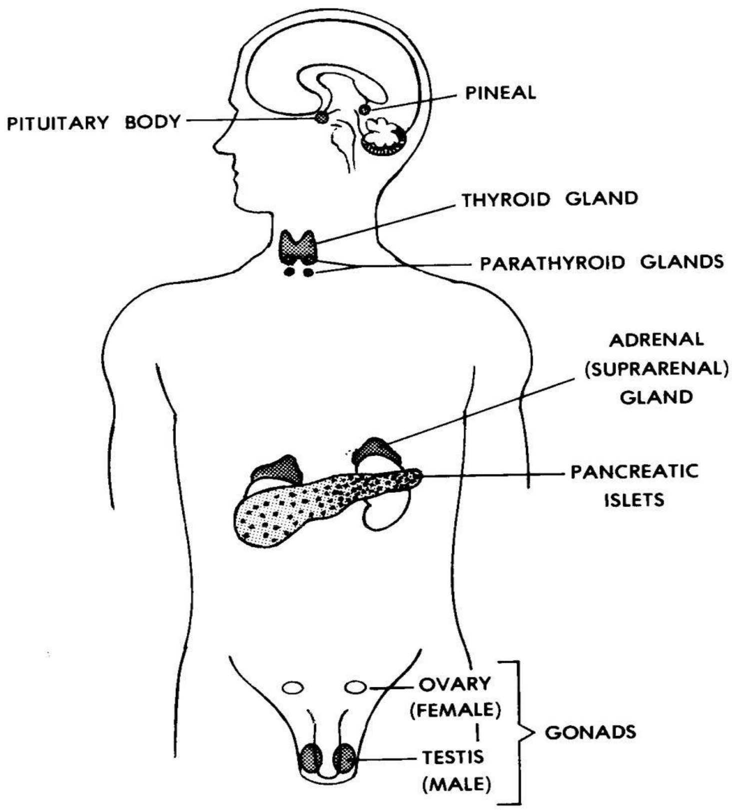


Figure 10-1. The endocrine glands of the human body and their locations.

THE PITUITARY BODY
GENERAL

a. **Location**. The pituitary body is a small pea-sized and pea- shaped structure. It is attached to the base of the brain in the region of the hypothalamus (see Lesson 11). In addition, it is housed within a hollow of the bony floor of the cranial cavity. This hollow is called the sella turcica ("Turk's saddle").

b. **Major Subdivisions**. The pituitary body is actually two glands-- the posterior pituitary gland and the anterior pituitary gland. Initially separate, these glands join together during development of the embryo.

POSTERIOR PITUITARY GLAND

The posterior pituitary gland is the portion which comes from and retains a direct connection with the base of the brain. The hormones of the posterior pituitary gland are actually produced in the hypothalamus of the brain. From the hypothalamus, the hormones are delivered to the posterior pituitary gland, where they are released into the bloodstream. At present, we recognize two hormones of the posterior pituitary gland.

a. **ADH (Antidiuretic Hormone)**. ADH is involved with the resorption or salvaging of water within the kidneys. ADH is produced under thirst conditions.

b. **Oxytocin**. Oxytocin is concerned with contractions of smooth muscle in the uterus and with milk secretion.

ANTERIOR PITUITARY GLAND

a. The anterior pituitary gland originates from the roof of the embryo's mouth. It then "attaches" itself to the posterior pituitary gland.

b. The anterior pituitary gland is indirectly connected to the hypothalamus by means of a venous portal system. By "portal," we mean that the veins carry substances from the capillaries at one point to the capillaries at another point (hypothalamus to the anterior pituitary gland).

c. In the hypothalamus, certain chemicals known as releasing factors are produced. These are carried by the portal system to the anterior pituitary gland. Here, they stimulate the cells of the anterior pituitary gland to secrete their specific hormones.

d. The anterior pituitary gland produces many hormones. In general, they stimulate the target organs to develop or produce their own products. This stimulating effect is referred to as trophic.

e. Of the many hormones produced by the anterior pituitary gland, we will examine:

d. Somatotrophic hormone (growth hormone). The target organs of this hormone are the growing structures of the body. This hormone influences such structures to grow.

e. ACTH (adrenocorticotrophic hormone). This hormone of the anterior pituitary gland stimulates the cortex of the suprarenal (adrenal) gland to produce its hormones. We will later see that the hormones of the suprarenal cortex are involved with anti-inflammatory reactions of the body.

2 Thyrotropin (TSH). This hormone stimulates the thyroid gland to produce its hormones.

3 Luteinizing hormone (LH). LH stimulates ovulation and luteinization of ovarian follicles in females and promotes testosterone production in males.

4 Follicle-stimulating hormone (FSH). FSH stimulates ovarian follicle growth in females and stimulates spermatogenesis in males.

5 Prolactin. Prolactin stimulates milk production and maternal behavior in females.

THE THYROID GLAND

LOCATION

The thyroid gland is in the neck region just below the larynx and surrounds the trachea.

ANATOMY

a. The right and left thyroid lobes are the masses on either side of the trachea.

The isthmus is found across the front of the trachea and connects the two lobes.

b. Each lobe of the thyroid gland is supplied by arteries from above and below (superior and inferior thyroid arteries).

HORMONES

The primary hormone of the thyroid gland is thyroxin. Thyroxin affects the basal metabolic rate (BMR), the level of activity of the body. Since iodine is a necessary element in the production of thyroxin, one can observe malformations of the thyroid gland (called goiters) where there is little or no iodine available. A second hormone, calcitonin, is produced by the thyroid gland and it is involved with calcium metabolism in the body.

THE PARATHYROID GLANDS

LOCATION AND STRUCTURE

Located on the posterior aspects of the thyroid lobes are two pairs of small round masses of tissue, known as the parathyroid glands.

HORMONE

The hormone produced by these glands is called parathyroid hormone, or parathormone. It is involved with calcium metabolism.

THE PANCREATIC ISLETS (ISLANDS OF LANGERHANS)

LOCATION AND STRUCTURE

Within the substance of the pancreas are distributed small groups of cells known as islets. Although the pancreas is a ducted gland of the digestive system, these isolated islets are, in fact, ductless glands.

HORMONES

Insulin and glucagon are the two most commonly recognized hormones of the islets. These hormones are involved with glucose metabolism.

THE SUPRARENAL (ADRENAL) GLANDS

LOCATION AND STRUCTURE

Embedded in the fat above each kidney is a suprarenal gland. Both suprarenal glands have an internal medulla and an external cortex.

HORMONES OF THE SUPRARENAL MEDULLA

The medullary portion of each suprarenal gland produces a pair of hormones-- epinephrine (adrenalin) and norepinephrine (noradrenalin). These hormones are involved in the mobilization of energy during the stress reaction ("fight or flight").

HORMONES OF THE SUPRARENAL CORTEX

Each suprarenal cortex produces a variety of hormones which can be grouped into three categories:

a. **Mineralocorticoids** (for example, aldosterone), which are concerned with the electrolytes of the body.

b. **Glucocorticoids** (for example, cortisol), which are concerned with many metabolic functions and are anti-inflammatory in nature.
c. **Sex hormones**. Adrenal androgens and estrogens.

THE GONADS

GENERAL

In humans, the primary sex organs are known as gonads (lesson 8). The gonads produce sex cells (gametes) and sex hormones. These sex hormones are in addition to those produced by the suprarenal cortex.

FEMALE SEX HORMONES

In the female, the ovaries produce two types of sex hormones during the menstrual cycle. During the first half of the cycle (days 1 - 14), the estrogens are produced. During the last half of the cycle (days 15 - 28), progesterone is produced. These hormones are concerned with female sexuality and with the preparation of female sex organs for reproduction.

MALE SEX HORMONES

In the male, certain cells of the testes produce the male sex hormones known as androgens (for example, testosterone). Androgens are concerned with male sexuality.

Gross Anatomy

Lesson 3: Urogenital System

Welcome to Lesson 3 of the Basic Human Anatomy Course. Today, we'll be studying the Human Urogenital System.

DEFINITION

The human urogenital systems are made up of the urinary organs, which produce the fluid called urine, and the genital, or reproductive, organs of male and female humans, which together can produce a new human being.

INTRODUCTION TO THE HUMAN URINARY SYSTEM

a. Proteins are one of the basic foodstuffs that humans consume. When proteins are used by the body, there are residue or waste products which can be poisonous (toxic) if allowed to accumulate in large amounts. The urinary system of the human body is specialized to remove these nitrogenous waste products from the circulating blood.

b. **Major Parts**. See figure 8-1 for the major parts of the human urinary system. This system includes two kidneys, two ureters (one connecting each kidney to the urinary bladder), the urinary bladder, and the urethra.

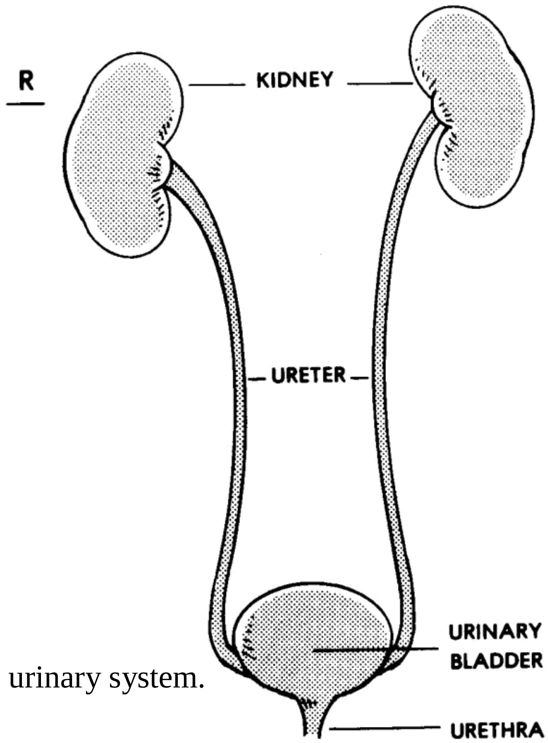


Figure 8-1. The human urinary system.

THE KIDNEY

 General.

The kidneys have the same shape and color as kidney beans, but are about 8-10 centimeters (3-3 1/2 inches) in length.

Each kidney has a fibrous capsule. On the concave, medial side of each kidney, there is a notch called the hilus. Through this hilus pass the ureter and the NAVL (nerve, artery, vein, and lymphatic) which service the kidney.

Each kidney is attached to the posterior wall of the abdominal cavity, just above the waistline level. Each is held in place by special fascia and fat.

 Gross Internal Structure. If we compare the structure of the kidney with that of

(3) cantaloupe (muskmelon), the renal cortex would correspond to the hard rind, the renal medulla would correspond with the edible flesh of the melon, while the renal sinus would correspond to the hollow center (after the seeds have been removed). The medulla consists of pyramids with their bases at the cortex and forming peaks, papillae, which empty into the sinus.
PAPILLA = pimple, nipple

See figure 8-2 for a section of the kidney showing the inner structure.

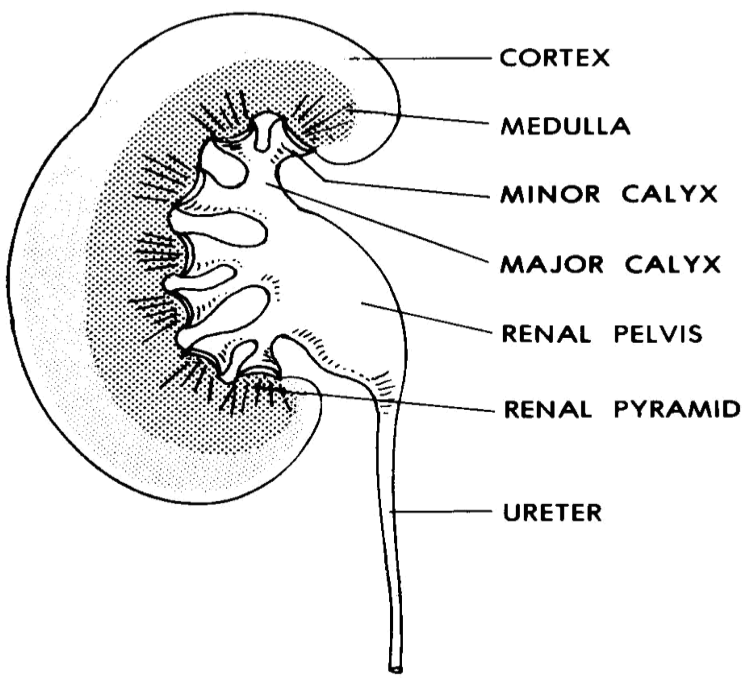


Figure 8-2. A section of a human kidney.

c. **The Nephron**. See figure 8-3 for an illustration of a nephron. Nephrons are the functional units of the human kidney. Their primary function is to remove the wastes of protein usage from the blood. In addition, they serve to conserve water and other materials for continued use by the body. The end result of nephron

function is a more or less concentrated fluid called urine. The kidneys contain great numbers of nephrons, about a million for each kidney. The main subdivisions of a nephron are the renal corpuscle and a tubular system.

(7) Renal corpuscle. The renal corpuscle has a hollow double- walled sac

called the renal capsule ("Bowman's capsule"). Leading into the capsule is a very small artery called the afferent arteriole. Within the capsule, this artery becomes a mass of capillaries known as the glomerulus. An efferent arteriole drains the blood away from the capsule. The capsule and the glomerulus together are known as the renal corpuscle.

(1) Tubules. Each renal capsule is drained by a renal tubule. The first part of this tubule runs quite a distance in a coiled formation and is called the proximal convoluted tubule. A long loop, the renal loop (of Henle), extends down into the medulla with two straight parts and a sharp bend at the bottom. As the tube returns to the cortex layer, it once again becomes coiled and here is known as the distal convoluted tubule.

(2) Filtration/reabsorption. Except for the blood cells and the larger proteins, the fluid portion of the blood passes through the walls of the glomerulus into the cavity between the two layers of the renal capsule. This fluid is called the glomerular filtrate. By a process of taking back (resorption), the majority of the fluid is removed from the tubules and the concentrated fluid is called the urine.

6 **The Collecting Tubule**. The distal convoluted tubules of several nephronsempty into a collecting tubule. The urine is then passed from the collecting tubule at the papilla of the medullary pyramid. Several collecting tubules are present in each pyramid.

7 **Renal Pelvis**. The renal pelvis is a hollow sac within the sinus of the kidney.Urine from the pyramids collects into the funnel-shaped renal pelvis. The ureter then drains the urine from the renal pelvis.

URETERS

The ureters are tubes which connect the kidneys to the urinary bladder. The smooth muscle walls of the ureters produce a peristalsis (wave-like movement) that moves the urine along drop by drop.

URINARY BLADDER

a. The urinary bladder is a muscular organ for storing the urine. Near the inferior posterior corners of the urinary bladder are openings where the ureters empty into the bladder. Also at the inferior aspect of the urinary bladder is the exit, the beginning of the urethra. The triangular area, between the openings of the ureters and the urethra, is called the trigone, or base of the urinary bladder.

b. The urinary bladder wall is stretchable to accommodate varying volumes of urine.

c. Nerve endings called stretch receptors are found in the wall of the urinary bladder. Usually, the pressure within the urinary bladder is low. However, as the volume of the enclosed urine approaches the bladder's capacity, stretching of the wall stimulates the stretch receptors. The cycle of events controlling urination (voiding or emptying of the urinary bladder) is known as the voiding reflex.

URETHRA

The urethra is a tube which conducts the urine from the urinary bladder to the outside of the body.
It begins at the anterior base of the urinary bladder.

a. **Urethral Sphincters**. The urethral sphincters are circular muscle masses which control the passage of the urine through the urethra. There are two urethral sphincters--an internal urethral sphincter and an external urethral sphincter.

(4) The internal urethral sphincter is located in the floor of the urinary bladder. It is made of smooth muscle tissue. It is controlled by nerves of the autonomic nervous system (lesson 11).

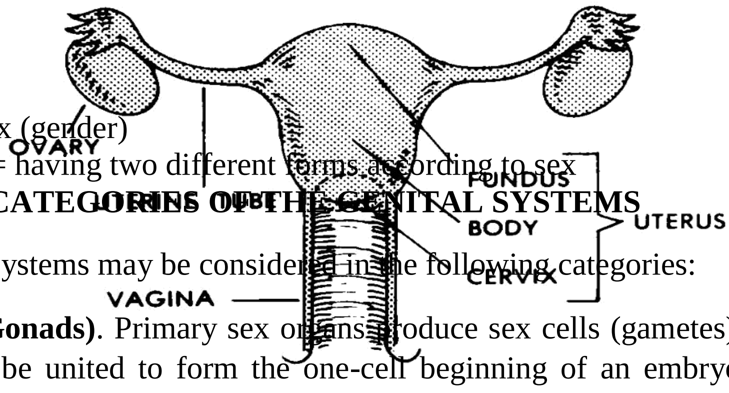
The external urethral sphincter is more inferior around the urethra in the area of the pelvic floor. It is made up of striated muscle tissue. It is controlled by the peripheral nervous system (lesson 11).

b. **Male-Female Differences**. The female urethra is short and direct. The maleurethra is much longer and has two curvatures. Whereas the female urethra serves only a urinary function, the male urethra serves both the urinary and reproductive functions.

INTRODUCTION TO HUMAN GENITAL (REPRODUCTIVE) SYSTEMS
SEXUAL DIMORPHISM

The human male and human female each has a system of organs specifically designed for the production of new humans. These systems are known as reproductive or genital systems. Since there are different systems for males and females, the genital systems are an example of sexual dimorphism.

MORPH = form, shape
DI = two
SEXUAL = according to sex (gender)
SEXUAL DIMORPHISM = having two different forms according to sex



A. ANTERIOR VIEW

MAJOR COMPONENT CATEGORIES OF THE GENITAL SYSTEMS

Components of the genital systems may be considered in the following categories:

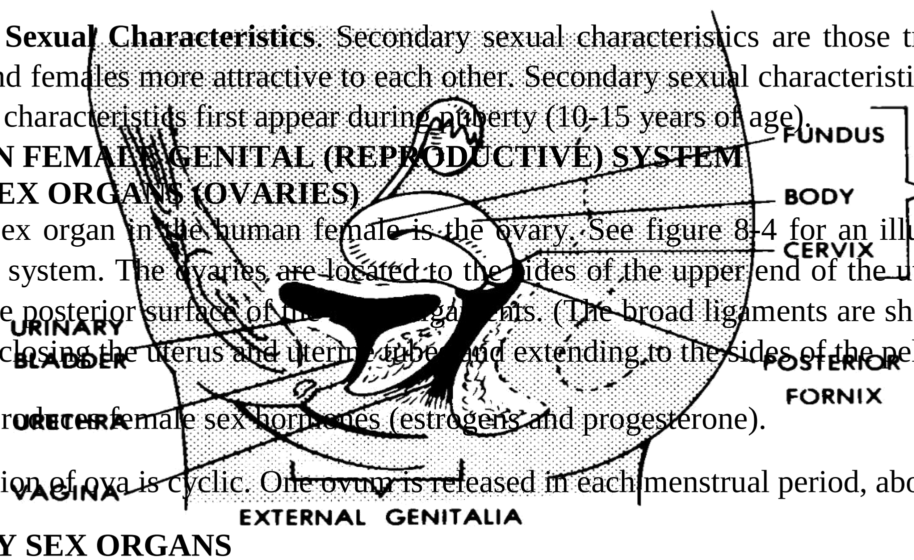
a. **Primary Sex Organs (Gonads)**. Primary sex organs produce sex cells (gametes). A male gamete and a female gamete may be united to form the one-cell beginning of an embryo (the process of fertilization). Primary sex organs also produce sex hormones.
b. **Secondary Sex Organs**. Secondary sex organs care for the product of the primary sex organ.
c. **Secondary Sexual Characteristics**. Secondary sexual characteristics are those traits that tend to make males and females more attractive to each other. Secondary sexual characteristics help to ensure mating. These characteristics first appear during puberty (10-15 years of age).

THE HUMAN FEMALE GENITAL (REPRODUCTIVE) SYSTEM
PRIMARY SEX ORGANS (OVARIES)

The primary sex organ in the human female is the ovary. See figure 8-4 for an illustration of the female genital system. The ovaries are located to the sides of the upper end of the uterus. They are anchored to the posterior surface of the broad ligaments. (The broad ligaments are sheets or folds of peritoneum enclosing the uterus and uterine tubes and extending to the sides of the pelvis.)

b. The ovary produces female sex hormones (estrogens and progesterone).

c. The production of ova is cyclic. One ovum is released in each menstrual period, about 28 days.



B. MIDSAGITTAL SECTION

SECONDARY SEX ORGANS

a. **Uterine Tubes (Fallopian Tubes, Oviducts)**. Extending to either side of the uterus are two muscular tubes which open at the outer ends like fringed trumpets. The fringe-like appendages encircle the ovaries. At their medial ends, the uterine tubes open into the uterus. The function of the uterine tubes is to pick up the ovum when released from the ovary and hold it UNTIL one of the following happens:

e. It is fertilized. After fertilization, the initial stages of embryo development take place. The developing embryo is eventually moved into the uterus.

f. The nutrient stored within the ovum is used up and the ovum dies. This may take three to five days.

Figure 8-4. The human female genital system.

b. **Uterus**. The uterus is the site where all but the first few days of embryo development takes place. After eight weeks of embryonic development, it is known as the fetus.

(1) Main subdivisions. The uterus is shaped like a pear, with the stem (cervix) facing downward and toward the rear. The fundus is the portion of the uterus above the openings of the uterine tubes. The main part, or body, is the portion between the cervix and the fundus. The uterus usually leans forward with the body slightly curved as it passes over the top of the urinary bladder. The cervix opens into the upper end of the vagina.

(2) Wall structure. The inner lining of the uterus is called the endometrium. Made up of epithelium, it is well supplied with blood vessels and glands. The muscular wall of the uterus is called the myometrium. In the body of the uterus, the muscular tissue is in a double spiral arrangement. In the cervix, it is in a circular arrangement.

(3) Age differences. The uterus of an infant female is undeveloped. During puberty, the uterus develops. The uterus of an adult is fully developed. The uterus of an old woman is reduced in size and nonfunctional.

c. **Vagina**. The vagina is a tubular canal connecting the cervix of the uterus withthe outside. It serves as a birth canal and as an organ of copulation. It is capable of stretching during childbirth. The lower opening of the vagina may be partially closed by a thin membrane known as the hymen.

d. **External Genitalia**. Other terms for the external genitals of the human femaleare vulva and pudendum. Included are the:

(1) Mons pubis. The mons pubis is a mound of fat tissue covered with skin and hair in front of the symphysis pubis (the joint of the pubic bones).

(2) Labia majora. Extending back from the mons pubis and encircling the vestibule (discussed below) are two folds known as the labia majora. Their construction is similar to the mons pubis, including fatty tissue and skin. The outer surfaces are covered with hair. The inner surfaces are moist and smooth. The corresponding structure in the male is the scrotum.

LABIA = lips (LABIUM, singular)

(3) Labia minora. The labia minora are two folds of skin lying within the labia majora and also enclosing the vestibule. In front, each labium minus (minus = singular of minora) divides into two folds. The fold above the clitoris (discussed below) is called the prepuce of the clitoris. The fold below is the frenulum.

(4) Clitoris. The clitoris is a small projection of sensitive erectile tissue which corresponds to the male penis. However, the female urethra does not pass through the clitoris.

(5) Vestibule. The cleft between the labia minora and behind the clitoris is called the vestibule. It includes the urethral opening in front and the vaginal opening slightly to the rear.

e. **Pregnancy and Delivery**. When an embryo forms an attachment to the endometrium, a pregnancy exists. The attachment eventually forms a placenta, an organ joining mother and offspring for such purposes as nutrition of the offspring. The fetal membranes surround the developing individual (fetus) and are filled with amniotic fluid.

(1) During the first eight weeks, the developing organism is known as an embryo. During this time, the major systems and parts of the body develop.

(2) During the remainder of the pregnancy, the developing organism is known as the fetus. During this time, growth and refinement of the body parts occur.

(3) Parturition is the actual delivery of the fetus into a free- living state. The delivery of the fetus is followed by a second delivery-- that of the placenta and fetal membranes.

f. **Menstruation and Menopause**. About two weeks after an ovum is released, if itis not fertilized, menstruation occurs. Menstruation involves the loss of all but the basal layer of the endometrium. This process includes bleeding. It first occurs at puberty and lasts until menopause (45 to 55 years of age). After menopause, pregnancy is no longer possible.

SECONDARY SEXUAL CHARACTERISTICS

The secondary sexual characteristics of females include growth of pubic hair, development of mammary glands, development of the pelvic girdle, and deposition of fat in the mons pubis and labia majora.

MAMMARY GLANDS

The mammary glands were previously mentioned in Lesson 3. Secretion of milk begins after parturition. Stimulation from suckling helps to maintain the normal rate of milk secretion. At the time of menopause, breast tissue becomes less prominent.

THE HUMAN MALE GENITAL (REPRODUCTIVE) SYSTEM

PRIMARY SEX ORGANS (TESTES) The primary sex organ of the human male is the testis. See figure 8-5 for an illustration of the male genital system. The testes are egg-shaped.

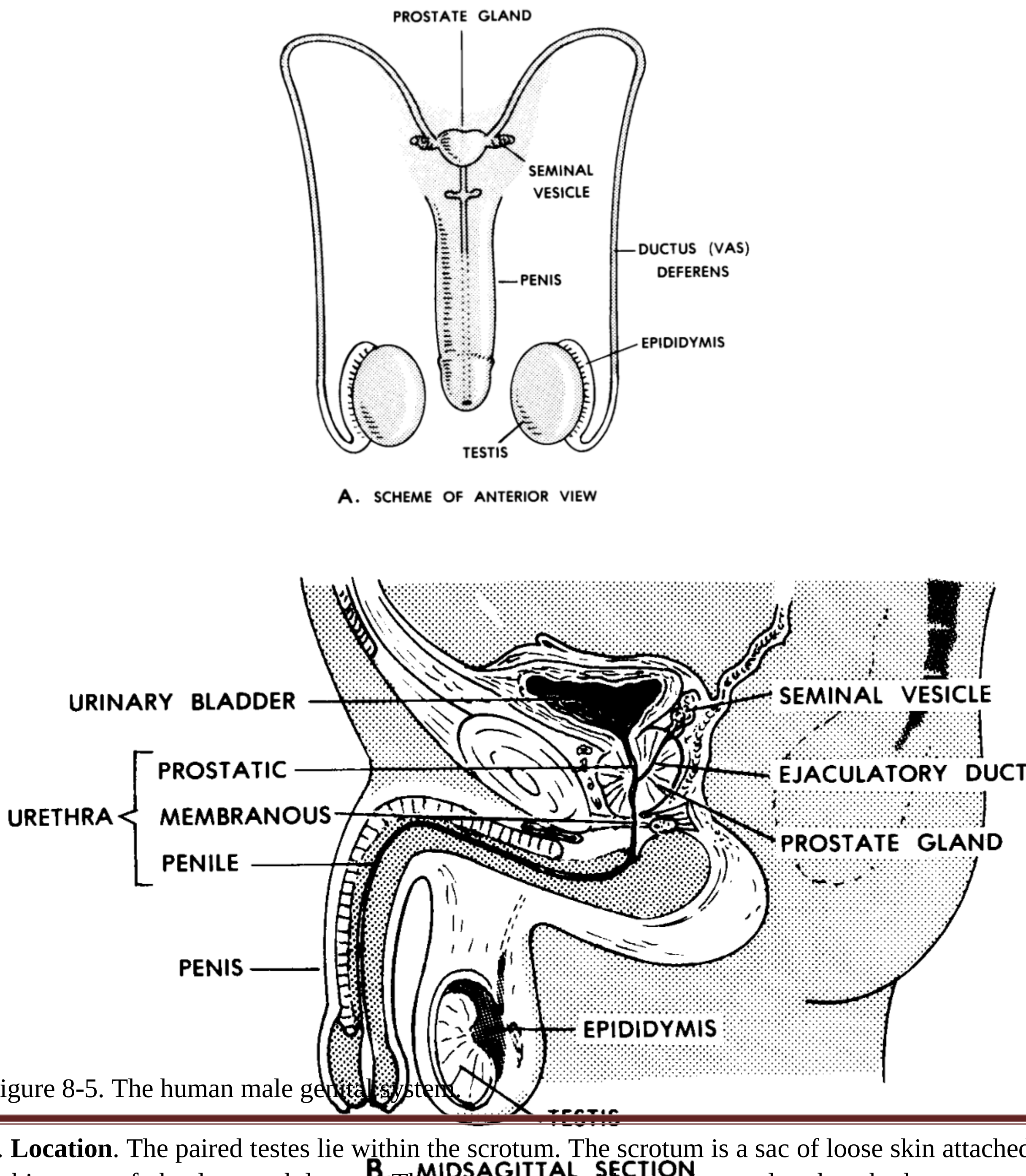


Figure 8-5. The human male genital system.

a. **Location**. The paired testes lie within the scrotum. The scrotum is a sac of loose skin attached in the pubic area of the lower abdomen. The scrotum provides a site cooler than body temperature to maintain the viability of the spermatozoa. However, when the air is too cold, muscles and muscular fibers draw the testes and scrotum closer to the body to maintain warmth. Otherwise, the scrotum hangs loosely. The tunica vaginalis is a serous cavity surrounding each testis.

b. **Functions**. The testis produces the male sex cells called spermatozoa (spermatozoon, singular). The spermatozoa are continuously produced by the millions. One such cell may eventually fertilize an ovum of a human female. The testes also produce male sex hormones called androgens.

SECONDARY SEX ORGANS

a. **Epididymis**. The epididymis is a coiled tube whose function is to aid in the maturation of spermatozoa. Its coiled length is only about one and one-half inches. Its uncoiled length is about 16 feet. When coiled, it extends downward along the posterior side of each testis. Its lining secretes a nutritive medium for spermatozoa. It receives spermatozoa from the testes in an immature state. As the spermatozoa pass through the nutrient, they mature.

b. **Ductus (Vas) Deferens**. The ductus deferens is a transporting tube which carries the mature sperm from the epididymis to the prostate. Each tube enters the abdomen through the inguinal canal. Each passes over a ureter to reach the back of the urinary bladder and then down to the prostate gland.

c. **Seminal Vesicles**. Lying alongside each ductus deferens as it crosses the back of the bladder is a tubular structure called the seminal vesicle. The seminal vesicle produces a fluid which becomes part of the ejaculate.

Ejaculatory Duct. Each ductus deferens and its corresponding seminal vesicle converge to form a short tube called the ejaculatory duct. The ejaculatory duct opens into the urethra within the prostate gland. The ejaculatory duct carries both spermatozoa and seminal vesicle fluid.

e. **Prostate Gland**. As the urethra leaves the urinary bladder, its first inch is surrounded by a chestnut-size gland called the prostate gland. The prostate gland provides an additional fluid to be added to the spermatozoa and seminal vesicle fluid.

f. **Penis**. As the urethra leaves the abdomen, it passes through the penis, the male organ of copulation.

(1) Surrounding the urethra is a central cylinder of erectile tissue called the corpus spongiosum. This cylinder is bulb-shaped at each end. The posterior end is attached to the base of the pelvis. The sensitive anterior end is known as the glans.

CORPUS SPONGIOSUM = spongy body

(2) Overlying the corpus spongiosum is a pair of cylinders of erectile tissue called the corpora cavernosa. These two cylinders are separate in their proximal fourth and joined in their distal three-fourths. They are attached to the pubic bones. Together, the corpus spongiosum and the corpora cavernosa combine to form the shaft of the penis.

CORPUS CAVERNOSUM = cavernous body

(3) The prepuce, or foreskin, is a covering of skin for the glans. It may be removed in a surgical procedure called circumcision.

SECONDARY SEXUAL CHARACTERISTICS

The secondary sexual characteristics of male include growth of facial, pubic, and chest hair; growth of the larynx to deepen the the voice; and deposition of protein to increase muscularity and general body size.

Lesson 4: Cardiovascular and Lymphatic System

INTRODUCTION

NEED FOR CIRCULATORY SYSTEMS

a. The need for circulatory systems is based on two criteria:

Number of cells. Multicellular animals are animals with a great number of cells.

Size. In larger animals, most cells are too far away from sources of food and oxygen for simple diffusion to provide sufficient amounts. Also, distances are too great for simple removal of wastes.

(4)Because of these criteria, we need a system (or systems) to carry materials to all cells. To get food and oxygen to the cells and to remove waste products, we need a transport system or circulatory system. Human circulatory systems are so effective that no cell is more than two cells away from a blood capillary.

BASIC COMPONENTS OF ANY CIRCULATORY SYSTEM

The four basic components of any circulatory system are a vehicle, conduits, a motive force, and exchange areas.

a. **Vehicle**. The vehicle is the substance which actually carries the materials being transported.

b. **Conduits**. A conduit is a channel, pipe, or tube through which a vehicle travels.

c. **Motive Force**. If we say that a force is motive, we mean that it produces movement. Systems providing a motive force are often known as pumps.

. **Exchange Areas**. Since the materials being transported must eventually be exchanged with a part of the body, special areas are developed for this purpose. They are called exchange areas.

CIRCULATORY SYSTEMS IN THE HUMAN BODY

a. The cardiovascular system is the circulatory system involving the heart and blood vessels.

b. The lymphatic system is a drainage-type circulatory system involved with the clear fluid known as lymph.

c. There are other minor circulatory systems in the human body, such as the one involved with cerebrospinal fluid.

THE HUMAN CARDIOVASCULAR SYSTEM

GENERAL

The human cardiovascular system is a collection of interacting structures designed to supply oxygen and nutrients to living cells and to remove carbon dioxide and other wastes. Its major components are the:

a. **Blood**. Blood is the vehicle for oxygen, nutrients, and wastes.

b. **Blood Vessels**. Blood vessels are the conduits, or channels, through which the blood is moved.

c. **Heart**. The heart is the pump which provides the primary motive force.

d. **Capillaries**. The capillaries, minute (very small) vessels, provide exchange areas. For example, in the capillaries of the lungs, oxygen is added and carbon dioxide is removed from the blood.

BLOOD

Blood is the vehicle for the human cardiovascular system. Its major subdivisions are the plasma, a fluid containing proteins, and the formed elements, including red blood cells, white blood cells, and platelets.

(8) **Plasma**.

Plasma makes up about 55 percent of the total blood volume. It is mainly composed of water. A variety of materials are dissolved in plasma. Among the most important of these are proteins.

After the blood clots, the clear fluid remaining is called serum. Serum does not contain the proteins used for clotting. Otherwise, it is very similar to plasma.

(9)**Formed Elements**. The formed elements make up about 45 percent of the totalblood volume. The formed elements are cellular in nature. While the red blood cells (RBCs) and white blood cells (WBCs) are cells, the platelets are only fragments of cells.

Red blood cells (erythrocytes). RBCs are biconcave discs. That is, they are shaped something like an inner tube from an automobile tire, but with a thin middle portion instead of a hole. There are approximately 5,000,000 RBCs in a cubic millimeter of normal adult blood. RBCs contain hemoglobin, a protein which carries most of the oxygen transported by the blood.

(3) White blood cells (leukocytes). There are various types of WBCs, but the most common are neutrophils and lymphocytes. Neutrophils phagocytize (swallow up) foreign particles and organisms and digest them. Lymphocytes produce antibodies and serve other functions in immunity. In normal adults, there are about 5,000 to 11,000 WBCs per cubic millimeter of blood.

(4) Platelets. Platelets are about half the size of erythrocytes. They are fragments of cells. Since they are fragile, they last only about three to five days. Their main function is to aid in clotting by clumping together and by releasing chemical factors related to clotting. There are 150,000 - 350,000 platelets in a cubic millimeter of normal blood.

8 **Some General Functions of the Blood**.

(2) Blood serves as a vehicle for oxygen, nutrients, carbon dioxide and other wastes, hormones, antibodies, heat, etc.

(3) Blood aids in temperature control. Beneath the skin, there is a network of vessels that functions much like a radiator. To avoid accumulation of excess heat in the body, the flow of blood to these vessels can be increased greatly. Here, aided by the evaporative cooling provided by the sweat glands, large amounts of heat can be rapidly given off. The flow of blood also helps keep the outer parts of the body from becoming too cold.

(4) The blood aids in protecting our bodies by providing immunity. Some WBCs phagocytize (swallow up) foreign particles and microorganisms. Other WBCs produce antibodies. The blood transports antibodies throughout the body.

(5) Blood clotting is another function of blood. Not only does this prevent continued blood loss, it also helps prevent invasion of the body by microorganisms and viruses by sealing the wound opening.

BLOOD VESSELS

The blood is conducted or carried through the body by tubular structures known as blood vessels. Since at no time does the whole blood ever leave a blood vessel of some sort, we refer to this system as a closed system.

a. **General Construction**. The blood vessels in general are tubular and have a three-layered wall.

Intima. The lumen (hollow central cavity) is lined by a layer of smooth epithelium known as the intima.

Media. A middle layer of smooth muscle tissue is called the media.

Adventitia. The adventitia is the outer layer of fibrous connective tissue that holds everything together.

g. **Types of Blood Vessels**. See figure 9-1 for a diagram of the human circulatorysystem. We recognize three types of blood vessels: ib

The arteries carry blood away from the chambers of the heart.

(4) The veins carry blood to the chambers of the heart.

(5) Capillaries are extremely thin-walled vessels having only the intimal layer through which exchanges can take place between the blood and the tissue cells.

e. **Relationships**. Arteries and veins are largest where they are closest to theheart. Away from the heart, they branch into smaller and smaller and more numerous vessels. The branching continues until the smallest arteries (arterioles) empty into the capillaries. The capillaries in turn are drained by the venules of the venous system.

f. **Valves**. Within the heart and the veins are structures known as valves. Valvesfunction to insure that the blood flows in only one direction.

THE HEART

Through the action of its very muscular walls, the heart produces the primary motive force to drive the blood through the arterial system. In humans, the heart is located just above the diaphragm, in the middle of the thorax, and extending slightly to the left. It is said that the heart of an average individual is about the size of that individual's clenched fist.

(3) **General Construction of the Human Heart**. See figure 9-2 for an illustration ofthe human heart.

(6) Chambers. The heart is divided into four cavities known as the chambers. The upper two chambers are known as the atria, right and left. Each atrium has an ear-like projection known as an auricle. The lower two chambers are known as ventricles, right and left. Between the two atria is a common wall known as the interatrial septum. Between the two ventricles is a common wall known as the interventricular septum.

ATRIUM = hall

AURICLE = ear-like flap

VENTER = belly
SEPTUM = fence

(2) Wall layers. The walls of the chambers are in three general layers. Lining the cavity of each chamber is a smooth epithelium known as the endocardium. (Endocarditis is an inflammation of the endocardium.) The middle layer is made up of cardiac muscle tissue and is known as the myocardium. The outer layer of the heart is another epithelium known as the epicardium.

(4) Relationship of wall thickness to required pressure levels. A cross-section of the chambers shows that the atrial walls are relatively thin. The right ventricular wall is much thicker. The left ventricular wall is three to five times thicker than that of the right. These differences in wall thickness reflect the amount of muscle tissue needed to produce the amount of pressure required of each chamber.

g. Cardiac valves (figure 9-3).

Between the atrium and ventricle of each side is the atrioventricular (A-V) valve. Each A-V valve prevents the blood from going back into the atrium from the ventricle of the same side. The right A-V valve is known as the tricuspid valve. The left A-V valve is known as the mitral valve. ("Might is never right.") The leaflets (flaps) of the A-V valves are prevented from being pushed back into the atria by fibrous cords. These fibrous cords are attached to the underside (the ventricular side) of the leaflets and are called chordae tendineae. At their other ends, the chordae tendineae are attached to the inner walls of the ventricles by papillary muscles.

(3) A major artery leads away from each ventricle--the pulmonary trunk from the right ventricle and the aortic arch from the left ventricle. A semilunar valve is found at the base of each of the pulmonary trunk and the aortic arch. These semilunar valves prevent blood from flowing back into the ventricles. The pulmonary (semilunar) valve and the aortic (semilunar) valve are each made up of three semilunar ("pocket-like") cusps.

b. **Control of the Heart Beat**. The heart is under several different control systems--extrinsic nervous control, intrinsic nervous control, and humoral control.

(4) Extrinsic nervous control. Extrinsic nervous control is control from outside of the heart. Extrinsic control is exerted by nerves of the autonomic nervous system. The sympathetic cardiac nerves accelerate (speed up) the heart. The vagus parasympathetic nerve decelerates (slows down) the heart.

(5) Intrinsic "nervous" control. Intrinsic "nervous" control is control built within the heart. The intrinsic "nervous" system consists of the sinoatrial (S-A) node (often referred to as the "pacemaker"), the atrioventricular (A-V) node, and the septal bundles. The septal bundles spread through the walls of the ventricles, just beneath the endocardium. This combination of nodes

and bundles initiates the heart beat automatically and transmits the impulse through the atria and the ventricles.

(3) Humoral control. In addition to the "nervous" control of heart action, it appears that there are substances in the blood itself which have varying effects on the functioning of the heart. Although these substances are not as yet well understood, they appear to have some importance. The transplanted heart seems to depend to a degree on this control mechanism, since much of its "nervous controls" have been lost for the initial period in the recipient's body.

c. **Coronary Arteries and Cardiac Veins**. We may say that the heart deals with twodifferent kinds of blood flow--"functional" blood and "nutritive" blood. "Functional" blood is the blood that the heart works on or pushes with its motive force. However, the walls of the heart require nutrition that they cannot get directly from the blood within the chambers. "Nutritive" blood is supplied to these walls by the coronary arteries, right and left. The coronary arteries arise from the base of the aortic arch and are distributed over the surface of the heart. This blood is collected by the cardiac veins and empties into the right atrium of the heart. Should a coronary artery, or one of its branches, become closed for whatever reason, that part of the heart wall formerly supplied nutrient blood by the closed vessel will very likely die.

d. **Pericardial Sac**. The average heart contracts in what is known as a heart beat,about 70-80 times a minute. To reduce the frictional forces that would be applied to its moving surfaces, the heart is enclosed in a special serous sac known as the pericardium ("around the heart").

CARDIOVASCULAR CIRCULATORY PATTERNS

a. **General**. The human cardiovascular circulatory system is described as a closed, two-cycle system.

(1) It is closed because at no place is the blood as whole blood ever outside the system.

(2) It is two-cycle because the blood passes through the heart twice with each complete circuit of the body. In the pulmonary cycle, the blood passes from the right heart, through the lungs, and to the left heart. In the systemic cycle, the blood passes from the left heart, through the body in general, and returns to the right heart.

(3) It is common for an area of the body to be supplied by more than one blood vessel so that if one is damaged, the others will continue the supply. This is known as collateral circulation. However, there are situations, such as in the heart and the brain, where a single artery supplies a specific part of a structure. Such an artery is called an end artery. When an end artery is damaged, that area supplied by it will usually die, as in the case of the coronary artery (para 9-7c) above or in the case of a "stroke" in the brain.

b. **Pulmonary Cycle**. The pulmonary cycle begins in the right ventricle of theheart. Contraction of the right ventricular wall applies pressure to the blood. This forces the tricuspid valve closed and the closed valve prevents blood from going back into the right atrium. The pressure forces blood past the semilunar valve into the pulmonary trunk. Upon relaxation of the right ventricle, back pressure of the blood in the pulmonary trunk closes the pulmonary semilunar valve. The blood then passes into the lungs through the pulmonary arterial system. Gases are exchanged between the alveoli of the lungs and the blood in the capillaries next to the alveoli. This blood, now saturated with oxygen, is collected by the pulmonary veins and carried to the left atrium of the heart. This completes the pulmonary cycle.

c. **Systemic Cycle**.

(1) Left ventricle of the heart. The oxygen-saturated blood is moved from the left atrium into the left ventricle. When the left ventricular wall contracts, the pressure closes the mitral valve, which prevents blood from returning to the left atrium. The contraction of the left ventricular wall therefore forces the blood through the aortic semilunar valve into the aortic arch. Upon relaxation of the left ventricular wall, the back pressure of the aortic arch forces the aortic semilunar valve closed.

(2) Arterial distributions. The blood then passes through the various arteries to the tissues of the body. See figure 9-5 for an illustration of the main arteries of the human body.

(a) The carotid arteries supply the head. The neck and upper members are supplied by the subclavian arteries.

(b) The aortic arch continues as a large single vessel known as the aorta passing down through the trunk of the body in front of the vertebral column. It gives off branches to the trunk wall and to the contents of the trunk.

(c) At the lower end of the trunk, the aorta divides into right and left iliac arteries, supplying the pelvic region and lower members.

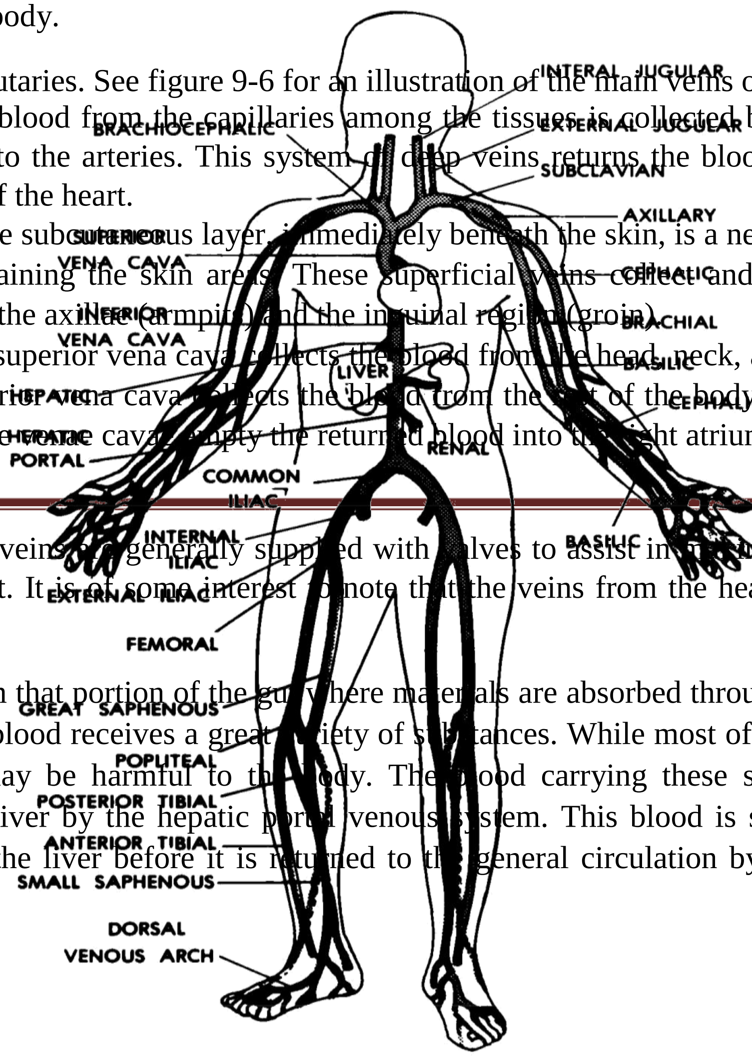
(3) Capillary beds of the body tissues. In the capillary beds of the tissues of the body, materials (such as food, oxygen, and waste products) are exchanged between the blood and the cells of the body.

(4) Venous tributaries. See figure 9-6 for an illustration of the main veins of the human body.

(a) The blood from the capillaries among the tissues is collected by a venous system parallel to the arteries. This system of deep veins returns the blood back to the right atrium of the heart.

(b) In the subcutaneous layer, immediately beneath the skin, is a network of superficial veins draining the skin areas. These superficial veins collect and then join the deep veins in the axillae (armpits) and the inguinal region (groin).

(c) The superior vena cava collects the blood from the head, neck, and upper members. The inferior vena cava collects the blood from the rest of the body. As the final major veins, the venae cavae empty the returned blood into the right atrium of heart.



(d) The veins are generally supplied with valves to assist in moving the blood flow toward the heart. It is of some interest to note that the veins from the head do not contain valves.

(e) From that portion of the gut where materials are absorbed through the walls into the capillaries, the blood receives a great variety of substances. While most of these substances are useful, some may be harmful to the body. The blood carrying these substances is carried directly to the liver by the hepatic portal venous system. This blood is specially treated and conditioned in the liver before it is returned to the general circulation by way of the hepatic veins.

Figure 9-6. Main veins of the human body.

THE HUMAN LYMPHATIC SYSTEM

GENERAL

Between the cells of the body are spaces filled with fluid. This is the interstitial (or tissue) fluid, often referred to as intercellular fluid. There are continuous exchanges between the intracellular fluid, the interstitial fluid, and the plasma of the blood. The lymphatic system returns to the bloodstream the excess interstitial fluid, which includes proteins and fluid derived from the blood.

STRUCTURES OF THE HUMAN LYMPHATIC SYSTEM

See figure 9-7 for an illustration of the human lymphatic system.

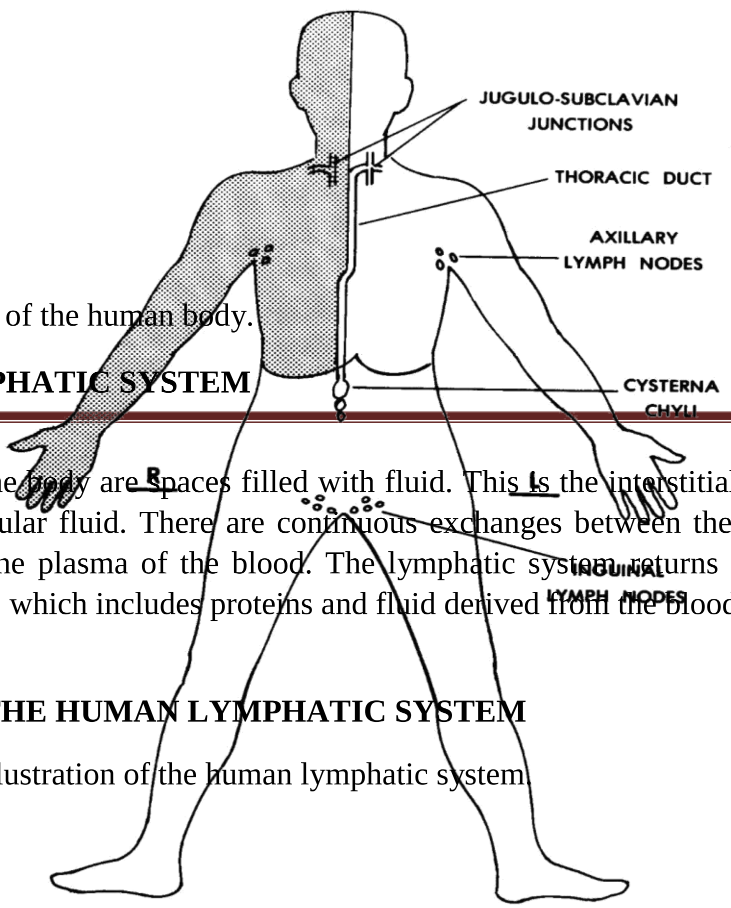


Figure 9-7. The human lymphatic system.

a. **Lymphatic Capillaries**. Lymphatic capillaries are located in the interstitial spaces. Here, they absorb the excess fluids.

b. **Lymph Vessels**. A tributary system of vessels collects these excess fluids, now called lymph. Like veins, lymphatic vessels are supplied with valves to help maintain a flow of lymph in one direction only. The lymphatic vessels, to a greater or lesser extent, parallel the venous vessels along the way. The major lymph vessel in the human body is called the thoracic duct. The thoracic duct passes from the abdomen up through the thorax and into the root of the neck in front of the vertebral column. The thoracic duct there empties into the junction of the left subclavian and jugular veins.

c. **Lymph Nodes**. Along the way, lymphatic vessels are interrupted by special structures known as lymph nodes. These lymph nodes serve as special filters for the lymph fluid passing through.

d. **Tonsils**. Tonsils are special collections of lymphoid tissue, very similar to a group of lymph nodes. These are protective structures and are located primarily at the entrances of the respiratory and digestive systems.

Anatomical terminology

Anatomical terminology is a form of scientific terminology used by anatomists, zoologists, and health professionals such as doctors.

Anatomical terminology uses many unique terms, suffixes, and prefixes deriving from Ancient Greek and Latin. These terms can be confusing to those unfamiliar with them, but can be more precise, reducing ambiguity and errors. Also, since these anatomical terms are not used in everyday conversation, their meanings are less likely to change, and less likely to be misinterpreted.

To illustrate how inexact day-to-day language can be: a scar "above the wrist" could be located on the forearm two or three inches away from the hand or at the base of the hand; and could be on the palm-side or back-side of the arm. By using precise anatomical terminology such ambiguity is eliminated.

An international standard for anatomical terminology, Terminologia Anatomica has been created.

Word formation

Anatomical terminology has quite regular morphology, the same prefixes and suffixes are used to add meanings to different roots. The root of a term often refers to an organ or tissue. For example, the Latin names of structures such as musculus biceps brachii can be split up and refer to, *musculus* for muscle, *biceps* for "two-headed", *brachii* as in the brachial region of the arm. The first word describes what is being spoken about, the second describes it, and the third points to location.[1]

When describing the position of anatomical structures, structures may be described according to the anatomical landmark they are near. These landmarks may include structures, such as the umbilicus or sternum, or anatomical *lines*, such as the *midclavicular line* from the centre of the clavicle. The cephalon or cephalic region refers to the head. This area is further differentiated into the cranium (skull), facies (face), frons (forehead), oculus (eye area), auris (ear), bucca (cheek), nasus (nose), oris (mouth), and mentum (chin). The neck area is called the cervix or cervical region.

Examples of structures named according to this include the frontalis muscle, submental lymph nodes, buccal membrane and orbicularis oculi muscle.

Sometimes, unique terminology is used to reduce confusion in different parts of the body. For example, different terms are used when it comes to the skull in compliance with its embryonic origin and its tilted position compared to in other animals. Here, *Rostral* refers to proximity to the front of the nose, and is particularly used when describing the skull.[2]:4 Similarly, different terminology is often used in the arms, in part to reduce ambiguity as to what the "front", "back", "inner" and "outer" surfaces are. For this reason, the terms below are used:

- *Radial* referring to the radius bone, seen laterally in the standard anatomical position.
- *Ulnar* referring to the ulna bone, medially positioned when in the standard anatomical position.

Other terms are also used to describe the movement and actions of the hands and feet, and other structures such as the eye.

History

International morphological terminology is used by the colleges of medicine and dentistry and other areas of the health sciences. It facilitates communication and exchanges between scientists from different countries of the world and it is used daily in the fields of research, teaching and medical care. The international morphological terminology refers to morphological sciences as a biological sciences' branch. In this field, the form and structure are examined as well as the changes or developments in the organism. It is descriptive and functional. Basically, it covers the gross anatomy and the microscopic (histology and cytology) of living beings. It involves both development anatomy (embryology) and the anatomy of the adult. It also includes comparative anatomy between different species. The vocabulary is extensive, varied and complex, and requires a systematic presentation.

Within the international field, a group of experts reviews, analyzes and discusses the morphological terms of the structures of the human body, forming today's Terminology Committee (FICAT) from the International Federation of Associations of Anatomists (IFAA).[3][4] It deals with the anatomical, histological and embryologic terminology. In the Latin American field, there are meetings called Iberian Latin American Symposium Terminology (SILAT), where a group of experts of the Pan American Association of Anatomy (PAA)[5] that speak Spanish and Portuguese, disseminates and studies the international morphological terminology.

The current international standard for human anatomical terminology is based on the Terminologia Anatomica (TA). It was developed by the Federative Committee on Anatomical Terminology (FCAT) and the International Federation of Associations of Anatomists (IFAA) and was released in 1998.[6] It supersedes the previous standard, *Nomina Anatomica*.[7] *Terminologia Anatomica* contains terminology for about 7500 human gross (macroscopic) anatomical structures.[8] For microanatomy, known as histology, a similar standard exists in Terminologia Histologica, and for embryology, the study of development, a standard exists in Terminologia Embryologica. These standards specify generally accepted names that can be used to refer to histological and embryological structures in journal articles, textbooks, and other areas. As of September 2016, two sections of the Terminologia Anatomica, including central nervous system and peripheral nervous system, were merged to form the Terminologia Neuroanatomica.

Recently, the Terminologia Anatomica has been perceived with a considerable criticism regarding its content including coverage, grammar and spelling mistakes, inconsistencies, and errors.[10]

Location]

Anatomical terminology is often chosen to highlight the relative location of body structures. For instance, an anatomist might describe one band of tissue as "inferior to" another or a physician might describe a tumor as "superficial to" a deeper body structure.[1]

Anatomical position

Anatomical terms used to describe location are based on a body positioned in what is called the *standard anatomical position*. This position is one in which a person is standing, feet apace, with palms forward and thumbs facing outwards.[11] Just as maps are normally oriented with north at the top, the standard body "map," or anatomical position, is that of the body standing upright, with the feet at shoulder width and parallel, toes forward. The upper limbs are held out to each side, and the palms of the hands face forward.[1]

Using the standard anatomical position reduces confusion. It means that regardless of the position of a body, the position of structures within it can be described without ambiguity.[11]

Regions

In terms of anatomy, the body is divided into regions. In the front, the trunk is referred to as the "thorax" and "abdomen". The back as a general area is the dorsum or dorsal area, and the lower back is the lumbus or lumbar region. The shoulder blades are the scapular area and the breastbone is the sternal region. The abdominal area is the region between the chest and the pelvis. The breast is also called the mammary region, the armpit as the axilla and axillary, and the navel as the umbilicus and umbilical. The pelvis is the lower torso, between the abdomen and the thighs. The groin, where the thigh joins the trunk, are the inguen and inguinal area.

The entire arm is referred to as the brachium and brachial, the front of the elbow as the antecubitis and antecubital, the back of the elbow as the olecranon or olecranal, the forearm as the antebrachium and antebrachial, the wrist as the carpus and carpal area, the hand as the manus and manual, the palm as the palma and palmar, the thumb as the pollex, and the fingers as the digits, phalanges, and phalangeal. The buttocks are the gluteus or gluteal region and the pubic area is the pubis.

Anatomists divide the lower limb into the thigh (the part of the limb between the hip and the knee) and the leg (which refers only to the area of the limb between the knee and the ankle).[11] The thigh is the femur and the femoral region. The kneecap is the patella and patellar while the back of the knee is the popliteus and popliteal area. The leg (between the knee and the ankle) is the crus and crural area, the lateral aspect of the leg is the peroneal area, and the calf is the sura and sural region. The ankle is the tarsus and tarsal, and the heel is the calcaneus or calcaneal. The foot is the pes and pedal region, and the sole of the foot the planta and plantar. As with the fingers, the toes are also called the digits, phalanges, and phalangeal area. The big toe is referred to as the hallux.

Abdomen

To promote clear communication, for instance about the location of a patient’s abdominal pain or a suspicious mass, the abdominal cavity can be divided into either nine regions or four quadrants.[1]

Quadrants

The abdomen may be divided into four quadrants, more commonly used in medicine, subdivides the cavity with one horizontal and one vertical line that intersect at the patient’s umbilicus (navel).[1] The right upper quadrant (RUQ) includes the lower right ribs, right side of the liver, and right side of the transverse colon. The left upper quadrant (LUQ) includes the lower left ribs, stomach, spleen, and upper left area of the transverse colon. The right lower quadrant (RLQ) includes the right half of the small intestines, ascending colon, right pelvic bone and upper right area of the bladder. The left lower quadrant (LLQ) contains the left half of the small intestine and left pelvic bone.[11]

Regions

The more detailed regional approach subdivides the cavity into nine regions, with two vertical and two horizontal lines drawn according to landmark structures. The vertical; or midclavicular lines, are drawn as if dropped from the midpoint of each clavicle. The superior horizontal line is the *subcostal line*, drawn immediately inferior to the ribs.[1] The inferior horizontal line is called the *intertubercular line*, and is to cross the iliac tubercles, found at the superior aspect of the pelvis. The upper right square is the right hypochondriac region and contains the base of the right ribs. The upper left square is the left hypochondriac region and contains the base of the left ribs.

The epigastric region is the upper central square and contains the bottom edge of the liver as well as the upper areas of the stomach. The diaphragm curves like an upside down U over these three regions. The central right region is called the right lumbar region and contains the ascending colon and the right edge of the small intestines. The central square contains the transverse colon and the upper regions of the small intestines. The left lumbar region contains the left edge of the transverse colon and the left edge of the small intestine. The lower right square is the right iliac region and contains the right pelvic bones and the ascending colon. The lower left square is the left iliac region and contains the left pelvic bone and the lower left regions of the small intestine. The lower central square contains the bottom of the pubic bones, upper regions of the bladder and the lower region of the small intestine.[11]

Standard terms

When anatomists refer to the right and left of the body, it is in reference to the right and left of the subject, not the right and left of the observer. When observing a body in the anatomical position, the left of the body is on the observer's right, and vice versa.

These standardized terms avoid confusion. Examples of terms include:[2]:4

- *Anterior* and *posterior*, which describe structures at the front (anterior) and back (posterior) of the body. For example, the toes are anterior to the heel, and the popliteus is posterior to the patella.[1]
- *Superior* and *inferior*, which describe a position above (superior) or below (inferior) another part of the body. For example, the orbits are superior to the oris, and the pelvis is inferior to the abdomen.[1]
- *Proximal* and *distal*, which describe a position that is closer to (proximal) or farther from (distal) the trunk of the body.[1] For example, the shoulder is proximal to the arm, and the foot is distal to the knee.
- *Superficial* and *deep*, which describe structures that are closer to (superficial) or farther from (deep) the surface of the body. For example, the skin is superficial to the bones, and the brain is deep to the skull.[1] Sometimes *profound* is used synonymously with *deep*.
- *Medial* and *lateral*, which describe a position that is closer to (medial) or farther from (lateral) the midline of the body. For example, the nose is medial to the eyes, and the thumb is lateral to the other fingers.
- *Ventral* and *dorsal*, which describe structures derived from the front (ventral) and back (dorsal) of the embryo, before limb rotation.
- *Rostral* and *caudal*, which describe structures close to (rostral) or farther from (caudal) the nose. For example, the eyes are rostral to the back of the skull, and the tailbone is caudal to the chest.
- *Cranial* and caudal, which describe structures close to the top of the skull (cranial), and towards the bottom of the body (caudal).
- Occasionally, *sinister* for left, and *dexter* for right are used.
- *Paired*, referring to a structure that is present on both sides of the body. For example, the hands are paired structures.

Axes

Each locational term above can define the direction of a vector, and pairs of them can define axes, that is, lines of orientation. For example, blood can be said to flow in a proximal or distal direction, and anteroposterior, mediolateral, and inferosuperior axes are lines along which the body extends, like the X, Y, and Z axes of a Cartesian coordinate system. An axis can be projected to a corresponding plane.

Planes

The three anatomical planes of the body: the sagittal, transverse (or horizontal), frontal planes

Anatomy is often described in *planes*, referring to two-dimensional *sections* of the body. A *section* is a two-dimensional surface of a three-dimensional structure that has been cut. A plane is an imaginary two-dimensional surface that passes through the body. Three planes are commonly referred to in anatomy and medicine:[1][2]:4

- The *sagittal plane* is the plane that divides the body or an organ vertically into right and left sides. If this vertical plane runs directly down the middle of the body, it is called the *midsagittal* or *median plane*. If it divides the body into unequal right and left sides, it is called a *parasagittal plane*, or less commonly a longitudinal section.[1]
- The *frontal plane* is the plane that divides the body or an organ into an anterior (front) portion and a posterior (rear) portion. The frontal plane is often referred to as a *coronal plane*, following Latin *corona*, which means "crown".[1]
- The *transverse plane* is the plane that divides the body or organ horizontally into upper and lower portions. Transverse planes produce images referred to as cross sections.[1]

Functional state

Anatomical terms may be used to describe the functional state of an organ:[*citation needed*]

- *Anastomoses* refers to the connection between two structures previously branched out, such as blood vessels or leaf veins.
- *Patent*, meaning a structure such as an artery or vein that abnormally remains open, such as a patent ductus arteriosus, referring to the ductus arteriosus which normally becomes ligamentum arteriosum within three weeks of birth. Something that is patent may also refer to a channel such as a blood vessel, section of bowel, collecting system or duct that is not occluded and remains open to free flow. Such obstructions may include a calculus (i.e. a kidney stone or gallstone), plaque (like that encountered in vital arteries such as coronary arteries and cerebral arteries), or another unspecified obstruction, such as a mass or bowel obstruction.
- A *plexus* refers to a net-like arrangement of a nerve.

Anatomical variation

The term *anatomical variation* is used to refer to a difference in anatomical structures that is not regarded as a disease. Many structures vary slightly between people, for example muscles that attach in slightly different places. For example, the presence or absence of the palmaris longus tendon. Anatomical variation is unlike congenital anomalies, which are considered a disorder.[12]

Movement

Joints, especially synovial joints allow the body a tremendous range of movements. Each movement at a synovial joint results from the contraction or relaxation of the muscles that are attached to the bones on either side of the articulation. The type of movement that can be produced at a synovial joint is determined by its structural type.

Movement types are generally paired, with one being the opposite of the other. Body movements are always described in relation to the anatomical position of the body: upright stance, with upper limbs to the side of body and palms facing forward.[11]

General motion

Terms describing motion in general include:

- *Flexion* and *extension*, which refer to a movement that decreases (flexion) or increases (extension) the angle between body parts. For example, when standing up, the knees are extended.
- *Abduction* and *adduction* refers to a motion that pulls a structure away from (abduction) or towards (adduction) the midline of the body or limb. For example, a star jump requires the legs to be abducted.
- *Internal rotation* (or *medial rotation*) and *external rotation* (or *lateral rotation*) refers to rotation towards (internal) or away from (external) the center of the body. For example, the Lotus position posture in yoga requires the legs to be externally rotated.
- *Elevation* and *depression* refer to movement in a superior (elevation) or inferior (depression) direction. Primarily refers to movements involving the scapula and mandible.[13]

Special motions of the hands and feet

These terms refer to movements that are regarded as unique to the hands and feet:[14]:590–7

- *Dorsiflexion* and *plantarflexion* refers to flexion (dorsiflexion) or extension of the foot at the ankle. For example, plantarflexion occurs when pressing the brake pedal of a car.
- *Palmarflexion* and *dorsiflexion* refer to movement of the flexion (palmarflexion) or extension (dorsiflexion) of the hand at the wrist. For example, prayer is often conducted with the hands dorsiflexed.
- *Pronation* and *supination* refer to rotation of the forearm or foot so that in the anatomical position the palm or sole is facing anteriorly (supination) or posteriorly (pronation) . For example, if a person makes a "thumbs up" gesture, supination will cause the thumb to point away from the body midline and the fingers and plam to be upwards, while pronation will cause the thumb to point towards the body midline with the back of the hand upwards.
- *Eversion* and *inversion* refer to movements that tilt the sole of the foot away from (eversion) or towards (inversion) the midline of the body.

Muscles

The biceps brachii flex the lower arm. The brachioradialis, in the forearm, and brachialis, located deep to the biceps in the upper arm, are both synergists that aid in this motion.

Muscle action that moves the axial skeleton work over a joint with an origin and insertion of the muscle on respective side. The insertion is on the bone deemed to move towards the origin during muscle contraction. Muscles are often present that engage in several actions of the joint; able to perform for example both flexion and extension of the forearm as in the biceps and triceps respectively.[11] This is not only to be able to revert actions of muscles, but also brings on stability of the actions though muscle coactivation.[15]

Agonist and antagonist muscles

The muscle performing an action is the *agonist*, while the muscle which contraction brings about an opposite action is the *antagonist*. For example, an extension of the lower arm is performed by the triceps as the agonist and the biceps as the antagonist (which contraction will perform flexion over the same joint). Muscles that work together to perform the same action are called synergists. In the above example synergists to the biceps can be the brachioradialis and the brachialis muscle.[11]

Skeletal and smooth muscle

The skeletal muscles of the body typically come in seven different general shapes. This figure shows the human body with the major muscle groups labeled.

The gross anatomy of a muscle is the most important indicator of its role in the body. One particularly important aspect of gross anatomy of muscles is pennation or lack thereof. In most muscles, all the fibers are oriented in the same direction, running in a line from the origin to the insertion. In pennate muscles, the individual fibers are oriented at an angle relative to the line of action, attaching to the origin and insertion tendons at each end. Because the contracting fibers are pulling at an angle to the overall action of the muscle, the change in length is smaller, but this same orientation allows for more fibers (thus more force) in a muscle of a given size. Pennate muscles are usually found where their length change is less important than maximum force, such as the rectus femoris.[16]

Skeletal muscle is arranged in discrete muscles, an example of which is the *biceps brachii*. The tough, fibrous epimysium of skeletal muscle is both connected to and continuous with the tendons. In turn, the tendons connect to the periosteum layer surrounding the bones, permitting the transfer of force from the muscles to the skeleton. Together, these fibrous layers, along with tendons and ligaments, constitute the deep fascia of the body.[16]

Joints

Movement is not limited to only synovial joints, although they allow for most freedom. Muscles also run over symphysis, which allow for movement in for example the vertebral column by compression of the intervertebral discs. Additionally, synovial joints can be divided into different types, depending on their axis of movement.[17]

Membranes

Serous membrane

A serous membrane (also referred to as a serosa) is a thin membrane that covers the walls of organs in the thoracic and abdominal cavities. The serous membranes have two layers; *parietal* and *visceral*, surrounding a fluid filled space.[1] The visceral layer of the membrane covers the organ (the viscera), and the parietal layer lines the walls of the body cavity (pariet- refers to a cavity wall). Between the parietal and visceral layers is a very thin, fluid-filled serous space, or cavity.[1] For example, the pericardium is the serous cavity which surrounds the heart.[1]

- *Visceral* and *parietal* describe structures that relate to an organ (visceral), or the wall of the cavity that the organ is in (parietal). For example, the parietal peritoneum surrounds the abdominal cavity.

Overview

The spine is made of 33 individual bones stacked one on top of the other. This spinal column provides the main support for your body, allowing you to stand upright, bend, and twist, while protecting the spinal cord from injury. Strong muscles and bones, flexible tendons and ligaments, and sensitive nerves contribute to a healthy spine. Yet, any of these structures affected by strain, injury, or disease can cause pain.

Spinal curves

When viewed from the side, an adult spine has a natural S-shaped curve. The neck (cervical) and low back(lumbar) regions have a slight concave curve, and the thoracic and sacral regions have a gentle convex curve (Fig. 1). The curves work like a coiled spring to absorb shock, maintain balance, and allow range of motion throughout the spinal column.

-Figure 1. The spine has three natural curves that form an S-shape; strong muscles keep our spine in alignment.

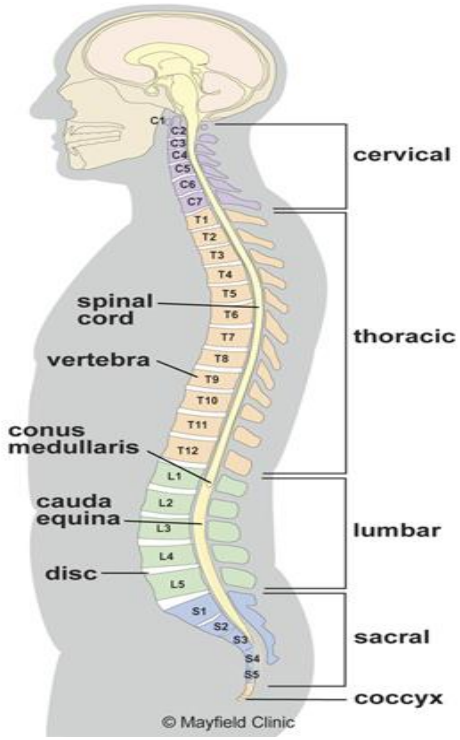


Figure 2. The five regions of the spinal column.

The abdominal and back muscles maintain the spine's natural curves. Good posture involves training your body to stand, walk, sit, and lie so that the least amount of strain is placed on the spine during movement or weight-bearing activities (see Posture). Excess body weight, weak muscles, and other forces can pull at the spine's alignment:

- An abnormal curve of the lumbar spine is lordosis, also called sway back.
- An abnormal curve of the thoracic spine is kyphosis, also called hunchback.
- An abnormal curve from side-to-side is called scoliosis.

Muscles

The two main muscle groups that affect the spine are extensors and flexors. The extensor muscles enable us to stand up and lift objects. The extensors are attached to the back of the spine. The flexor muscles are in the front and include the abdominal muscles. These muscles enable us to flex, or bend forward, and are important in lifting and controlling the arch in the lower back.

The back muscles stabilize your spine. Something as common as poor muscle tone or a large belly can pull your entire body out of alignment. Misalignment puts incredible strain on the spine (see Exercise for a Healthy Back).

Vertebrae

Vertebrae are the 33 individual bones that interlock with each other to form the spinal column. The vertebrae are numbered and divided into regions: cervical, thoracic, lumbar, sacrum, and coccyx (Fig. 2). Only the top 24 bones are moveable; the vertebrae of the sacrum and coccyx are fused. The vertebrae in each region have unique features that help them perform their main functions.

Cervical (neck) - the main function of the cervical spine is to support the weight of the head (about 10 pounds). The seven cervical vertebrae are numbered C1 to C7. The neck has the greatest range of motion because of two specialized vertebrae that connect to the skull. The first vertebra (C1) is the ring-shaped atlas that connects directly to the skull. This joint allows for the nodding or “yes” motion of the head. The second vertebra (C2) is the peg-shaped axis, which has a projection called the odontoid, that the atlas pivots around. This joint allows for the side-to-side or “no” motion of the head.

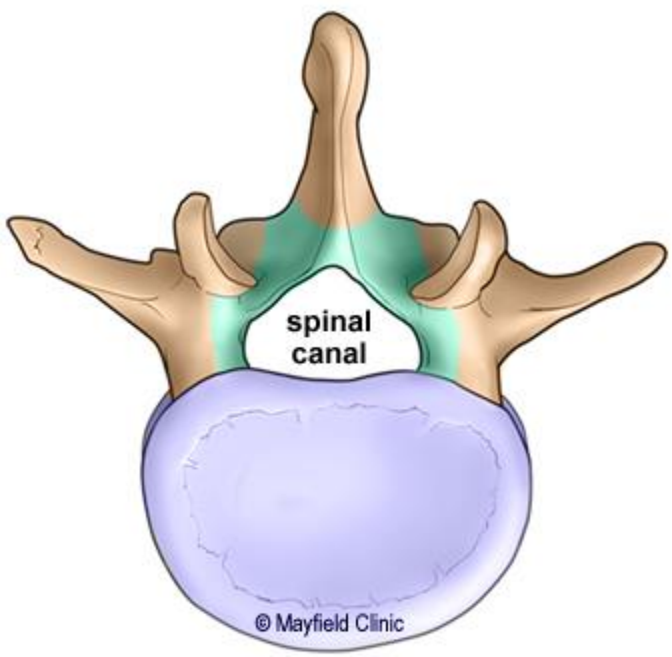
Thoracic (mid back) - the main function of the thoracic spine is to hold the rib cage and protect the heart and lungs. The twelve thoracic vertebrae are numbered T1 to T12. The range of motion in the thoracic spine is limited.

Lumbar (low back) - the main function of the lumbar spine is to bear the weight of the body. The five lumbar vertebrae are numbered L1 to L5. These vertebrae are much larger in size to absorb the stress of lifting and carrying heavy objects.

Sacrum - the main function of the sacrum is to connect the spine to the hip bones (iliac). There are five sacral vertebrae, which are fused together. Together with the iliac bones, they form a ring called the pelvic girdle.

Coccyx region - the four fused bones of the coccyx or tailbone provide attachment for ligaments and muscles of the pelvic floor.

While vertebrae have unique regional features, every vertebra has three functional parts (Fig. 3):



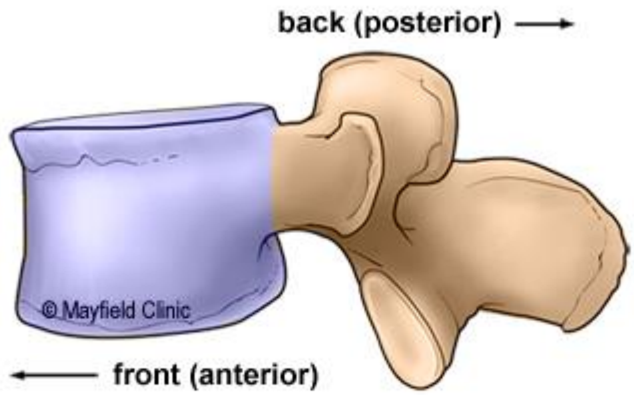
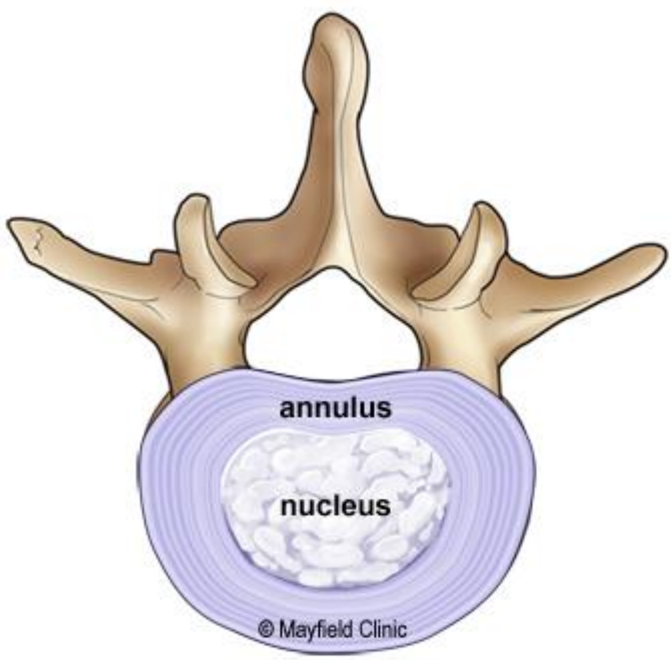


Figure 3. A vertebra has three parts: body (purple), vertebral arch (green), and processes for muscle attachment (tan).

- a drum-shaped body designed to bear weight and withstand compression (purple)
- an arch-shaped bone that protects the spinal cord (green)
- star-shaped processes designed as outriggers for muscle attachment (tan)

Intervertebral discs

Each vertebra in your spine is separated and cushioned by an intervertebral disc, which keeps the bones from rubbing together. Discs are designed like a radial car tire. The outer ring, called the annulus, has crisscrossing fibrous bands, much like a tire tread. These bands attach between the bodies of each vertebra. Inside the disc is a gel-filled center called the nucleus, much like a tire tube (Fig. 4).



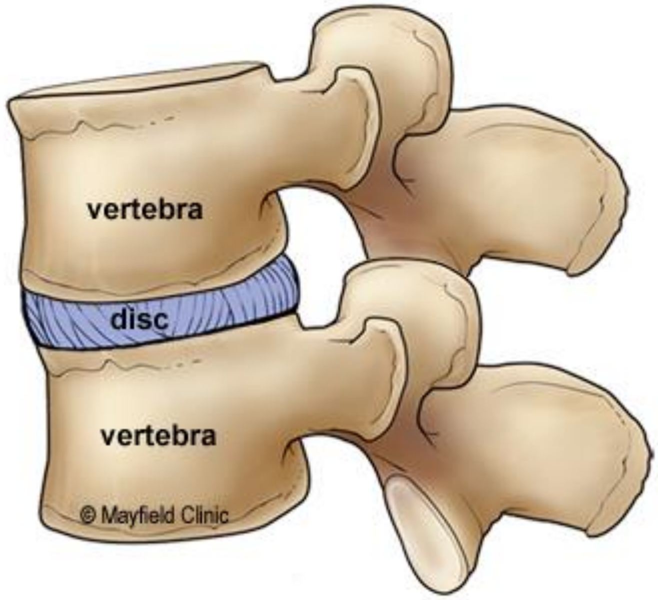


Figure 4. Discs are made of a gel-filled center called the nucleus and a tough fibrous outer ring called the annulus. The annulus pulls the vertebrae bones together against the resistance of the gel-filled nucleus.

Discs function like coiled springs. The crisscrossing fibers of the annulus pull the vertebral bones together against the elastic resistance of the gel-filled nucleus. The nucleus acts like a ball bearing when you move, allowing the vertebral bodies to roll over the incompressible gel. The gel-filled nucleus contains mostly fluid. This fluid is absorbed during the night as you lie down and is pushed out during the day as you move upright.

With age, our discs increasingly lose the ability to reabsorb fluid and become brittle and flatter; this is why we get shorter as we grow older. Also diseases, such as osteoarthritis and osteoporosis, cause bone spurs (osteophytes) to grow. Injury and strain can cause discs to bulge or herniate, a condition in which the nucleus is pushed out through the annulus to compress the nerve roots causing back pain.

Vertebral arch & spinal canal

On the back of each vertebra are bony projections that form the vertebral arch. The arch is made of two supporting pedicles and two laminae (Fig. 5). The hollow spinal canal contains the spinal cord, fat, ligaments, and blood vessels. Under each pedicle, a pair of spinal nerves exits the spinal cord and pass through the intervertebral foramen to branch out to your body.

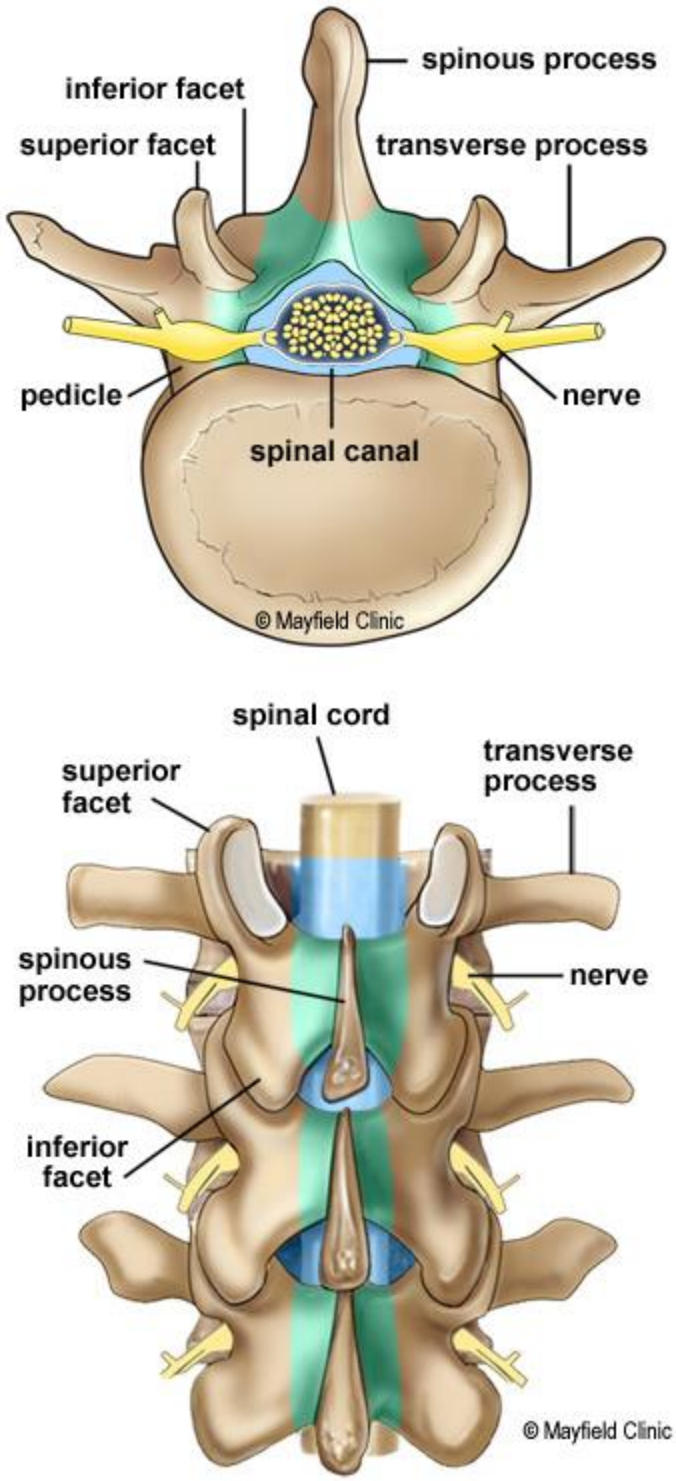


Figure 5. The vertebral arch (green) forms the spinal canal (blue) through which the spinal cord runs. Seven bony processes arise from the vertebral arch to form the facet joints and processes for muscle attachment.
Surgeons often remove the lamina of the vertebral arch (laminectomy) to access the spinal cord and nerves to treat stenosis, tumors, or herniated discs.

Seven processes arise from the vertebral arch: the spinous process, two transverse processes, two superior facets, and two inferior facets.

Facet joints

The facet joints of the spine allow back motion. Each vertebra has four facet joints, one pair that connects to the vertebra above (superior facets) and one pair that connects to the vertebra below (inferior facets) (Fig. 6).

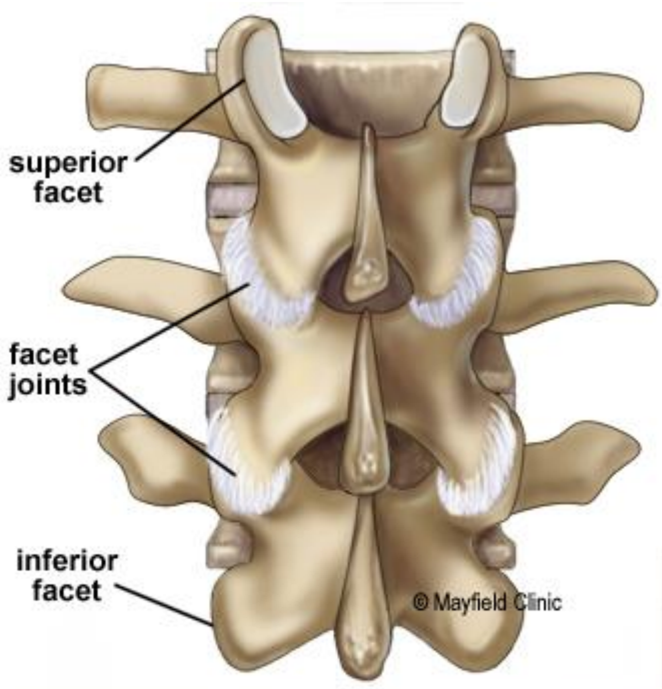


Figure 6. The superior and inferior facets connect each vertebra together. There are four facet joints associated with each vertebra.

Ligaments

The ligaments are strong fibrous bands that hold the vertebrae together, stabilize the spine, and protect the discs. The three major ligaments of the spine are the ligamentum flavum, anterior longitudinal ligament (ALL), and posterior longitudinal ligament (PLL) (Fig. 7). The ALL and PLL are continuous bands that run from the top to the bottom of the spinal column along the vertebral bodies. They prevent excessive movement of the vertebral bones. The ligamentum flavum attaches between the lamina of each vertebra.

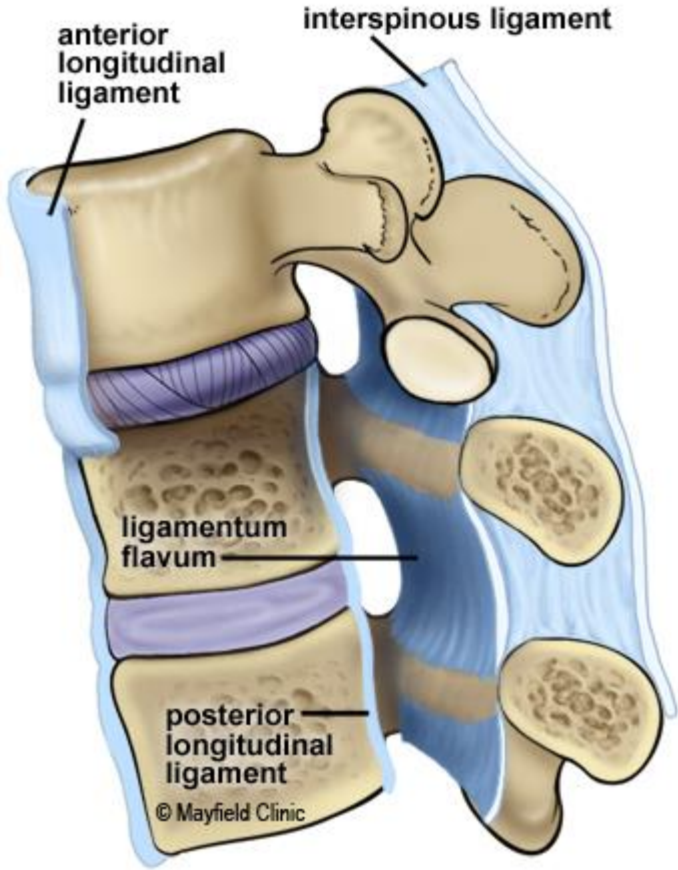


Figure 7. The ligamentum flavum, anterior longitudinal ligament (ALL), and posterior longitudinal ligament (PLL) allow the flexion and extension of the spine while keeping the bones aligned.

Spinal cord

The spinal cord is about 18 inches long and is the thickness of your thumb. It runs from the brainstem to the 1st lumbar vertebra protected within the spinal canal. At the end of the spinal cord, the cord fibers separate into the cauda equina and continue down through the spinal canal to your tailbone before branching off to your legs and feet. The spinal cord serves as an information super-highway, relaying messages between the brain and the body. The brain sends motor messages to the limbs and body through the spinal cord allowing for movement. The limbs and body send sensory messages to the brain through the spinal cord about what we feel and touch. Sometimes the spinal cord can react without sending information to the brain. These special pathways, called spinal reflexes, are designed to immediately protect our body from harm.

Any damage to the spinal cord can result in a loss of sensory and motor function below the level of injury. For example, an injury to the thoracic or lumbar area may cause motor and sensory loss of the legs and trunk (called paraplegia). An injury to the cervical (neck) area may cause sensory and motor loss of the arms and legs (called tetraplegia, formerly known as quadriplegia).

Spinal nerves

Thirty-one pairs of spinal nerves branch off the spinal cord. The spinal nerves act as “telephone lines,” carrying messages back and forth between your body and spinal cord to control sensation and movement. Each spinal nerve has two roots (Fig. 8). The ventral (front) root carries motor impulses from the brain and the dorsal (back) root carries sensory impulses to the brain. The ventral and dorsal roots fuse together to form a spinal nerve, which travels down the spinal canal, alongside the cord, until it reaches its exit hole - the intervertebral foramen (Fig. 9). Once the nerve passes through the intervertebral foramen, it branches; each branch has both motor and sensory fibers. The smaller branch (called the posterior primary ramus) turns posteriorly to supply the skin and muscles of the back of the body. The larger branch (called the anterior primary ramus) turns anteriorly to supply the skin and muscles of the front of the body and forms most of the major nerves.

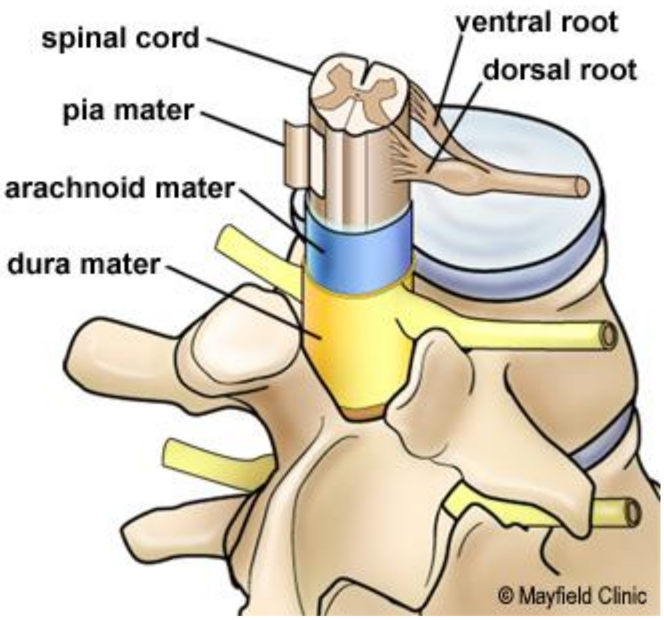


Figure 8. The ventral (motor) and dorsal (sensory) roots join to form the spinal nerve. The spinal cord is covered by three layers of meninges: pia, arachnoid and dura mater.

The spinal nerves are numbered according to the vertebrae above which it exits the spinal canal. The 8 cervical spinal nerves are C1 through C8, the 12 thoracic spinal nerves are T1 through T12, the 5 lumbar spinal nerves are L1 through L5, and the 5 sacral spinal nerves are S1 through S5. There is 1 coccygeal nerve.

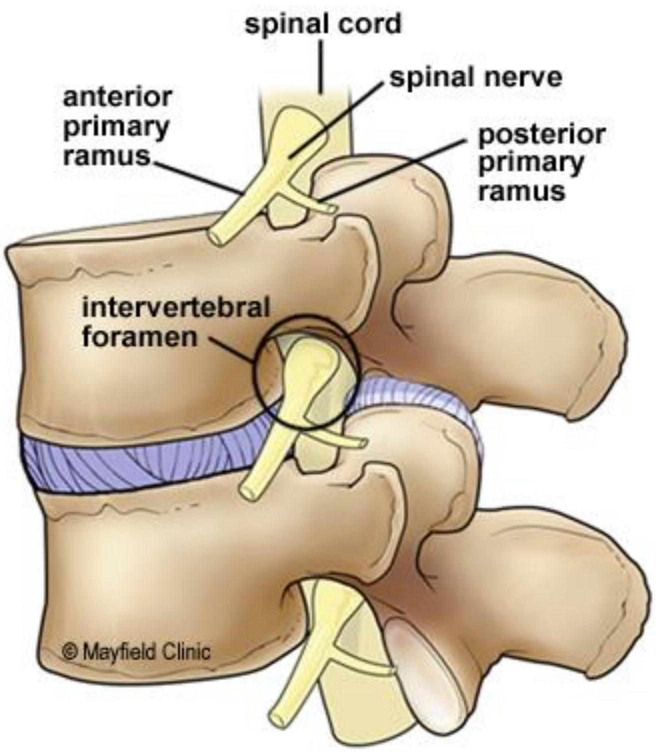


Figure 9. The spinal nerves exit the spinal canal through the intervertebral foramen below each pedicle.

The spinal nerves innervate specific areas and form a striped pattern across the body called dermatomes (Fig. 10). Doctors use this pattern to diagnose the location of a spinal problem based on the area of pain or muscle weakness. For example leg pain (sciatica) usually indicates a problem near the L4-S3 nerves.

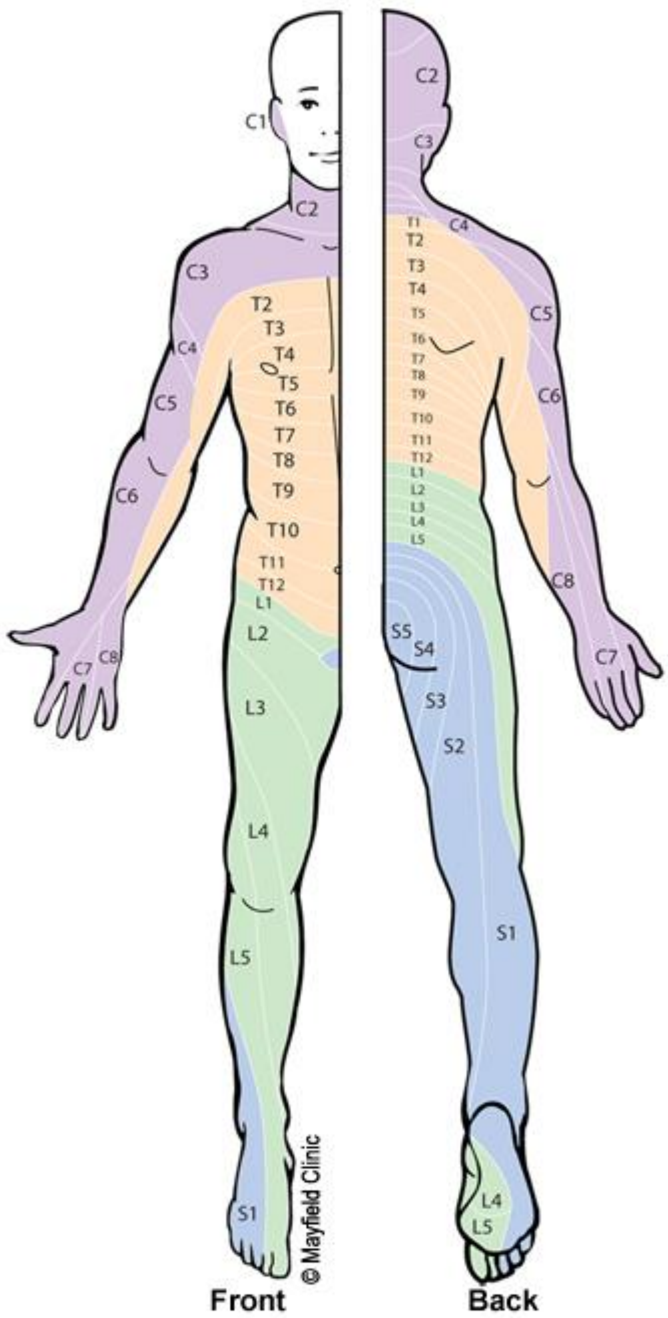


Figure 10. A dermatome pattern shows which spinal nerves are responsible for sensory and motor control of specific areas of the body.

Sternum

The sternum or breastbone is a long flat bone located in the central part of the chest. It connects to the ribs via cartilage and forms the front of the rib cage, thus helping to protect the heart, lungs, and major blood vessels from injury. Shaped roughly like a necktie, it is one of the largest and longest flat bones of the body. Its three regions are the manubrium, the body, and the xiphoid process

Structure

The sternum is a long, flat bone, forming the middle portion of the front of the chest. The top of the sternum supports the clavicles (collarbones) and its edges join with the costal cartilages of the first two pairs of ribs. The inner surface of the sternum is also the attachment of the sternopericardial ligaments. Its top is also connected to the sternocleidomastoid muscle. The sternum consists of three main parts, listed from the top:

- Manubrium
- Body (gladiolus)
- Xiphoid process

In its natural position, the sternum is angled obliquely, downward and forward. It is slightly convex in front and concave behind; broad above, shaped like a "T", becoming narrowed at the point where the manubrium joins the body, after which it again widens a little to below the middle of the body, and then narrows to its lower extremity. In adults the sternum is on average about 17 cm, longer in the male than in the female.

Manubrium

The manubrium (Latin: *handle*) is the broad upper part of the sternum. It has a quadrangular shape, narrowing from the top, which gives it four borders. The suprasternal notch (jugular notch) is located in the middle at the upper broadest part of the manubrium. This notch can be felt between the two clavicles. On either side of this notch are the right and left clavicular notches.

The manubrium joins with the body of the sternum, the clavicles and the cartilages of the first pair of ribs. The inferior border, oval and rough, is covered with a thin layer of cartilage for articulation with the body. The lateral borders are each marked above by a depression for the first costal cartilage, and below by a small facet, which, with a similar facet on the upper angle of the body, forms a notch for the reception of the costal cartilage of the second rib. Between the depression for the first costal cartilage and the demi-facet for the second is a narrow, curved edge, which slopes from above downward towards the middle. Also, the superior sternopericardial ligament attaches the pericardium to the posterior side of the manubrium.

Body

The body, or gladiolus, is the longest part. It is flat and considered to have only a front and back surface. It is flat on the front, directed upward and forward, and marked by three transverse ridges which cross the bone opposite the third, fourth, and fifth articular depressions. The pectoralis major attaches to it on either side. At the junction of the third and fourth parts of the body is occasionally seen an orifice, the sternal foramen, of varying size and form. The posterior surface, slightly concave, is also marked by three transverse lines, less distinct, however, than those in front; from its lower part, on either side, the transversus thoracis

The sternal angle is located at the point where the body joins the manubrium. The sternal angle can be felt at the point where the sternum projects farthest forward. However, in some people the sternal angle is concave or rounded. During physical examinations, the sternal angle is a useful landmark because the second rib attaches here.

Each outer border, at its superior angle, has a small facet, which with a similar facet on the manubrium, forms a cavity for the cartilage of the second rib; below this are four angular depressions which receive the cartilages of the third, fourth, fifth, and sixth ribs. The inferior angle has a small facet, which, with a corresponding one on the xiphoid process, forms a notch for the cartilage of the seventh rib. These articular depressions are separated by a series of curved interarticular intervals, which diminish in length from above downward, and correspond to the intercostal spaces. Most of the cartilages belonging to the true ribs, articulate with the sternum at the lines of junction of its primitive component segments. This is well seen in some other vertebrates, where the parts of the bone remain separated for longer

The upper border is oval and articulates with the manubrium, at the sternal angle. The lower border is narrow, and articulates with the xiphoid process.

Xiphoid process

Located at the inferior end of the sternum is the pointed xiphoid process. Improperly performed chest compressions during cardiopulmonary resuscitation can cause the xiphoid process to snap off, driving it into the liver which can cause a fatal hemorrhage.[1]

The sternum is composed of highly vascular tissue, covered by a thin layer of compact bone which is thickest in the manubrium between the articular facets for the clavicles. The inferior sternopericardial ligament attaches the pericardium to the posterior xiphoid process.

Joints

The cartilages of the top five ribs join with the sternum at the sternocostal joints. The right and left clavicular notches articulate with the right and left clavicles, respectively. The costal cartilage of the second rib articulates with the sternum at the sternal angle making it easy to locate.

The transversus thoracis muscle is innervated by one of the intercostal nerves and superiorly attaches at the posterior surface of the lower sternum. Its inferior attachment is the internal surface of costal cartilages two through six and works to depress the ribs.

The sternum develops from two cartilaginous bars one on the left and one on the right, connected with the cartilages of the ribs on each side. These two bars fuse together along the middle to form the cartilaginous sternum which is ossified from six centers: one for the manubrium, four for the body, and one for the xiphoid process

The ossification centers appear in the intervals between the articular depressions for the costal cartilages, in the following order: in the manubrium and first piece of the body, during the sixth month of fetal life; in the second and third pieces of the body, during the seventh month of fetal life; in its fourth piece, during the first year after birth; and in the xiphoid process, between the fifth and eighteenth years.

The centers make their appearance at the upper parts of the segments, and proceed gradually downward. To these may be added the occasional existence of two small *episternal* centers, which make their appearance one on either side of the jugular notch; they are probably vestiges of the episternal bone of the monotremata and lizards

Occasionally some of the segments are formed from more than one center, the number and position of which vary. Thus, the first piece may have two, three, or even six centers.

When two are present, they are generally situated one above the other, the upper being the larger; the second piece has seldom more than one; the third, fourth, and fifth pieces are often formed from two centers placed laterally, the irregular union of which explains the rare occurrence of the sternal foramen, or of the vertical fissure which occasionally intersects this part of the bone constituting the malformation known as *fissura sterni;* these conditions are further explained by the manner in which the cartilaginous sternum is formed.

More rarely still the upper end of the sternum may be divided by a fissure. Union of the various centers of the body begins about puberty, and proceeds from below upward; by the age of twenty-five they are all united.

The xiphoid process may become joined to the body before the age of thirty, but this occurs more frequently after forty; on the other hand, it sometimes remains ununited in old age. In advanced life the manubrium is occasionally joined to the body by bone. When this takes place, however, the bony tissue is generally only superficial, the central portion of the intervening cartilage remaining unossified.

Rib

In vertebrate anatomy, **ribs** (Latin: *costae*) are the long curved bones which form the rib cage, part of the axial skeleton. In most tetrapods, ribs surround the chest, enabling the lungs to expand and thus facilitate breathing by expanding the chest cavity. They serve to protect the lungs, heart, and other internal organs of the thorax. In some animals, especially snakes, ribs may provide support and protection for the entire body.

Rib details

Ribs are classed as flat bones which usually have a protective role in the body. Humans have 24 ribs, in 12 pairs. All are attached at the back to the thoracic vertebrae, and are numbered from 1–12 according to the vertebrae they attach to. The first rib is attached to thoracic vertebra 1 (T1). At the front of the body most of the ribs are joined by costal cartilages to the sternum. The ribs connect to the vertebrae with two joints, the costovertebral joints.

The parts of a rib include the head, neck, body (or *shaft*), tubercle, and angle.

The **head of the rib** lies next to a vertebra. The ribs connect to the vertebrae with two costovertebral joints, one on the head and one on the neck. The head of the rib has a superior and an inferior articulating region, separated by a crest. These articulate with the superior and inferior costal facets on the connecting vertebrae.[1] The crest gives attachment to the intra-articulate ligament that joins the rib to the vertebra of the same number, at the intervertebral disc. Another ligament, the radiate ligament joins the head of the rib to the both the body of the upper vertebra and to the body of the lower vertebra. The smaller middle part of the ligament connects to the intervertebral disc. This plane joint is known as the articulation of the head of the rib.

The other costovertebral joint is that between the tubercle on the neck and the transverse process of the joining thoracic vertebra of the same rib number, and this is known as the costotransverse joint. The superior costotransverse ligament attaches from the non-articular facet of the tubercle to the transverse process of the vertebra.

The **neck of the rib** is a flattened part that extends laterally from the head. The neck is about 3 cm long. Its anterior surface is flat and smooth, whilst its posterior is perforated by numerous foramina and its surface rough, to give attachment to the ligament of the neck. Its upper border presents a rough crest (*crista colli costae*) for the attachment of the anterior costotransverse ligament; its lower border is rounded.

A **tubercle of rib** on the posterior surface of the neck of the rib, has two facets (surfaces) one articulating and one non-articulating. The articular facet, is small and oval and is the lower and more medial of the two, and connects to the transverse costal facet on the thoracic vertebra of the same rib number. The transverse costal facet is on the end of the transverse process of the lower of the two vertebrae to which the head is connected. The non-articular portion is a rough elevation and affords attachment to the ligament of the tubercle. The tubercle is much more prominent in the upper ribs than in the lower ribs.

Rib cage

The first seven sets of ribs, known as "true ribs", are attached to the sternum by the costal cartilages. The first rib is unique and easier to distinguish than other ribs. It is a short, flat, C-shaped bone. The vertebral attachment can be found just below the neck at the first thoracic vertebra, and the majority of this bone can be found above the level of the clavicle. Ribs 2 through 7 have a more traditional appearance and become longer and less curved as they progress downwards. The following five sets are known as "false ribs", three of these sharing a common cartilaginous connection to the sternum, while the last two (eleventh and twelfth ribs) are termed floating ribs. They are attached to the vertebrae only, and not to the sternum or cartilage coming off of the sternum.

In general, human ribs increase in length from ribs 1 through 7 and decrease in length again through rib 12. Along with this change in size, the ribs become progressively oblique (slanted) from ribs 1 through 9, then less slanted through rib 12

The rib cage is separated from the lower abdomen by the thoracic diaphragm which controls breathing. When the diaphragm contracts, the thoracic cavity is expanded, reducing intra-thoracic pressure and drawing air into the lungs. This happens through one of two actions (or a mix of the two): when the lower ribs the diaphragm connects to are stabilized by muscles and the central tendon is mobile, when the muscle contracts the central tendon is drawn down, compressing the cavity underneath and expanding the thoracic cavity downward. When the central tendon is stabilized and the lower ribs are mobile, a contraction of the diaphragm elevates the ribs, which works in conjunction with other muscles to expand the thoracic indent upward.

Development

Early in the developing embryo, somites form and soon subdivide into three mesodermal components – the myotome, dermatome, and the sclerotome. The vertebrae and ribs develop from the sclerotomes

During the fourth week (fertilization age) *costal processes* have formed on the vertebral bodies. These processes are small, lateral protrusions of mesenchyme that develop in association with the vertebral arches. During the fifth week the costal processes on the thoracic vertebrae become longer to form the ribs. In the sixth week, the costovertebral joints begin to develop and separate the ribs from the vertebrae. The first seven pairs of ribs, the true ribs join at the front to the sternal bars. By the fetal stage the sternal bars have completely fused.

The ribs begin as cartilage that later ossifies – a process called endochondral ossification. Primary ossification centers are located near the angle of each rib, and ossification continues in the direction away from the head and neck. During adolescence secondary ossification centers are formed in the tubercles and heads of the ribs.

In anatomy, the **scapula** (plural **scapulae** or **scapulas**), also known as the **shoulder bone**, **shoulder blade**, **wing bone** or **blade bone**, is the bone that connects the humerus (upper arm bone) with the clavicle (collar bone). Like their connected bones, the scapulae are paired, with each scapula on either side of the body being roughly a mirror image of the other. The name derives from the Classical Latin word for trowel or small shovel, which it was thought to resemble.

In compound terms, the prefix **omo-** is used for the shoulder blade in Latin medical terminology. This prefix is derived from ὦμος (ōmos), the Ancient Greek word for shoulder, and is cognate with the Latin *umerus*.

The scapula forms the back of the shoulder girdle. In humans, it is a flat bone, roughly triangular in shape, placed on a posterolateral aspect of the thoracic cage

The scapula is a wide, flat bone lying on the thoracic wall that provides an attachment for three groups of muscles: intrinsic, extrinsic, and stabilising and rotating muscles. The intrinsic muscles of the scapula include the muscles of the rotator cuff—the subscapularis, teres minor, supraspinatus, and infraspinatus These muscles attach to the surface of the scapula and are responsible for the internal and external rotation of the shoulder joint, along with humeral abduction.

The extrinsic muscles include the biceps, triceps, and deltoid muscles and attach to the coracoid process and supraglenoid tubercle of the scapula, infraglenoid tubercle of the scapula, and spine of the scapula. These muscles are responsible for several actions of the glenohumeral joint.

The third group, which is mainly responsible for stabilization and rotation of the scapula, consists of the trapezius, serratus anterior, levator scapulae, and rhomboid muscles. These attach to the medial, superior, and inferior borders of the scapula.

The head, processes, and the thickened parts of the bone contain cancellous tissue; the rest consists of a thin layer of compact tissue.

The central part of the supraspinatus fossa and the upper part of the infraspinatous fossa, but especially the former, are usually so thin in humans as to be semitransparent; occasionally the bone is found wanting in this situation, and the adjacent muscles are separated only by fibrous tissue. The scapula has two surfaces, three borders, three angles, and three processes.

Surfaces

Front or subscapular fossa

The front of the scapula (also known as the costal or ventral surface) has a broad concavity called the **subscapular fossa**, to which the subscapularis muscle attaches. The medial two-thirds of the fossa have 3 longitudinal oblique ridges, and another thick ridge adjoins the lateral border; they run outward and upward. The ridges give attachment to the tendinous insertions, and the surfaces between them to the fleshy fibers, of the subscapularis muscle. The lateral third of the fossa is smooth and covered by the fibers of this muscle.

At the upper part of the fossa is a transverse depression, where the bone appears to be bent on itself along a line at right angles to and passing through the center of the glenoid cavity, forming a considerable angle, called the subscapular angle; this gives greater strength to the body of the bone by its arched form, while the summit of the arch serves to support the spine and acromion.

The costal surface superior of the scapula is the origin of 1st digitation for the serratus anterior origin.

Back

The back of the scapula (also called the dorsal or posterior surface) is arched from above downward, and is subdivided into two unequal parts by the spine of the scapula. The portion above the spine is called the supraspinous fossa, and that below it the infraspinous fossa. The two fossae are connected by the spinoglenoid notch, situated lateral to the root of the spine.

- The *supraspinous fossa*, the smaller of the two, is concave, smooth, and broader at its vertebral than at its humeral end; its medial two-thirds give origin to the Supraspinatus.
- The *infraspinous fossa* is much larger than the preceding; toward its vertebral margin a shallow concavity is seen at its upper part; its center presents a prominent convexity, while near the axillary border is a deep groove which runs from the upper toward the lower part. The medial two-thirds of the fossa give origin to the Infraspinatus; the lateral third is covered by this muscle.

There is a ridge on the outer part of the back of the scapula. This runs from the lower part of the glenoid cavity, downward and backward to the vertebral border, about 2.5 cm above the inferior angle. Attached to the ridge is a fibrous septum, which separates the infraspinatus muscle from the Teres major and Teres minor muscles. The upper two-thirds of the surface between the ridge and the axillary border is narrow, and is crossed near its center by a groove for the scapular circumflex vessels; the Teres minor attaches here.

The broad and narrow portions above alluded to are separated by an oblique line, which runs from the axillary border, downward and backward, to meet the elevated ridge: to it is attached a fibrous septum which separates the Teres muscles from each other.

Its lower third presents a broader, somewhat triangular surface, the **inferior angle of the scapula**, which gives origin to the Teres major, and over which the Latissimus dorsi glides; frequently the latter muscle takes origin by a few fibers from this part.

Side

The acromion forms the summit of the shoulder, and is a large, somewhat triangular or oblong process, flattened from behind forward, projecting at first laterally, and then curving forward and upward, so as to overhang the glenoid cavity.

Angles

There are 3 angles:

The **superior angle of the scapula** or **medial angle**, is covered by the trapezius muscle. This angle is formed by the junction of the superior and medial borders of the scapula. The superior angle is located at the approximate level of the second thoracic vertebra. The superior angle of the scapula is thin, smooth, rounded, and inclined somewhat lateralward, and gives attachment to a few fibers of the levator scapulae muscle.[4]

The **inferior angle of the scapula** is the lowest part of the scapula and is covered by the latissimus dorsi muscle. It moves forwards round the chest when the arm is abducted. The inferior angle is formed by the union of the medial and lateral borders of the scapula. It is thick and rough and its posterior or back surface affords attachment to the teres major and often to a few fibers of the latissimus dorsi. The anatomical plane that passes vertically through the inferior angle is named the scapular line.

The **lateral angle of the scapula** or **glenoid angle** also known as the **head of the scapula** is the thickest part of the scapula. It is broad and bears the glenoid cavity on its articular surface which is directed forward, laterally and slightly upwards, and articulates with the head of the humerus. The inferior angle is broader below than above and its vertical diameter is the longest. The surface is covered with cartilage in the fresh state; and its margins, slightly raised, give attachment to a fibrocartilaginous structure, the glenoidal labrum, which deepens the cavity. At its apex is a slight elevation, the supraglenoid tuberosity, to which the long head of the biceps brachii is attached.

The **anatomic neck of the scapula** is the slightly constricted portion which surrounds the head and is more distinct below and behind than above and in front. The **surgical neck of the scapula** passes directly medial to the base of the coracoid process.[5]

Borders

There are three borders of the scapula:

- The **superior border** is the shortest and thinnest; it is concave, and extends from the superior angle to the base of the coracoid process. It is referred to as the cranial border in animals.

At its lateral part is a deep, semicircular notch, the scapular notch, formed partly by the base of the coracoid process. This notch is converted into a foramen by the superior transverse scapular ligament, and serves for the passage of the suprascapular nerve; sometimes the ligament is ossified.

The adjacent part of the superior border affords attachment to the omohyoideus.

The **axillary border** (or "lateral border") is the thickest of the three. It begins above at the lower margin of the glenoid cavity, and inclines obliquely downward and backward to the inferior angle. It is referred to as the caudal border in animals.

It begins above at the lower margin of the glenoid cavity, and inclines obliquely downward and backward to the inferior angle.

Immediately below the glenoid cavity is a rough impression, the infraglenoid tuberosity, about 2.5 cm (1 in). in length, which gives origin to the long head of the triceps brachii; in front of this is a longitudinal groove, which extends as far as the lower third of this border, and affords origin to part of the subscapularis.

The inferior third is thin and sharp, and serves for the attachment of a few fibers of the teres major behind, and of the subscapularis in front. The **medial border** (also called the vertebral border or medial margin) is the longest of the three borders, and extends from the superior angle to the inferior angle.[6] In animals it is referred to as the **dorsal border**.

Four muscles attach to the medial border. Serratus anterior has a long attachment on the anterior lip. Three muscles insert along the posterior lip, the levator scapulae (uppermost), rhomboid minor (middle), and to the rhomboid major (lower middle).

The scapula is ossified from 7 or more centers: one for the body, two for the coracoid process, two for the acromion, one for the vertebral border, and one for the inferior angle. Ossification of the body begins about the second month of fetal life, by an irregular quadrilateral plate of bone forming, immediately behind the glenoid cavity. This plate extends to form the chief part of the bone, the scapular spine growing up from its dorsal surface about the third month. Ossification starts as membranous ossification before birth.[7][8] After birth, the cartilaginous components would undergo endochondral ossification. The larger part of the scapula undergoes membranous ossification.[9] Some of the outer parts of the scapula are cartilaginous at birth, and would therefore undergo endochondral ossification.[10]

At birth, a large part of the scapula is osseous, but the glenoid cavity, the coracoid process, the acromion, the vertebral border and the inferior angle are cartilaginous. From the 15th to the 18th month after birth, ossification takes place in the middle of the coracoid process, which as a rule becomes joined with the rest of the bone about the 15th year.

Between the 14th and 20th years, the remaining parts ossify in quick succession, and usually in the following order: first, in the root of the coracoid process, in the form of a broad scale; secondly, near the base of the acromion; thirdly, in the inferior angle and contiguous part of the vertebral border; fourthly, near the outer end of the acromion; fifthly, in the vertebral border. The base of the acromion is formed by an extension from the spine; the two nuclei of the acromion unite, and then join with the extension from the spine. The upper third of the glenoid cavity is ossified from a separate center (sub coracoid), which appears between the 10th and 11th years and joins between the 16th and the 18th years. Further, an epiphysial plate appears for the lower part of the glenoid cavity, and the tip of the coracoid process frequently has a separate nucleus. These various epiphyses are joined to the bone by the 25th year.

Failure of bony union between the acromion and spine sometimes occurs (see os acromiale), the junction being effected by fibrous tissue, or by an imperfect articulation; in some cases of supposed fracture of the acromion with ligamentous union, it is probable that the detached segment was never united to the rest of the bone.

Consisting of the clavicle (collar bone) and scapula (shoulder blade), the pectoral girdle forms the attachment point between the arm and the chest. The clavicle, which gets its name from the Latin word for key, is a long bone that connects the scapula to the sternum (breast bone) of the chest. It is located just under the skin in the thoracic region between the shoulder and the base of the neck. The clavicle is slightly curved like a letter S and is about five inches in length. Two joints are formed by the clavicle — the sternoclavicular joint with the sternum, and the acromioclavicular joint with the acromion of the scapula. The clavicle permits the shoulder joint to move in circles while remaining attached to the bones of the chest.

Posterior to the clavicle is the scapula, a flat, triangular bone located lateral to the thoracic spine in the dorsal region of the body. The scapula forms two joints — the acromioclavicular (AC) joint with the clavicle and the shoulder (humeroscapular) joint with the humerus. The glenoid cavity is located on the lateral end of the scapula and forms the socket for the ball-and-socket shoulder joint. Many muscles attach to the scapula to move the shoulder, including the trapezius, deltoid, rhomboids, and the muscles of the rotator cuff.

The humerus is the only bone of the upper arm. It is a long, large bone that extends from the scapula of the shoulder to the ulna and radius of the lower arm. The proximal end of the humerus, known as the head, is a round structure that forms the ball of the ball-and-socket shoulder joint. On its distal end, the humerus forms a wide, cylindrical process that meets the ulna and radius to form the inner hinge of the elbow joint. The pectoral, deltoid, latissimus dorsi, and rotator cuff muscles attach to the humerus to rotate, raise, and lower the arm at the shoulder joint.

Our forearm contains two long, parallel bones: the ulna and the radius. The ulna is the longer and larger of the two bones, residing on the medial (pinky finger) side of the forearm. It is widest at its proximal end and narrows considerably at its distal end. At its proximal end, the ulna forms the hinge of the elbow joint with the humerus. The end of the ulna, known as the olecranon, extends past the humerus and forms the bony tip of the elbow. At its distal end, the ulna forms the wrist joint with the radius and the carpals.

Compared to the ulna, the radius is slightly shorter, thinner, and located on the medial side of the forearm. The radius is narrowest at the elbow and widens as it extends towards the wrist. At its proximal end, the rounded head of the radius forms the pivoting part of the elbow joint that permits rotation of the lower arm and hand. At its distal end, the radius is much wider than the ulna and forms the bulk of the wrist joint with the ulna and carpals. The distal end of the radius also rotates around the ulna when the hand and forearm rotate.

Despite being such a small region of the body, the hand contains twenty-seven tiny bones and many flexible joints.

- The carpals are a group of eight roughly cube-shaped bones in the proximal end of the hand. They form the wrist joint with the ulna and radius of the forearm and also form joints with the metacarpals of the palm of the hand. The carpals form many small gliding joints with each other to give extra flexibility to the wrist and hand.

- The five long, cylindrical metacarpals form the supporting bones of the palm of the hand. Each metacarpal forms a joint with the carpals and another joint with the proximal phalanx of a finger. Metacarpals are able to abduct to spread the fingers and palm apart and can adduct to draw the fingers and palm together. The metacarpals also give flexibility to the hand when gripping an object or when touching the thumb and pinky finger together.
- The phalanges (singular: phalanx) are a group of fourteen bones that support and move the digits. Each digit contains three phalanges — proximal, middle, and distal — except for the thumb, which contains just a proximal phalanx and a distal phalanx. The phalanges are long bones that form hinge joints between themselves and also condyloid (oval) joints with the metacarpals. These joints permit the flexion, extension, adduction, and abduction of the digits.

Our arms and hands require a balance of strength and dexterity to perform diverse tasks such as lifting heavy boxes, swimming, playing a musical instrument, and writing. The joints of the arm and hand permit a wide range of motion while maintaining the strength of the upper limb. Many skeletal muscles attach to and pull on these bones to move them with strength, speed, and accuracy. Like all bones of the body, upper limb bones help the body to maintain homeostasis by storing minerals and fats and by producing blood cells in the red bone marrow.

ELBOW ARM ANATOMY

Definition

The arm also referred to as the upper limb is connected to the chest by the shoulder joint. It is divided into two segments separated by the elbow: the upper arm and the forearm, the latter extending to the wrist and the hand.

The arm and elbow

The arm also referred to as the upper limb is connected to the chest by the shoulder joint. It is divided into two segments separated by the elbow: the upper arm and the forearm, the latter extending to the wrist and the hand.

Bones of the upper arm and elbow

The upper arm is the region of the body located between the shoulder and the elbow. This segment of the arm is comprised of a single, long and large bone named *humerus*. The anatomy of the humerus consists in the proximal end (head), which articulates into the socket of the shoulder joint, followed by a humerus neck, and a long, cylindrical shaft containing the bone marrow. In the distal portion, the humerus ends with two round extremities, the condyles, which are located in opposition to the bones of the forearm, the radius and ulna. The upper arm is connected to the bones of the forearm through the elbow joint, which is a hinged joint that articulates the humerus with the ulna and radius.

Bones of the forearm

The forearm is made of two bones, the *radius* and the *ulna*. The radius is located on the outside of the forearm along the thumb line. It becomes wider at the wrist. The ulna runs on the internal side of the arm, along the little finger. It is felt at the inner tip of the elbow. The radius and ulna are connected with one another by a strong interosseous membrane. In the proximal region, the radius and ulna articulate with the humerus bone of the upper arm to form the elbow joint.

Bones at the wrist

In the wrist joint the radius and ulna articulate with three carpal bones of the wrist: the scaphoid, the lunate, and triquetrum. The radius and ulna allow the rotation of the forearm by turning the palm of the hand up (supination) and down (pronation). In this movement the radius slides around the ulna, which remains in its position.

Elbow joint

The elbow is made by the distal end of the humerus and the proximal end of two smaller bones forming the lower arm, the radius on the outer side, and the ulna on the inner side. These bones allow for the twisting movement of the hand. At the elbow the humerus ends with two processes, the medial and lateral epicondyles that can be felt on each side of the elbow. The head of the radius or radial head is a round concave area, which allows the movement around the opposed end of the humerus (capitellum), whereas the coronoid is the corresponding area of the ulna facing the distal humeral extremity, the trochlea.

Ligaments

Ligaments are strong bands of elastic connective tissue that join bones to other bones. At the elbow they play an important role in stabilising the function of the joint where three bones of the upper extremity articulate with one another. There are three main ligaments at the elbow joint:

Medial Collateral Ligament or Ulnar Collateral Ligament: consists of the anterior and posterior bands. Both originate from the medial epicondyle and cross through the elbow joint. The anterior band attaches at the coronoid process of the ulna, and the posterior band to the olecranon process.

Lateral Collateral Ligament or Radial Collateral Ligament: is a short, thin ligament, which passes from the lateral epicondyle to the annular ligament.

Annular Ligament: is a circular ligament surrounding the radial head that is tightened into the notch of the ulna. It’s role is to stabilise the radio-ulnar joint.

Muscles of the upper arm

Deltoid: is a large and the strongest muscle of the shoulder, connecting to the shoulder blade, the clavicle and the humerus. It is used to lift the arm sideways and rotate it laterally and medially.

Triceps brachii: is the three-headed muscle on the posterior side of the upper arm. It is used to straighten the forearm. It is particularly evident in athletic individuals.

Brachialis: is a strong elbow flexor and helps the biceps brachii to bend the elbow.

Brachioradialis: extends from distal humerus to the lower radius. It is used to flex the elbow and aid pronation and supination of the forearm.

Anconeus: is a small muscle of the elbow with a triangular shape joining the ulna to the lateral humerus. It assists in elbow extension and rotation.

Extensor carpi radialis longus: is a long muscle arising partially at the lateral supracondylar ridge and partially at the lateral epicondyle of the humerus. It runs on the thumb side of the forearm and inserts at the base of the 2nd metacarpal bone (corresponding to the index finger). It is a major muscle used for wrist abduction and extension.

Biceps or Biceps brachii: is the muscle likely used more often when moving the arm. It is connected to the bones of the shoulder, the glenoid and coracoid process, via two tendons, and to the proximal region (tuberosity of the radius) with one tendon. The biceps is essential to bend the arm and turn the hand outward (supination).

Muscles of the forearm

The muscles of the forearm are located on the dorsal and ventral side of the forearm.

Many of them originate from the epicondyles of the upper arm (humerus) and are involved in the movement of the elbow, hand and fingers. Muscles on the dorsal side of the forearm:

Muscles on the dorsal side of the forearm:

Extensor carpi ulnaris: lies on the ulnar side of the forearm. It originates from the lateral epicondyle at the inner elbow and crosses the forearm downward to insert at the base of the 5th metacarpal of the hand. It is used for the extension and adduction of the wrist.

Extensor carpi radialis longus: is a long muscle on the radial side of the forearm used to extend the hand and flex the forearm. It inserts at the lateral humerus to attach distally at the second metacarpal bone of the index finger.

Extensor digitorum: is located on the forearm back side. It arises at lateral epicondyle of the humerus and divides into four tendons to reach the distal and middle phalanges of the fingers. It controls the extension of the medial fingers.

Extensor carpi radialis brevis: originates above the lateral epicondyle of the humerus and inserts into the 3rd metacarpal bone. It functions in synergy with the extensor carpi longus and is used to abduct and extend the hand and wrist.

Extensor digiti minimi: arises at the lateral epicondyle of the humerus and joins with the hand muscle, the extensor digitorium communis. It controls the movements of the little finger (flexion, extension).

Flexor carpi ulnaris: arises at the medial epicondyle of the humerus and the ulnar head. It extends to the wrist where it inserts at the pisiform bone prior to the 5th metacarpal bone. It works together with the extensor carpi radialis to flex or adduct the wrist.

Abductor pollicis longus: together with extensor pollicis muscles, it controls the thumb movement. It begins at the proximal radius and ulna and attaches at the base of 1st metacarpal bone. It assists in thumb abduction and extension and contributes to wrist flexion.

Extensor pollicis brevis: is located on the dorsal forearm. It originates at the distal radius and inserts at the base of the proximal phalanx of the thumb (latin: pollux-pollicis) where it forms the known snuff box at the radial wrist. It works with extensor pollicis longus in the extension and abduction of the thumb.

Muscles of the deep forearm back:

Supinator: is a short muscle arranged in two layers. Its fibres run from the ulna and the lateral end of the humerus to the radius. It supports the biceps brachii in rotating the forearm (supination).

Extensor pollicis longus: originates at the ulna bone and interosseous membrane and inserts at the distal phalange of the thumb. It is used for thumb extension.

Extensor indicis: originates at the interosseous membrane and ulna and travels to the index finger parallel to the extensor digitorum tendon. It assists in the index extension of all phalanges and also of the wrist mid-carpal joints.

Muscles on the ventral side of the forearm:

Pronator teres: inserts proximally with two heads at medial epicondyle of the humerus and ulnar coronoid process and runs diagonally across the forearm to connect to the outer radius. It is used with the pronator quadratus during forearm pronation (palm down)

Flexor carpi radialis: inserts at the humerus epicondyle and runs through the anterior forearm to the base of the 2nd metacarpal bone. It is used during wrist flexion and hand abduction.

Flexor carpi ulnaris: originates with two ends, one at the medial epicondyle of the humerus and the other at the olecranon. It inserts at the wrist carpal bones, the pisiform, hamamate and to the basis of the 5th metacarpal bone. It is used to flex and adduct the hand and wrist.

Palmaris longus: is a thin muscle arising at the medial epicondyle that runs in the middle of the forearm, where it inserts on the palmar aponeurosis on the hand palm. Its function is to flex the hand at the wrist. It can be absent in over 10% of the population or consist of a tendon rather then muscle tissue.

Flexor digitorum superficialis: has two heads one inserting at the medial epicondyle and the other at the radius head. It separates into two tendons that insert at the middle phalanges of the fingers. They are used during flexion of the interphalangeal joints of middle phalanges (2nd to 5th fingers).

Deep muscles of the front forearm:

Flexor digitorum profundus: inserts at the ulna and interosseous membrane and runs to the phalanges of the 2nd to the 5th finger. It controls the flexion of the distal phalanges.

Flexor pollicis longus: originates from the distal radius and runs through the medial forearm to reach the tip of the thumb as a tendon enclosed into the carpal tunnel. It is used for thumb flexion.

Pronator quadratus: is a squared (latin: quadratus) muscle located at the forearm near the wrist. It runs horizontally to connect the ulna with the radius. It assists the pronator teres muscle in forearm pronation (palm facing).

Tendons of the Upper Arm

The tendons of the upper arm connect the muscles to the bones of the forearms. At the proximal side (shoulder) there are two tendons of the biceps: the tendon of the long head inserts to the glenoid, whereas the short head connects with the coracoid process of the shoulder.

The distal tendon of the biceps is connected to the proximal radius and flexes the forearm at the elbow and supinates the forearm. The distal tendon of the triceps is connected to the olecranon and extends the forearm in the elbow joint.

Tendons of the forearm

The forearm tendons (extensors) connect the muscles of the forearm to the lateral epicondyle of the humerus. The extensor carpi radialis brevis is the muscle mostly known for being involved in a pathology named tennis elbow.

Anteriorly - the biceps tendon connects the biceps muscle to the radius. It is used to bend the elbow with strength (see image on previous page).

Posteriorly - the triceps tendon attaches the triceps muscle to the ulna. It is used to straighten the arm with a push-up (see image on previous page).

Elbow capsule

Synovial membrane

The synovial membrane forms a fibrous capsule around the elbow joint. It produces the synovial fluid, which reduces the friction of the bones and tendons by absorbing the pressure during the movement of the joint. It extends from the surface of the humerus, along the ulna and the radius.

Other structures assist in stabilising and protecting the integrity of the elbow joint capsule. The cartilage is a thin layer of connective tissue covering the extremity of all articulating bones (humerus, radius and ulna), which prevents the friction of the bones during the movements of the elbow. In addition, a multitude of ligaments connect the bones with one another to stabilise further the elbow joint (see ligaments).

Blood vessels

Blood vessels are an intricate network of flexible ducts that circulate blood through the body's tissues. They are divided into arteries and veins. The arteries supply the body with oxygenated blood originating from the heart, while the veins transport carbon dioxide-rich blood from peripheral tissues back to the heart. Together they form the vascular system.

Arteries

The subclavian artery is the largest artery providing blood to the upper limbs. It differs on each body side: the right subclavian artery arises from the brachiocephalic trunk whereas the left subclavian artery branches directly from the aorta. After crossing the lateral side of the first rib, the subclavian artery enters the axilla to become the axillary artery and further down it divides again to form the brachial artery.

The largest artery of the arm is the *brachial artery*, which is a direct extension of the subclavian artery. Downstream, the brachial artery forms the *profunda brachii* or, deep artery of the arm, that travels along the posterior surface of the humerus. It supplies the muscles in the posterior part of the arm (e.g triceps brachii), and ends up into a network of vessels at the elbow. As it descends immediately posterior to the median nerve it divides into smaller arteries as it continues towards the arm, wrist and hand. Then it crosses the *cubital fossa* (or elbow pit, the triangular area on the anterior side of the elbow), it bifurcates into the radial and ulnar arteries. Doctors use this pulsating artery to measure blood pressure. Injury to the brachial artery can seriously affect the hand as it is the only blood supply. At the elbow, the brachial artery divides into:

Ulnar artery with its branches, the superior and inferior ulnar collateral arteries, is located at the medial and anterior side of the forearm to reach the wrist

Radial artery descends in the anterior and lateral side of the forearm. Downstream, it divides into different branches to supply the hand

Interosseous recurrent artery supplies the interosseous membrane between the radius and ulna.

Veins

The main veins of the upper arm, elbow and forearm are the *cephalic vein*, the *basilic vein* and the *median cubital vein* situated on the superficial upper extremities. Their description follows the flow of venous blood, ascending from the lower forearm to the upper arm.

Cephalic vein runs from the forearm through the elbow and arm, up to the shoulder where it merges with the axillary vein in the upper chest

The basilic vein runs at the forearm, it passes the elbow and takes the name *axillary vein* at the shoulder. It also merges with the *subclavian vein.* The basilic vein joins with the brachial vein to form the axillary vein

Median cubital vein is a large superficial vein running parallel to the brachial artery. It connects the basilic and cephalic veins. This vein is usually clearly visible through the skin

Median antebrachial vein runs in the anterior aspect of the forearm between the radial and ulnar veins and drains into the basilic vein

Cubital vein is used to draw blood with a needle, or venipuncture, to deliver intravenous infusion of various solutions and medications.

Brachial, radial and ulnar veins are located in the deeper forearm. They take the same names of their corresponding arteries and flow parallel to them. At the elbow, the ulnar and radial veins join to form the brachial vein.

Nerves

The upper limbs are innervated by five nerves: the median, ulnar, radial, axillar and musculocutaneous nerves, each one mediating distinct motor and sensory functions.

Brachial Plexus

The nerves of the arm originate from the cervical spine vertebrae (C5-C8 and T1) and descend along the body to form the brachial plexus from where they interchange and extend along the shoulder, the upper arm and forearm up to the hand and fingers.

Axillary nerve

The axillary nerve or the circumflex nerve is located in the axilla and originates from the brachial plexus. It innervates the upper arm and shoulder region. Differently from other nerves it does not descend along the arm. After leaving the plexus it divides into the anterior and posterior branch.

The anterior branch innervates the deltoid muscle in the upper arm while the posterior branch extends to the upper shoulder, supplying the teres minor (a muscle located in the lateral side of the scapula attaching to the rotator cuff in the shoulder joint) and the posterior area of the deltoid. The axillary nerve provides sensory function to the skin of the shoulder joint and deltoid muscle.

Nerves of the upper extremities

Three main nerves of the arm are:

Median nerve

Radial nerve

Ulnar nerve

Pathological symptoms of the elbow and forearm can be induced by problems of the nerves. The nerves are enclosed by tunnels and due to the complex arm movements; they are subject to bending and straightening. Alterations of the nerves and tunnels can lead to pain, numbness and weakness in the arm and hand. These nerves can also be injured during trauma and improper surgery.

Median nerve

The median nerve controls the following motor functions: forearm pronation, thumb palmar abduction and thumb/index/long finger flexion. The motor branches of the median nerve and the respective muscles they innervate are listed below:

Proximal extrinsic motor branches (median nerve):

1. Pronator teres

2. Flexor carpi radialis

3. Palmaris longus

4. Flexor digitorum superficialis

***Proximal extrinsic motor branches* (*anterior interosseous nerve*)**

5. Flexor digitorum profundus (to index and, usually long finger)

6. Flexor pollicis longus

7. Pronator quadratus

Distal intrinsic motor branches (thenar branch)

1. Abductor pollicis brevis

2. Flexor pollicis brevis (superficial head)

3. Opponens pollicis

***Distal intrinsic motor branches* (common digital branches of the median nerve)**

4. First lumbrical (to index and long fingers)

5. Second lumbrical (to index and long fingers)

Palmar branch (to radial base of palm)

Articular branches to the wrist joint (via distal anterior interosseous nerve).

Sensory Branches of the median nerve

These branches control sensation to the illustrated areas of the hand and fingers: volar thumb, index, long, and radial half of ring finger. They also provide sensation to specific areas of the hand - the pinch surfaces of the thumb, index and third fingers. Compression of the median nerve at the wrist is known for causing the carpal tunnel syndrome.

Radial nerve

Motor branches of the radial nerve contribute to the function of the elbow, wrist, finger and thumb.

The muscles Innervated by the radial nerve are:

Triceps brachii / anconeus

Brachioradialis

Extensor carpi radialis longus

Extensor carpi radialis brevis

Supinator

Extensor carpi ulnaris

Extensor digitorum communis

Extensor digiti minimi

Abductor pollicis longus

Extensor pollicis brevis

Extensor indicis proprius

Extensor pollicis longus

Brachialis (contribution; though main supply to brachialis is the musculocutaneous nerve)

Sensory branches

The sensory component of the radial nerve, the superficial radial sensory nerve (or radial sensory branch), is the frequent cause of neuropathic pain following injury.

These are the sensory branches:

Posterior brachial cutaneous nerve/ inferior lateral brachial cutaneous nerve

Posterior antebrachial cutaneous nerve

Radial sensory nerve (sensory branch of the radial nerve)

Ulnar nerve

Motor branches: ulnar nerve contributes to the following motor functions: fine hand movements, coordination of finger motion and pinch strength, flexion of the small and ring fingers.

Proximal extrinsic motor branches (ulnar nerve)

Flexor carpi ulnaris

Flexor digitorum profundus (ulnar half to small, ring +/- long finger)

Distal intrinsic motor branch (superficial ulnar nerve branch)

Palmaris brevis

Distal intrinsic motor branches (deep ulnar nerve branch)

Abductor digiti minimi

Flexor digiti minimi

Opponens digiti minimi

3rd and 4th lumbricals (to small & ring fingers)

Palmar and dorsal interosseous muscles

Adductor pollicis

Flexor pollicis brevis

First dorsal interosseous

First palmar interosseous

Sensory branches

The ulnar nerve mediates parts of the sensation of the palm and of the small finger including the ulnar border of the fourth finger. The ulnar nerve is enclosed in the Guyon canal, where a pathologic nerve entrapment can occur.

These are the main branches of the ulnar nerve:

Dorsal branch

Common and proper digital nerves (superficial branch) to volar small and ulnar half of ring finger

Palmar branch

Articular branches to the elbow joint and carpal and metacarpo-phalangeal joints.

Image shows the areas of sensation of the median radial and ulnar nerves.

ELBOW ARM ANATOMY

Definition

The arm also referred to as the upper limb is connected to the chest by the shoulder joint. It is divided into two segments separated by the elbow: the upper arm and the forearm, the latter extending to the wrist and the hand.

The arm and elbow

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Bones of the upper arm and elbow

The upper arm is the region of the body located between the shoulder and the elbow. This segment of the arm is comprised of a single, long and large bone named *humerus*. The anatomy of the humerus consists in the proximal end (head), which articulates into the socket of the shoulder joint, followed by a humerus neck, and a long, cylindrical shaft containing the bone marrow. In the distal portion, the humerus ends with two round extremities, the condyles, which are located in opposition to the bones of the forearm, the radius and ulna. The upper arm is connected to the bones of the forearm through the elbow joint, which is a hinged joint that articulates the humerus with the ulna and radius.

Bones of the forearm

The forearm is made of two bones, the *radius* and the *ulna*. The radius is located on the outside of the forearm along the thumb line. It becomes wider at the wrist. The ulna runs on the internal side of the arm, along the little finger. It is felt at the inner tip of the elbow. The radius and ulna are connected with one another by a strong interosseous membrane. In the proximal region, the radius and ulna articulate with the humerus bone of the upper arm to form the elbow joint.

Bones at the wrist

In the wrist joint the radius and ulna articulate with three carpal bones of the wrist: the scaphoid, the lunate, and triquetrum. The radius and ulna allow the rotation of the forearm by turning the palm of the hand up (supination) and down (pronation). In this movement the radius slides around the ulna, which remains in its position.

Elbow joint

The elbow is made by the distal end of the humerus and the proximal end of two smaller bones forming the lower arm, the radius on the outer side, and the ulna on the inner side. These bones allow for the twisting movement of the hand. At the elbow the humerus ends with two processes, the medial and lateral epicondyles that can be felt on each side of the elbow. The head of the radius or radial head is a round concave area, which allows the movement around the opposed end of the humerus (capitellum), whereas the coronoid is the corresponding area of the ulna facing the distal humeral extremity, the trochlea.

Ligaments

Ligaments are strong bands of elastic connective tissue that join bones to other bones. At the elbow they play an important role in stabilising the function of the joint where three bones of the upper extremity articulate with one another. There are three main ligaments at the elbow joint:

Medial Collateral Ligament or Ulnar Collateral Ligament: consists of the anterior and posterior bands. Both originate from the medial epicondyle and cross through the elbow joint. The anterior band attaches at the coronoid process of the ulna, and the posterior band to the olecranon process.

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Anconeus: is a small muscle of the elbow with a triangular shape joining the ulna to the lateral humerus. It assists in elbow extension and rotation.

Extensor carpi radialis longus: is a long muscle arising partially at the lateral supracondylar ridge and partially at the lateral epicondyle of the humerus. It runs on the thumb side of the forearm and inserts at the base of the 2nd metacarpal bone (corresponding to the index finger). It is a major muscle used for wrist abduction and extension.

Biceps or Biceps brachii: is the muscle likely used more often when moving the arm. It is connected to the bones of the shoulder, the glenoid and coracoid process, via two tendons, and to the proximal region (tuberosity of the radius) with one tendon. The biceps is essential to bend the arm and turn the hand outward (supination).

Muscles of the forearm

The muscles of the forearm are located on the dorsal and ventral side of the forearm.

Many of them originate from the epicondyles of the upper arm (humerus) and are involved in the movement of the elbow, hand and fingers. Muscles on the dorsal side of the forearm:

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Extensor carpi ulnaris: lies on the ulnar side of the forearm. It originates from the lateral epicondyle at the inner elbow and crosses the forearm downward to insert at the base of the 5th metacarpal of the hand. It is used for the extension and adduction of the wrist.

Extensor carpi radialis longus: is a long muscle on the radial side of the forearm used to extend the hand and flex the forearm. It inserts at the lateral humerus to attach distally at the second metacarpal bone of the index finger.

Extensor digitorum: is located on the forearm back side. It arises at lateral epicondyle of the humerus and divides into four tendons to reach the distal and middle phalanges of the fingers. It controls the extension of the medial fingers.

Extensor carpi radialis brevis: originates above the lateral epicondyle of the humerus and inserts into the 3rd metacarpal bone. It functions in synergy with the extensor carpi longus and is used to abduct and extend the hand and wrist.

Extensor digiti minimi: arises at the lateral epicondyle of the humerus and joins with the hand muscle, the extensor digitorium communis. It controls the movements of the little finger (flexion, extension).

Flexor carpi ulnaris: arises at the medial epicondyle of the humerus and the ulnar head. It extends to the wrist where it inserts at the pisiform bone prior to the 5th metacarpal bone. It works together with the extensor carpi radialis to flex or adduct the wrist.

Abductor pollicis longus: together with extensor pollicis muscles, it controls the thumb movement. It begins at the proximal radius and ulna and attaches at the base of 1st metacarpal bone. It assists in thumb abduction and extension and contributes to wrist flexion.

Extensor pollicis brevis: is located on the dorsal forearm. It originates at the distal radius and inserts at the base of the proximal phalanx of the thumb (latin: pollux-pollicis) where it forms the known snuff box at the radial wrist. It works with extensor pollicis longus in the extension and abduction of the thumb.

Muscles of the deep forearm back:

Supinator: is a short muscle arranged in two layers. Its fibres run from the ulna and the lateral end of the humerus to the radius. It supports the biceps brachii in rotating the forearm (supination).

Extensor pollicis longus: originates at the ulna bone and interosseous membrane and inserts at the distal phalange of the thumb. It is used for thumb extension.

Extensor indicis: originates at the interosseous membrane and ulna and travels to the index finger parallel to the extensor digitorum tendon. It assists in the index extension of all phalanges and also of the wrist mid-carpal joints.

Muscles on the ventral side of the forearm:

Pronator teres: inserts proximally with two heads at medial epicondyle of the humerus and ulnar coronoid process and runs diagonally across the forearm to connect to the outer radius. It is used with the pronator quadratus during forearm pronation (palm down)

Flexor carpi radialis: inserts at the humerus epicondyle and runs through the anterior forearm to the base of the 2nd metacarpal bone. It is used during wrist flexion and hand abduction.

Flexor carpi ulnaris: originates with two ends, one at the medial epicondyle of the humerus and the other at the olecranon. It inserts at the wrist carpal bones, the pisiform, hamamate and to the basis of the 5th metacarpal bone. It is used to flex and adduct the hand and wrist.

Palmaris longus: is a thin muscle arising at the medial epicondyle that runs in the middle of the forearm, where it inserts on the palmar aponeurosis on the hand palm. Its function is to flex the hand at the wrist. It can be absent in over 10% of the population or consist of a tendon rather then muscle tissue.

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Deep muscles of the front forearm:

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Pronator quadratus: is a squared (latin: quadratus) muscle located at the forearm near the wrist. It runs horizontally to connect the ulna with the radius. It assists the pronator teres muscle in forearm pronation (palm facing).

Tendons of the Upper Arm

The tendons of the upper arm connect the muscles to the bones of the forearms. At the proximal side (shoulder) there are two tendons of the biceps: the tendon of the long head inserts to the glenoid, whereas the short head connects with the coracoid process of the shoulder.

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Arteries

The subclavian artery is the largest artery providing blood to the upper limbs. It differs on each body side: the right subclavian artery arises from the brachiocephalic trunk whereas the left subclavian artery branches directly from the aorta. After crossing the lateral side of the first rib, the subclavian artery enters the axilla to become the axillary artery and further down it divides again to form the brachial artery.

The largest artery of the arm is the *brachial artery*, which is a direct extension of the subclavian artery. Downstream, the brachial artery forms the *profunda brachii* or, deep artery of the arm, that travels along the posterior surface of the humerus. It supplies the muscles in the posterior part of the arm (e.g triceps brachii), and ends up into a network of vessels at the elbow. As it descends immediately posterior to the median nerve it divides into smaller arteries as it continues towards the arm, wrist and hand. Then it crosses the *cubital fossa* (or elbow pit, the triangular area on the anterior side of the elbow), it bifurcates into the radial and ulnar arteries. Doctors use this pulsating artery to measure blood pressure. Injury to the brachial artery can seriously affect the hand as it is the only blood supply. At the elbow, the brachial artery divides into:

Ulnar artery with its branches, the superior and inferior ulnar collateral arteries, is located at the medial and anterior side of the forearm to reach the wrist

Radial artery descends in the anterior and lateral side of the forearm. Downstream, it divides into different branches to supply the hand

Interosseous recurrent artery supplies the interosseous membrane between the radius and ulna.

Veins

The main veins of the upper arm, elbow and forearm are the *cephalic vein*, the *basilic vein* and the *median cubital vein* situated on the superficial upper extremities. Their description follows the flow of venous blood, ascending from the lower forearm to the upper arm.

Cephalic vein runs from the forearm through the elbow and arm, up to the shoulder where it merges with the axillary vein in the upper chest

The basilic vein runs at the forearm, it passes the elbow and takes the name *axillary vein* at the shoulder. It also merges with the *subclavian vein*. The basilic vein joins with the brachial vein to form the axillary vein

Median cubital vein is a large superficial vein running parallel to the brachial artery. It connects the basilic and cephalic veins. This vein is usually clearly visible through the skin

Median antebrachial vein runs in the anterior aspect of the forearm between the radial and ulnar veins and drains into the basilic vein

Cubital vein is used to draw blood with a needle, or venipuncture, to deliver intravenous infusion of various solutions and medications.

Brachial, radial and ulnar veins are located in the deeper forearm. They take the same names of their corresponding arteries and flow parallel to them. At the elbow, the ulnar and radial veins join to form the brachial vein.

Nerves

The upper limbs are innervated by five nerves: the median, ulnar, radial, axillar and musculocutaneous nerves, each one mediating distinct motor and sensory functions.

Brachial Plexus

The nerves of the arm originate from the cervical spine vertebrae (C5-C8 and T1) and descend along the body to form the brachial plexus from where they interchange and extend along the shoulder, the upper arm and forearm up to the hand and fingers.

Axillary nerve

The axillary nerve or the circumflex nerve is located in the axilla and originates from the brachial plexus. It innervates the upper arm and shoulder region. Differently from other nerves it does not descend along the arm. After leaving the plexus it divides into the anterior and posterior branch.

The anterior branch innervates the deltoid muscle in the upper arm while the posterior branch extends to the upper shoulder, supplying the teres minor (a muscle located in the lateral side of the scapula attaching to the rotator cuff in the shoulder joint) and the posterior area of the deltoid. The axillary nerve provides sensory function to the skin of the shoulder joint and deltoid muscle.

Nerves of the upper extremities

Three main nerves of the arm are:

Median nerve

Radial nerve

Ulnar nerve

Pathological symptoms of the elbow and forearm can be induced by problems of the nerves. The nerves are enclosed by tunnels and due to the complex arm movements; they are subject to bending and straightening. Alterations of the nerves and tunnels can lead to pain, numbness and weakness in the arm and hand. These nerves can also be injured during trauma and improper surgery.

Median nerve

The median nerve controls the following motor functions: forearm pronation, thumb palmar abduction and thumb/index/long finger flexion. The motor branches of the median nerve and the respective muscles they innervate are listed below:

Proximal extrinsic motor branches (median nerve):

1. Pronator teres

2. Flexor carpi radialis

3. Palmaris longus

4. Flexor digitorum superficialis

Proximal extrinsic motor branches **(*anterior interosseous nerve*)**

5. Flexor digitorum profundus (to index and, usually long finger)

6. Flexor pollicis longus

7. Pronator quadratus

Distal intrinsic motor branches (thenar branch)

1. Abductor pollicis brevis

2. Flexor pollicis brevis (superficial head)

3. Opponens pollicis

Distal intrinsic motor branches **(common digital branches of the median nerve)**

4. First lumbrical (to index and long fingers)

5. Second lumbrical (to index and long fingers)

Palmar branch (to radial base of palm)

Articular branches to the wrist joint (via distal anterior interosseous nerve).

Sensory Branches of the median nerve

These branches control sensation to the illustrated areas of the hand and fingers: volar thumb, index, long, and radial half of ring finger. They also provide sensation to specific areas of the hand - the pinch surfaces of the thumb, index and third fingers. Compression of the median nerve at the wrist is known for causing the carpal tunnel syndrome.

Radial nerve

Motor branches of the radial nerve contribute to the function of the elbow, wrist, finger and thumb.

The muscles Innervated by the radial nerve are:

Triceps brachii / anconeus

Brachioradialis

Extensor carpi radialis longus

Extensor carpi radialis brevis

Supinator

Extensor carpi ulnaris

Extensor digitorum communis

Extensor digiti minimi

Abductor pollicis longus

Extensor pollicis brevis

Extensor indicis proprius

Extensor pollicis longus

Brachialis (contribution; though main supply to brachialis is the musculocutaneous nerve)

Sensory branches

The sensory component of the radial nerve, the superficial radial sensory nerve (or radial sensory branch), is the frequent cause of neuropathic pain following injury.

These are the sensory branches:

Posterior brachial cutaneous nerve/ inferior lateral brachial cutaneous nerve

Posterior antebrachial cutaneous nerve

Radial sensory nerve (sensory branch of the radial nerve)

Ulnar nerve

Motor branches: ulnar nerve contributes to the following motor functions: fine hand movements, coordination of finger motion and pinch strength, flexion of the small and ring fingers.

Proximal extrinsic motor branches (ulnar nerve)

Flexor carpi ulnaris

Flexor digitorum profundus (ulnar half to small, ring +/- long finger)

Distal intrinsic motor branch (superficial ulnar nerve branch)

Palmaris brevis

Distal intrinsic motor branches (deep ulnar nerve branch)

Abductor digiti minimi

Flexor digiti minimi

Opponens digiti minimi

3rd and 4th lumbricals (to small & ring fingers)

Palmar and dorsal interosseous muscles

Adductor pollicis

Flexor pollicis brevis

First dorsal interosseous

First palmar interosseous

Sensory branches

The ulnar nerve mediates parts of the sensation of the palm and of the small finger including the ulnar border of the fourth finger. The ulnar nerve is enclosed in the Guyon canal, where a pathologic nerve entrapment can occur.

These are the main branches of the ulnar nerve:

Dorsal branch

Common and proper digital nerves (superficial branch) to volar small and ulnar half of ring finger

Palmar branch

Articular branches to the elbow joint and carpal and metacarpo-phalangeal joints.

Image shows the areas of sensation of the median radial and ulnar nerves.

The bones of the hand provide support and flexibility to the soft tissues. They can be divided into **three** categories:

- **Carpal bones** (Proximal) – A set of eight irregularly shaped bones. These are located in the wrist area.
- **Metacarpals** – There are five metacarpals, each one related to a digit
- **Phalanges** (Distal) – The bones of the fingers. Each finger has three phalanges, except for the thumb, which has two.

In this article, we shall look at the anatomical features of the bones of the hand.

By TeachMeSeries Ltd (2020)

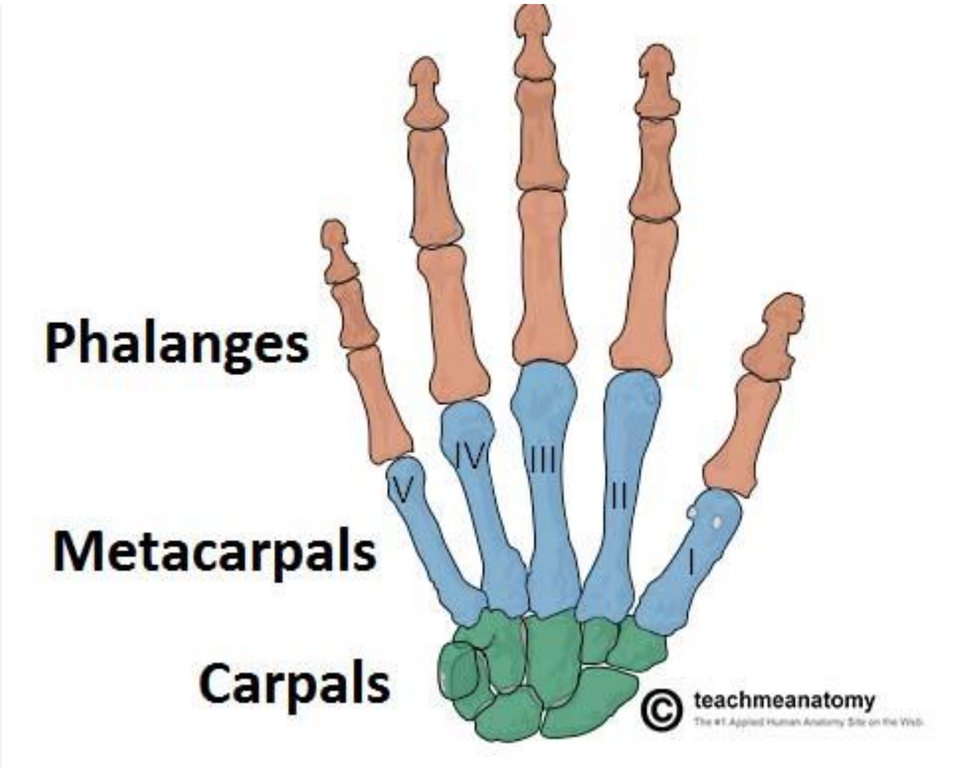

Fig 1 – Overview of the bones of the hand.

Carpal Bones

The carpal bones are a group of eight, irregularly shaped bones. They are organised into two rows; proximal and distal.

Proximal Row (lateral to medial)	Distal Row (lateral to medial)
Scaphoid Lunate Triquetrum Pisiform (a sesamoid bone, formed within the tendon of the flexor carpi ulnaris)	Trapezium Trapezoid Capitate Hamate (has a projection on its palmar surface, known as the 'hook of hamate'

Collectively, the carpal bones form an **arch** in the coronal plane. A membranous band, the flexor retinaculum, spans between the medial and lateral edges of the arch, forming the carpal tunnel.

Proximally, the scaphoid and lunate articulate with the radius to form the **wrist joint** (also known as the 'radio-carpal joint'). In the distal row, all of the carpal bones articulate with the metacarpals.

By TeachMeSeries Ltd (2020)

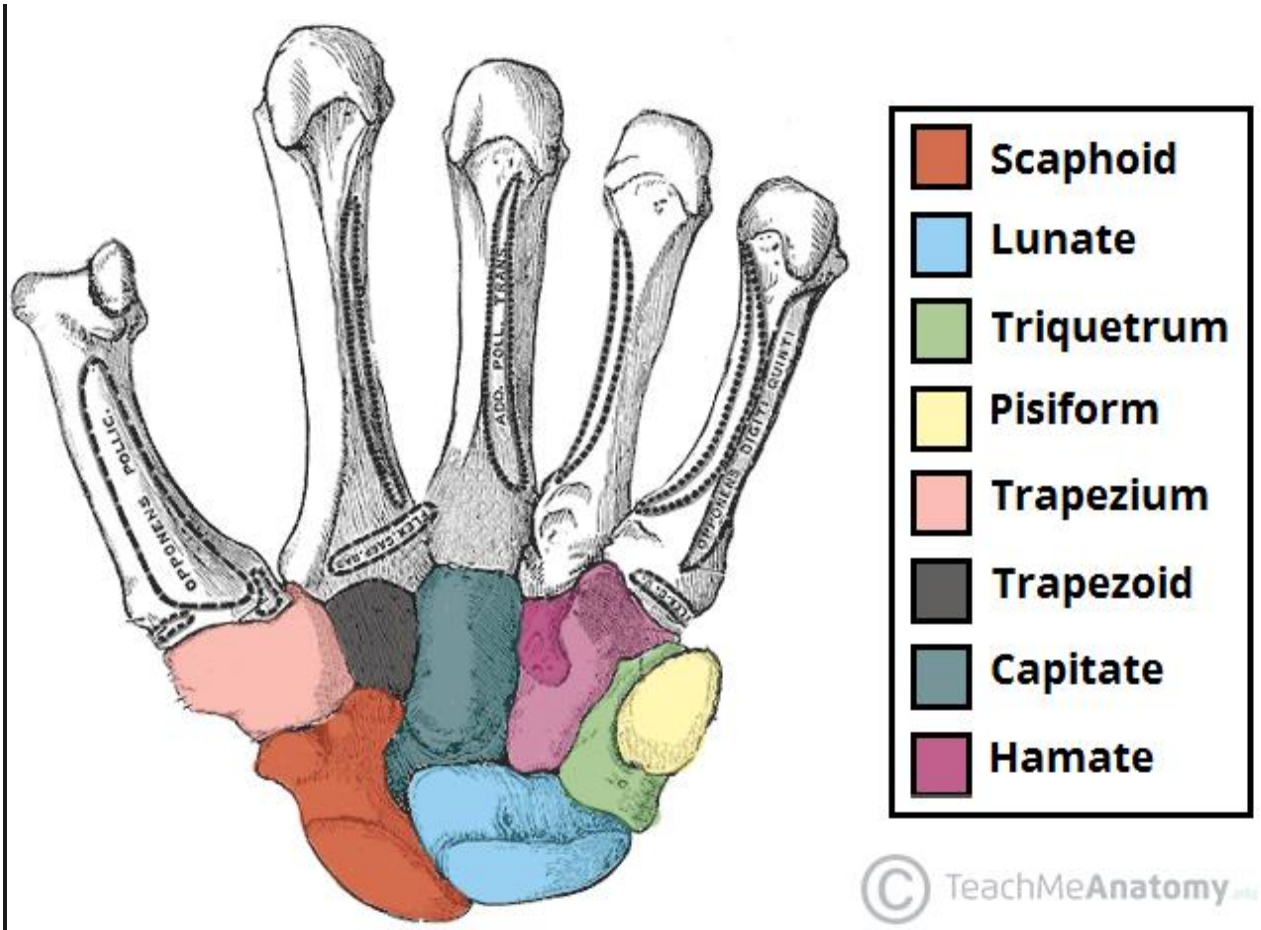

Fig 2 – Palmar view of the carpal bones of the left hand.
By [TeachMeSeries Ltd](#) (2020)

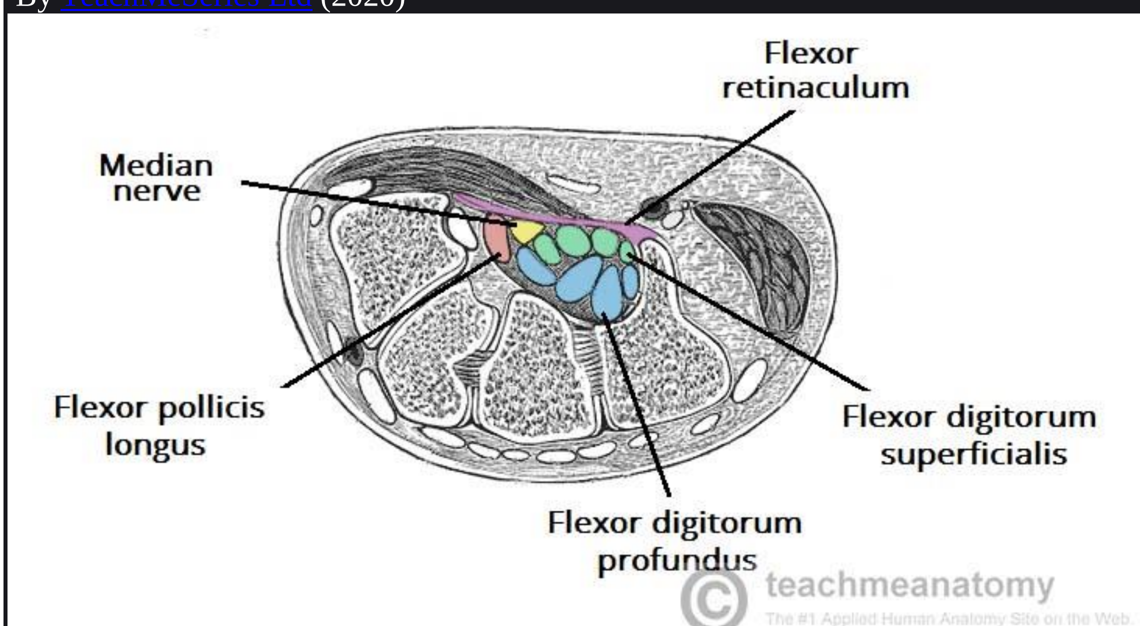

Fig 3 – Transverse section of the carpal tunnel.

Metacarpal Bones

The metacarpal bones articulate proximally with the carpals, and distally with the proximal phalanges. They are numbered, and each associated with a digit:

- Metacarpal I – Thumb.

- Metacarpal II – Index finger.
- Metacarpal III – Middle finger.
- Metacarpal IV – Ring finger.
- Metacarpal V – Little finger.

Each metacarpal consists of a base, shaft and a head. The medial and lateral surfaces of the metacarpals are **concave**, allowing attachment of the **interossei** muscles.

Phalanges

The **phalanges** are the bones of the fingers. The thumb has a proximal and distal phalanx, while the rest of the digits have proximal, middle and distal phalanges.

Hip bone

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The **hip bone** (**os coxae**, **innominate bone**, **pelvic bone**[1] or **coxal bone**) is a large irregular bone, constricted in the center and expanded above and below. In some vertebrates (including humans before puberty) it is composed of three parts: the ilium, ischium, and the pubis.

The two hip bones join at the pubic symphysis and together with the sacrum and coccyx (the pelvic part of the spine) comprise the skeletal component of the pelvis – the pelvic girdle which surrounds the pelvic cavity. They are connected to the sacrum, which is part of the axial skeleton, at the sacroiliac joint. Each hip bone is connected to the corresponding femur (thigh bone) (forming the primary connection between the bones of the lower limb and the axial skeleton) through the large ball and socket joint of the hip.

The hip bone is formed by three parts: the ilium, ischium, and pubis. At birth, these three components are separated by hyaline cartilage. They join each other in a Y-shaped portion of cartilage in the acetabulum. By the end of puberty the three regions will have fused together, and by the age 25 they will have ossified. The two hip bones join each other at the pubic symphysis. Together with the sacrum and coccyx, the hip bones form the pelvis.[2]

Ilium

Main article: Ilium (bone)

Ilium (plural *ilia*) is the uppermost and largest region. It makes up two fifths of the acetabulum. It is divisible into two parts: the body and the ala or wing of ilium; the separation is indicated on the top surface by a curved line, the arcuate line, and on the external surface by the margin of the acetabulum. The body of ilium forms the sacroiliac joint with the sacrum. The edge of the wing of ilium forms the S-shaped iliac crest which is easily located through the skin. The iliac crest shows clear marks of the attachment of the three abdominal wall muscles.[2]

Ischium

Main article: Ischium

The ischium forms the lower and back part of the hip bone and is located below the ilium and behind the pubis. The ischium is the strongest of the three regions that form the hip bone. It is divisible into three portions: the body, the superior ramus, and the inferior ramus. The body forms approximately one-third of the acetabulum.

The ischium forms a large swelling, the tuberosity of the ischium, also referred to colloquially as the "sit bone". When sitting, the weight is frequently placed upon the *ischial tuberosity*. The gluteus maximus covers it in the upright posture, but leaves it free in the seated position.[2]

Pubis

Main article: Pubis (bone)

The *pubic region* or *pubis* is the ventral and anterior of the three parts forming the hip bone. It is divisible into a body, a superior ramus, and an inferior ramus. The body forms one-fifth of the acetabulum. The body forms the wide, strong, medial and flat portion of the pubic bone which unites with the other pubic bone in the pubic symphysis.[2] The fibrocartilaginous pad which lies between the symphysial surfaces of the coxal bones, that secures the pubic symphysis, is called the *interpubic disc*.

Pelvic brim

The *pelvic brim* is a continuous oval ridge of bone that runs along the pubic symphysis, pubic crests, arcuate lines, sacral alae, and sacral promontory.[3]

False pelvis, pelvic inlet, and ramus

The *false pelvis* is that portion superior to the pelvic brim; it is bounded by the alae of the ilia laterally and the sacral promontory and lumbar vertebrae posteriorly.[3]

The *true pelvis* is the region inferior to the pelvic brim that is almost entirely surrounded by bone.[3]

The *pelvic inlet* is the opening delineated by the pelvic brim. The widest dimension of the pelvic inlet is from left to right, that is, along the frontal plane.[3] The *pelvic outlet* is the margin of the true pelvis. It is bounded anteriorly by the pubic arch, laterally by the ischia, and posteriorly by the sacrum and coccyx.[3]

The *superior pubic ramus* is a part of the pubic bone which forms a portion of the obturator foramen. It extends from the body to the median plane where it articulates with its fellow of the opposite side. It is conveniently described in two portions: a medial flattened part and a narrow lateral prismoid portion. The *inferior pubic ramus* is thin and flat. It passes laterally and downward from the medial end of the superior ramus. It becomes narrower as it descends and joins with the inferior ramus of the ischium below the obturator foramen.

Development and sexual dimorphism

Plan of ossification of the hip bone. Left hip bone, external surface.

The hip bone is ossified from eight centers: three primary, one each for the ilium, ischium, and pubis, and five secondary, one each for the iliac crest, the anterior inferior spine (said to occur more frequently in the male than in the female), the tuberosity of the ischium, the pubic symphysis (more frequent in the female than in the male), and one or more for the Y-shaped piece at the bottom of the acetabulum.

The centers appear in the following order: in the lower part of the ilium, immediately above the greater sciatic notch, about the eighth or ninth week of fetal life; in the superior ramus of the ischium, about the third month; in the superior ramus of the pubis, between the fourth and fifth months. At birth, the three primary centers are quite separate, the crest, the bottom of the acetabulum, the ischial tuberosity, and the inferior rami of the ischium and pubis being still cartilaginous.

By the seventh or eighth year, the inferior rami of the pubis and ischium are almost completely united by bone. About the thirteenth or fourteenth year, the three primary centers have extended their growth into the bottom of the acetabulum, and are there separated from each other by a Y-shaped portion of cartilage, which now presents traces of ossification, often by two or more centers. One of these, the os acetabuli, appears about the age of twelve, between the ilium and pubis, and fuses with them about the age of eighteen; it forms the pubic part of the acetabulum. The ilium and ischium then become joined, and lastly the pubis and ischium, through the intervention of this Y-shaped portion.

Several muscles attach to the hip bone including the internal muscles of the pelvic, abdominal muscles, back muscles, all the gluteal muscles, muscles of the lateral rotator group, hamstring muscles, two muscles from the anterior compartment of the thigh.

Abdominal muscles

- The abdominal external oblique muscle attaches to the iliac crest.
- The abdominal internal oblique muscle attaches to pecten pubis.
- The transversus abdominis muscle attaches to the pubic crest and pecten pubis via a conjoint tendon

Back muscles

The multifidus muscle in the sacral region attaches to the medial surface of posterior superior iliac spine, the posterior sacroiliac ligaments and several places to the sacrum.

Gluteal muscles

- The gluteus maximus muscle arises from the posterior gluteal line of the inner upper ilium, and the rough portion of bone including the iliac crest, the fascia covering the gluteus medius (gluteal aponeurosis), as well as the sacrum, coccyx, the erector spinae (lumbodorsal fascia), the sacrotuberous ligament.

- The gluteus medius muscle: originates on the outer surface of the ilium between the iliac crest and the posterior gluteal line above, and the anterior gluteal line below. The gluteus medius also originates from the gluteal aponeurosis that covers its outer surface.
- Gluteus minimus muscle originates between the anterior and inferior gluteal lines, and from the margin of the greater sciatic notch.

Lateral rotator group

The piriformis muscle originates from the superior margin of the greater sciatic notch (as well as the sacroiliac joint capsule and the sacrotuberous ligament and part of the spine and sacrum.

- The superior gemellus muscle arises from the outer surface of the ischial spine
- The obturator internus muscle arises from the inner surface of the antero-lateral wall of the hip bone, where it surrounds the greater part of the obturator foramen, being attached to the inferior rami of the pubis and ischium, and at the side to the inner surface of the hip bone below and behind the pelvic brim, reaching from the upper part of the greater sciatic foramen above and behind to the obturator foramen below and in front. It also arises from the pelvic surface of the obturator membrane except in the posterior part, from the tendinous arch, and to a slight extent from the obturator fascia, which covers the muscle.
- The inferior gemellus muscle arises from the upper part of the tuberosity of the ischium, immediately below the groove for the obturator internus tendon.
- The obturator externus muscle arises from the margin of bone immediately around the medial side of the obturator foramen, from the rami of the pubis, and the inferior ramus of the ischium; it also arises from the medial two-thirds of the outer surface of the obturator membrane, and from the tendinous arch.

Hamstrings

The long head biceps femoris arises from the lower and inner impression on the back part of the tuberosity of the ischium, by a tendon common to it and the semitendinosus, and from the lower part of the sacrotuberous ligament;[4]

- The semitendinosus arises from the lower and medial impression on the tuberosity of the ischium, by a tendon common to it and the long head of the biceps femoris; it also arises from an aponeurosis which connects the adjacent surfaces of the two muscles to the extent of about 7.5 cm. from their origin.
- The semimembranosus arises from the lower and medial impression on the tuberosity of the ischium

Anterior compartment of thigh

- The rectus femoris muscle arises by two tendons: one, the anterior or straight, from the anterior inferior iliac spine; the other, the posterior or reflected, from a groove above the rim of the acetabulum.
- The sartorius muscle arises by tendinous fibres from the anterior superior iliac spine,

Shoulder muscles

- The latissimus dorsi muscle attaches to the iliac crest and several places on the spine and ribs.

Clinical significance

Fractures

Main article: Pelvic fracture

Fractures of the hip bone are termed pelvic fractures, and should not be confused with hip fractures, which are actually femoral fractures[5] that occur in the proximal end of the femur.

Preparation for childbirth

Pelvimetry is the assessment of the female pelvis[6] in relation to the birth of a baby in order to detect an increased risk for obstructed labor.

Evolution of the pelvis in animals

The hip bone first appears in fishes, where it consists of a simple, usually triangular bone, to which the pelvic fin articulates. The hip bones on each side usually connect with each other at the forward end, and are even solidly fused in lungfishes and sharks, but they never attach to the vertebral column.[7]

In the early tetrapods, this early hip bone evolved to become the ischium and pubis, while the ilium formed as a new structure, initially somewhat rod-like in form, but soon adding a larger bony blade. The acetabulum is already present at the point where the three bones meet. In these early forms, the connection with the vertebral column is not complete, with a small pair of ribs connecting the two structures; nonetheless the pelvis already forms the complete ring found in most subsequent forms.[7]

In practice, modern amphibians and reptiles have substantially modified this ancestral structure, based on their varied forms and lifestyles. The obturator foramen is generally very small in such animals, although most reptiles do possess a large gap between the pubis and ischium, referred to as the *thyroid fenestra*, which presents a similar appearance to the obturator foramen in mammals. In birds, the pubic symphysis is present only in the ostrich, and the two hip bones are usually widely separated, making it easier to lay large eggs.[7]

In therapsids, the hip bone came to rotate counter-clockwise, relative to its position in reptiles, so that the ilium moved forward, and the pubis and ischium moved to the rear. The same pattern is seen in all modern mammals, and the thyroid fenestra and obturator foramen have merged to form a single space. The ilium is typically narrow and triangular in mammals, but is much larger in ungulates and humans, in which it anchors powerful gluteal muscles. Monotremes and marsupials also possess a fourth pair of bones, the prepubes or "marsupial bones", which extend forward from the pubes, and help to support the abdominal muscles and, in marsupials, the pouch. In placental mammals, the pelvis as a whole is generally wider in females than in males, to allow for the birth of the young

The pelvic bones of cetaceans were formerly considered to be vestigial, but they are now known to play a role in sexual selection.

The pelvis is a bony structure that can be found in both male and female skeletons. The exception to this compound structure, when compared to all other bones, is that it has differences that are classified by sex, both for functional and general developmental reasons. The rest of the human skeleton differs only in size, which is genetically determined and is usually slightly larger in males than in females.

The structure of the pelvis is designed to give females the ability to undergo pregnancy and childbirth, while males are able to hold larger and heavier muscles upon their frame. Therefore it is heavier in men and has more muscle attachments, a narrower pubic arch, subpubic angle and space between the ischial tuberosities which in turn makes the pelvic outlet smaller. The ilia in women are comparatively more flared than in men which makes their greater pelvis more shallow. The shape of the pelvic inlet and the obturator foramen is oval in women and heart-shaped and round in men respectively. In general, the pelvis is broader in women so that there is ample space for the fetus to exit its mother's body.

It is clear that the anatomy of pelvis is complex and consists of the several bones that are connected with mutual joints. Also, a couple of ligaments in the pelvis participate in forming the pelvis cavity. All of these structures, together with the clinical conditions that may affect the pelvis, will be described in this article. The pelvis is formed by four bones which include a pair of **hip bones** otherwise known as innominate bones, the **sacrum**, which comes with the five lower sacral bones that are fused together and the **coccyx** which has four fused and a single individual terminal vertebra. The **pelvic girdle** consists of the hip bones and the sacrum and its function is to transmit the weight from the upper body to the **lower limbs**, while allowing the body to stay balanced. Meanwhile the ilium, the ischium and the pubis fuse together at puberty to form the innominate bones and are joined by the cartilage found in the acetabulum. The pelvis as a compound structure contains four joints:

- The two sacroiliac joints which are atypical synovial joints and have a very limited range of movement. The articulatory surfaces are between the sacrum and the ilium. It is stabilised by the interosseous ligaments and by the anterior and posterior sacroiliac ligaments.
- The sacrococcygeal joint which is a secondary cartilaginous joint that connects the sacrum to the coccyx. It is reinforced via the anterior and posterior sacrococcygeal ligaments.
- Lastly, the pubic symphysis which is the joint that unites the pubic bones in a secondary cartilaginous articulation. It contains a fibrocartilaginous interpubic disc and is reinforced by the superior and inferior pubic ligaments.
- The two main ligaments of the pelvis are the sacrotuberous and sacrospinous ligaments, which enclose the greater and lesser sciatic notches, forming the greater and lesser sciatic foramina. Due to natural forces, when in an orthostatic or upright stance, the weight of the upper body which is relayed via the spine rotates the sacrum and tips it backwards. However, this movement is prevented by the pelvic ligaments.
- The sacrotuberous ligament extends from the dorsum of the lateral border of the sacrum as well as the posterior surface of the ilium to the ischial tuberosity and is the larger of the two ligaments. The sacrospinous ligament stretches between the lateral border of the sacrum to the ischial spine.

The **femur** (/ˈfiːmər/, pl. *femurs* or *femora* /ˈfɛmərə/)[1][2], or **thigh bone**, is the proximal bone of the hindlimb in tetrapod vertebrates (for example, the largest bone of the human thigh). The head of the femur articulates with the acetabulum in the pelvic bone forming the hip joint, while the distal part of the femur articulates with the tibia and kneecap, forming the knee joint. By most measures the two (left and right) femurs are the strongest bones of the body, and in humans,[*vague*] the longest. The femur is the only bone in the upper leg. The two femurs converge medially toward the knees, where they articulate with the proximal ends of the tibiae. The angle of convergence of the femora is a major factor in determining the femoral-tibial angle. Human females have wider pelvic bones, causing their femora to converge more than in males.

In the condition *genu valgum* (knock knee) the femurs converge so much that the knees touch one another. The opposite extreme is *genu varum* (bow-leggedness). In the general population of people without either *genu valgum* or *genu varum*, the femoral-tibial angle is about 175 degrees.[3]

The femur is the longest and, by some measures, the strongest bone in the human body. This depends on the type of measurement taken to calculate strength. Some strength tests show the temporal bone in the skull to be the strongest bone. The femur length on average is 26.74% of a person's height,[4] a ratio found in both men and women and most ethnic groups with only restricted variation, and is useful in anthropology because it offers a basis for a reasonable estimate of a subject's height from an incomplete skeleton.

The femur is categorised as a long bone and comprises a diaphysis (shaft or body) and two epiphyses (extremities) that articulate with adjacent bones in the hip and knee.

The upper or proximal extremity (close to the torso) contains the head, neck, the two trochanters and adjacent structures.[3]

The head of the femur, which articulates with the acetabulum of the pelvic bone, comprises two-thirds of a sphere. It has a small groove, or fovea, connected through the round ligament to the sides of the acetabular notch. The head of the femur is connected to the shaft through the neck or *collum*. The neck is 4–5 cm. long and the diameter is smallest front to back and compressed at its middle. The collum forms an angle with the shaft in about 130 degrees. This angle is highly variant. In the infant it is about 150 degrees and in old age reduced to 120 degrees on average. An abnormal increase in the angle is known as coxa valga and an abnormal reduction is called coxa vara. Both the head and neck of the femur is vastly embedded in the hip musculature and can not be directly palpated. In skinny people with the thigh laterally rotated, the head of the femur can be felt deep as a resistance profound (deep) for the femoral artery.[3]

The transition area between the head and neck is quite rough due to attachment of muscles and the hip joint capsule. Here the two trochanters, greater and lesser trochanter, are found. The greater trochanter is almost box-shaped and is the most lateral prominent of the femur. The highest point of the greater trochanter is located higher than the collum and reaches the midpoint of the hip joint. The greater trochanter can easily be felt. The trochanteric fossa is a deep depression bounded posteriorly by the intertrochanteric crest on medial surface of the greater trochanter. The lesser trochanter is a cone-shaped extension of the lowest part of the femur neck. The two trochanters are joined by the intertrochanteric crest on the back side and by the intertrochanteric line on the front.[3]

A slight ridge is sometimes seen commencing about the middle of the intertrochanteric crest, and reaching vertically downward for about 5 cm. along the back part of the body: it is called the linea quadrata (or quadrate line).

About the junction of the upper one-third and lower two-thirds on the intertrochanteric crest is the quadrate tubercle located. The size of the tubercle varies and it is not always located on the intertrochanteric crest and that also adjacent areas can be part of the quadrate tubercle, such as the posterior surface of the greater trochanter or the neck of the femur. In a small anatomical study it was shown that the epiphyseal line passes directly through the quadrate tubercle.

The body of the femur (or shaft) is long, slender and almost cylindrical in form. It is a little broader above than in the center, broadest and somewhat flattened from before backward below. It is slightly arched, so as to be convex in front, and concave behind, where it is strengthened by a prominent longitudinal ridge, the linea aspera which diverges proximally and distal as the medial and lateral ridge. Proximally the lateral ridge of the linea aspera becomes the gluteal tuberosity while the medial ridge continues as the pectineal line. Besides the linea aspera the shaft has two other bordes; a lateral and medial border. These three bordes separates the shaft into three surfaces: One anterior, one medial and one lateral. Due to the vast musculature of the thigh the shaft can not be palpated.[3]

The third trochanter is a bony projection occasionally present on the proximal femur near the superior border of the gluteal tuberosity. When present, it is oblong, rounded, or conical in shape and sometimes continuous with the gluteal ridge.[6] A structure of minor importance in humans, the incidence of the third trochanter varies from 17–72% between ethnic groups and it is frequently reported as more common in females than in males.

The lower extremity of the femur (or distal extremity) is larger than the upper extremity. It is somewhat cuboid in form, but its transverse diameter is greater than its antero-posterior (front to back). It consists of two oblong eminences known as the condyles.

Anteriorly, the condyles are slightly prominent and are separated by a smooth shallow articular depression called the patellar surface. Posteriorly, they project considerably and a deep notch, the Intercondylar fossa of femur, is present between them. The lateral condyle is the more prominent and is the broader both in its antero-posterior and transverse diameters. The medial condyle is the longer and, when the femur is held with its body perpendicular, projects to a lower level. When, however, the femur is in its natural oblique position the lower surfaces of the two condyles lie practically in the same horizontal plane. The condyles are not quite parallel with one another; the long axis of the lateral is almost directly antero-posterior, but that of the medial runs backward and medialward. Their opposed surfaces are small, rough, and concave, and form the walls of the intercondyloid fossa. This fossa is limited above by a ridge, the intercondyloid line, and below by the central part of the posterior margin of the patellar surface. The posterior cruciate ligament of the knee joint is attached to the lower and front part of the medial wall of the fossa and the anterior cruciate ligament to an impression on the upper and back part of its lateral wall.[3]

The articular surface of the lower end of the femur occupies the anterior, inferior, and posterior surfaces of the condyles. Its front part is named the patellar surface and articulates with the patella; it presents a median groove which extends downward to the intercondyloid fossa and two convexities, the lateral of which is broader, more prominent, and extends farther upward than the medial.[3]

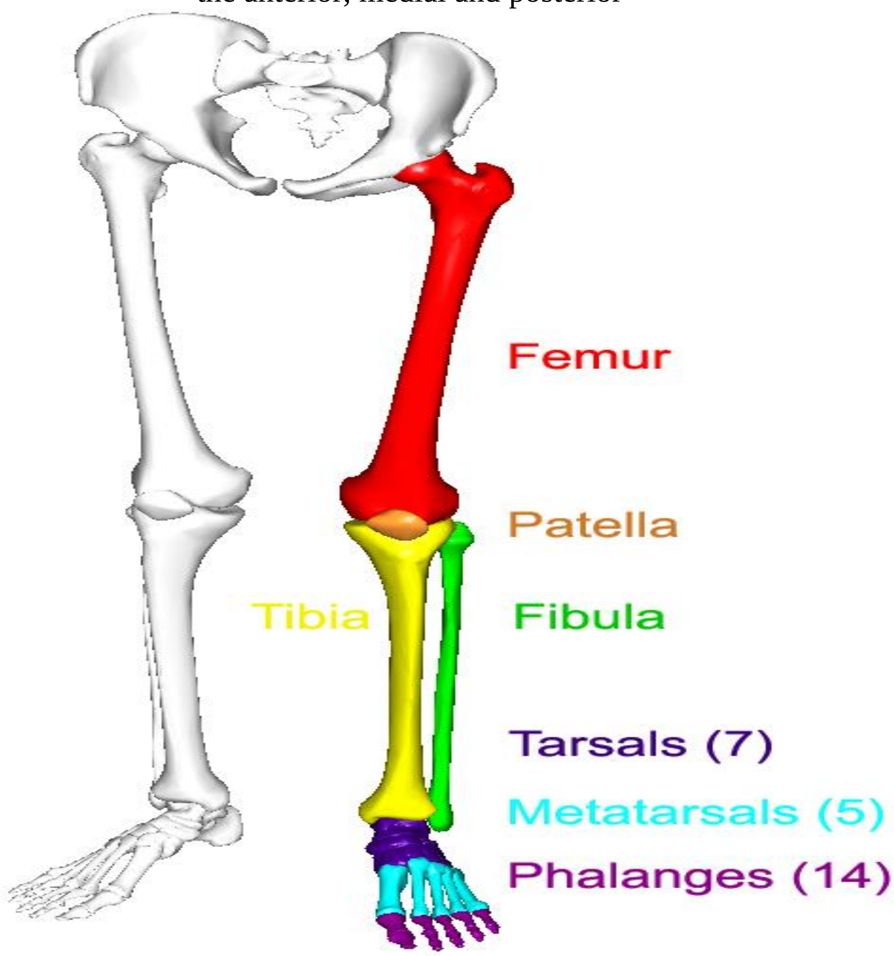
Each condyle is surmounted by an elevation, the epicondyle. The medial epicondyle is a large convex eminence to which the tibial collateral ligament of the knee-joint is attached. At its upper part is the adductor tubercle and behind it is a rough impression which gives origin to the medial head of the gastrocnemius. The lateral epicondyle which is smaller and less prominent than the medial, gives attachment to the fibular collateral ligament of the knee-joint

The femur develops from the limb buds as a result of interactions between the ectoderm and the underlying mesoderm, formation occurs roughly around the fourth week of development.[8]

By the sixth week of development, the first hyaline cartilage model of the femur is formed by chondrocytes. Endochondral ossification begins by the end of the embryonic period and primary ossification centers are present in all long bones of the limbs, including the femur, by the 12th week of development. The hindlimb development lags behind forelimb development by 1–2 days.

As the femur is the only bone in the thigh, it serves as an attachment point for all the muscles that exert their force over the hip and knee joints. Some biarticular muscles – which cross two joints, like the gastrocnemius and plantaris muscles – also originate from the femur. In all, 23 individual muscles either originate from or insert onto the femur.

In cross-section, the thigh is divided up into three separate fascial compartments divided by fascia, each containing muscles. These compartments use the femur as an axis, and are separated by tough connective tissue membranes (or septa). Each of these compartments has its own blood and nerve supply, and contains a different group of muscles. These compartments are named the anterior, medial and posterior fascial



compartments

The **human leg**, in the general word sense, is the entire lower limb[1][2] of the human body, including the foot, thigh and even the hip or gluteal region. However, the definition in human anatomy refers only to the section of the lower limb extending from the knee to the ankle, also known as the **crus**.[3][4][5] Legs are used for standing, and all forms of locomotion including recreational such as dancing, and constitute a significant portion of a person's mass. Female legs generally have greater hip anteversion and tibiofemoral angles, but shorter femur and tibial lengths than those in malesThe major bones of the leg are the femur (thigh bone), tibia (shin bone), and adjacent fibula, and these are all long bones. The patella (kneecap) is the sesamoid bone in front of the knee. Most of the leg skeleton has bony prominences and margins that can be palpated and some serve as anatomical landmarks that define the extent of the leg. These landmarks are the anterior superior iliac spine, the greater trochanter, the superior margin of the medial condyle of tibia, and the medial malleolus.[8] Notable exceptions to palpation are the hip joint, and the neck and body, or shaft of the femur.

Usually, the large joints of the lower limb are aligned in a straight line, which represents the mechanical longitudinal axis of the leg, the Mikulicz line. This line stretches from the hip joint (or more precisely the head of the femur), through the knee joint (the intercondylar eminence of the tibia), and down to the center of the ankle (the ankle mortise, the fork-like grip between the medial and lateral malleoli). In the tibial shaft, the mechanical and anatomical axes coincide, but in the femoral shaft they diverge 6°, resulting in the *femorotibial angle* of 174° in a leg with normal axial alignment. A leg is considered straight when, with the feet brought together, both the medial malleoli of the ankle and the medial condyles of the knee are touching. Divergence from the normal femorotibial angle is called genu varum if the center of the knee joint is lateral to the mechanical axis (intermalleolar distance exceeds 3 cm), and genu valgum if it is medial to the mechanical axis (intercondylar distance exceeds 5 cm). These conditions impose unbalanced loads on the joints and stretching of either the thigh's adductors and abductors.[9]

The angle of inclination formed between the neck and shaft of the femur, (collodiaphysial angle), varies with age—about 150° in the newborn, it gradually decreases to 126–128° in adults, to reach 120° in old age. Pathological changes in this angle results in abnormal posture of the leg: A small angle produces coxa vara and a large angle in coxa valga; the latter is usually combined with genu varum and coxa vara leads genu valgum. Additionally, a line drawn through the femoral neck superimposed on a line drawn through the femoral condyles forms an angle, the *torsion* angle, which makes it possible for flexion movements of the hip joint to be transposed into rotary movements of the femoral head. Abnormally increased torsion angles results in a limb turned inward and a decreased angle in a limb turned outward; both cases resulting in a reduced range of a persons mobility

The feet are flexible structures of bones, joints, muscles, and soft tissues that let us stand upright and perform activities like walking, running, and jumping. The feet are divided into three sections:

- The forefoot contains the five toes (phalanges) and the five longer bones (metatarsals).

- The midfoot is a pyramid-like collection of bones that form the arches of the feet. These include the three cuneiform bones, the cuboid bone, and the navicular bone.
- The hindfoot forms the heel and ankle. The talus bone supports the leg bones (tibia and fibula), forming the ankle. The calcaneus (heel bone) is the largest bone in the foot.

Muscles, tendons, and ligaments run along the surfaces of the feet, allowing the complex movements needed for motion and balance. The Achilles tendon connects the heel to the calf muscle and is essential for running, jumping, and standing on the toes.

Feet Conditions

- Plantar fasciitis: Inflammation in the plantar fascia ligament along the bottom of the foot. Pain in the heel and arch, worst in the morning, are symptoms.
- Osteoarthritis of the feet: Age and wear and tear cause the cartilage in the feet to wear out. Pain, swelling, and deformity in the feet are symptoms of osteoarthritis.
- Gout: An inflammatory condition in which crystals periodically deposit in joints, causing severe pain and swelling. The big toe is often affected by gout.
- Athlete's foot: A fungal infection of the feet, causing dry, flaking, red, and irritated skin. Daily washing and keeping the feet dry can prevent athlete's foot.
- Rheumatoid arthritis: An autoimmune form of arthritis that causes inflammation and joint damage. Joints in the feet, ankle, and toes may be affected by rheumatoid arthritis.
- Bunions (hallux valgus): A bony prominence next to the base of the big toe that may cause the big toe to turn inward. Bunions may occur in anyone, but are often caused by heredity or ill-fitting footwear.
- Achilles tendon injury: Pain in the back of the heel may suggest a problem with the Achilles tendon. The injury can be sudden or a nagging daily pain (tendinitis).
- Diabetic foot infection: People with diabetes are vulnerable to infections of the feet, which can be more severe than they appear. People with diabetes should examine their feet daily for any injury or signs of developing infection such as redness, warmth, swelling, and pain.
- Swollen feet (edema): A small amount of swelling in the feet can be normal after prolonged standing and common in people with varicose veins. Feet edema can also be a sign of heart, kidney, or liver problems.
- Calluses: A buildup of tough skin over an area of frequent friction or pressure on the feet. Calluses usually develop on the balls of the feet or the heels and may be uncomfortable or painful.
- Corns: Like calluses, corns consist of excessive tough skin buildup at areas of excessive pressure on the feet. Corns typically have a cone shape with a point, and can be painful.
- Heel spurs: An abnormal growth of bone in the heel, which may cause severe pain during walking or standing. People with plantar fasciitis, flat feet, or high arches are more likely to develop heel spurs.
- Ingrown toenails: One or both sides of a toenail may grow into the skin. Ingrown toenails may be painful or lead to infections.
- Fallen arches (flat feet): The arches of the feet flatten during standing or walking, potentially causing other feet problems. Flat feet can be corrected with shoe inserts (orthotics), if necessary.
- Nail fungal infection (onychomycosis): Fungus creates discoloration or a crumbling texture in the fingernails or toenails. Nail infections can be difficult to treat.
- Mallet toes: The joint in the middle of a toe may become unable to straighten, causing the toe to point down. Irritation and other feet problems may develop without special footwear to accommodate the mallet toe.
- Metatarsalgia: Pain and inflammation in the ball of the foot. Strenuous activity or ill-fitting shoes are the usual causes.

- Claw toes: Abnormal contraction of the toe joints, causing a claw-like appearance. Claw toe can be painful and usually requires a change in footwear.
- Fracture: The metatarsal bones are the most frequently broken bones in the feet, either from injury or repetitive use. Pain, swelling, redness, and bruising may be signs of a fracture.
- Plantar wart: A viral infection in the sole of the foot that can form a callus with a central dark spot. Plantar warts can be painful and difficult to treat.
- Morton's neuroma: A growth consisting of nerve tissue often between the third and fourth toes. A neuroma may cause pain, numbness, and burning and often improves with a change in footwear.

Skull Base Anatomy—Anterior and Middle Skull Base

The skull base has two surfaces:

Endocranial (inner): the floor of the cranial cavity, on which the brain rests (Fig. 2.1).

Exocranial (external) surface (Fig. 2.2).

- The bones, which form the skull base, are the frontal, sphenoid, ethmoid, temporal, and occipital bones (the anterior part of the exocranial surface is also formed by the zygomatic, maxillary, and palatine bones).
- The inner surface of the skull base can be divided into three transverse parts (anterior, middle, and posterior fossae) (Fig. 2.3a) and in three sagittal parts (central and lateral parts) (Fig. 2.3b).
- The median part of the anterior skull base covers the upper nasal cavity and the sphenoid sinus; the middle part contains the cavernous sinuses laterally, which house the carotid arteries (parasellar compartments); the posterior part includes the clivus, which reaches the anterior margin of the great occipital foramen.

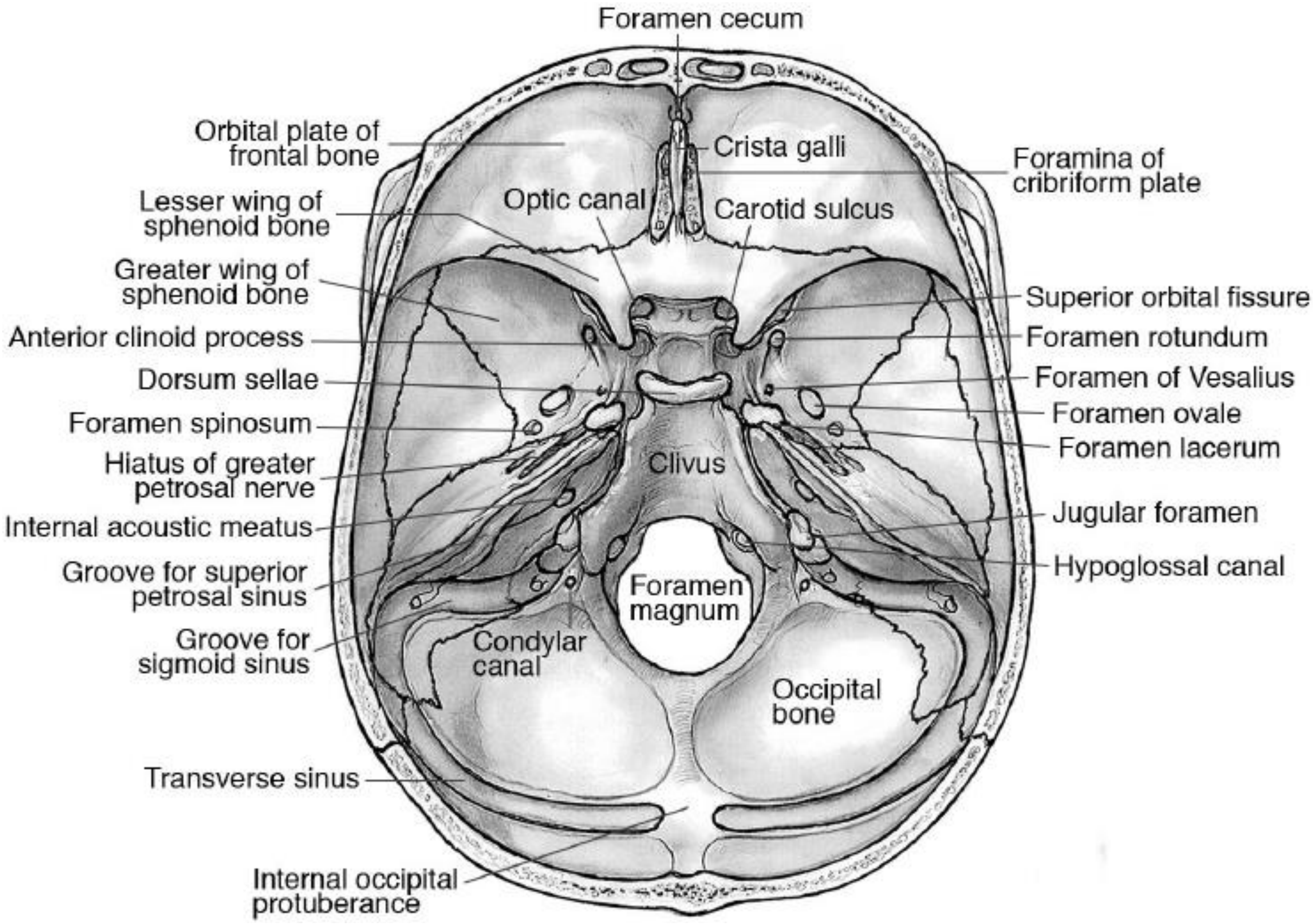


Fig. 2.1 Endocranial surface of the skull base.

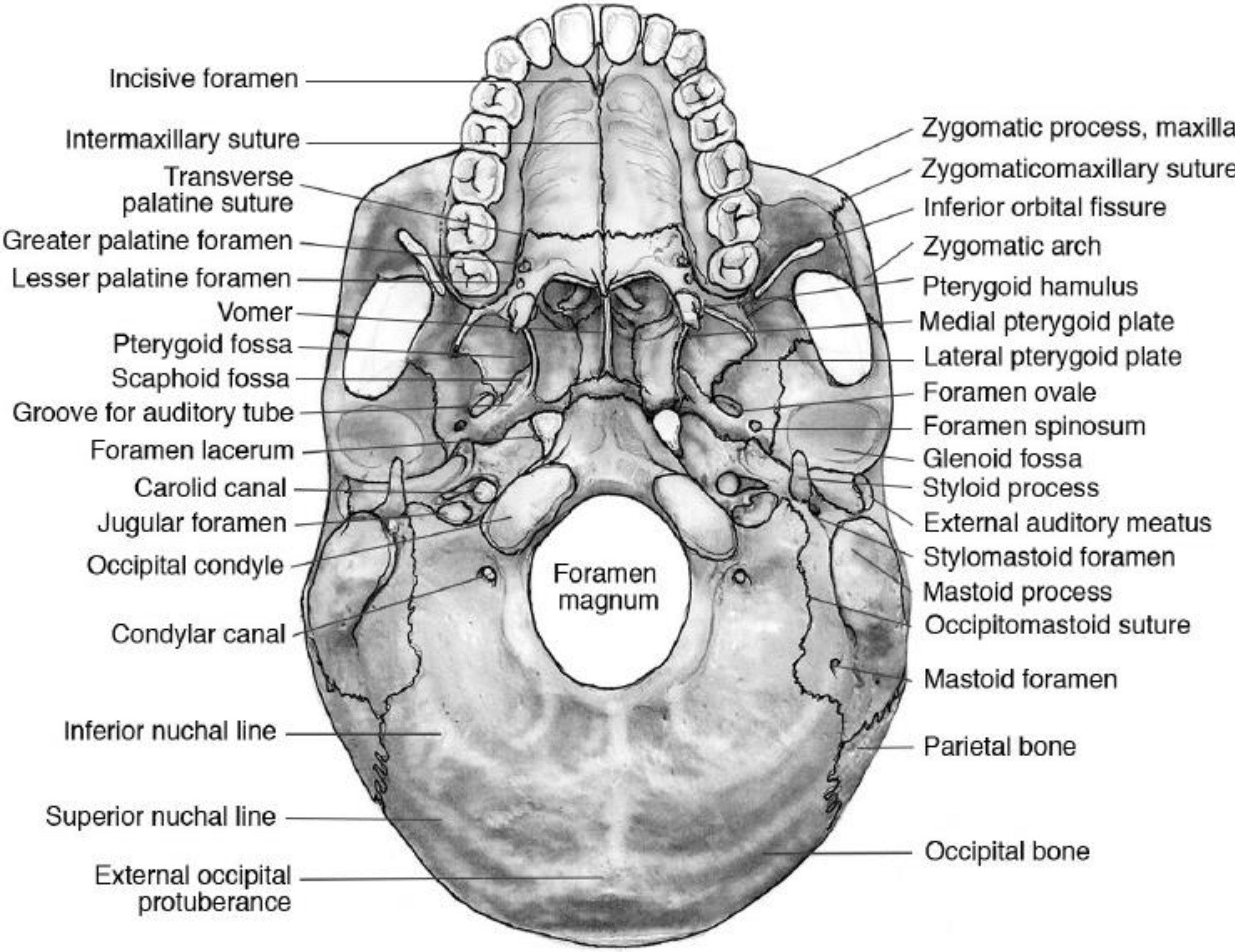


Fig. 2.2 Exocranial surface of the skull base.

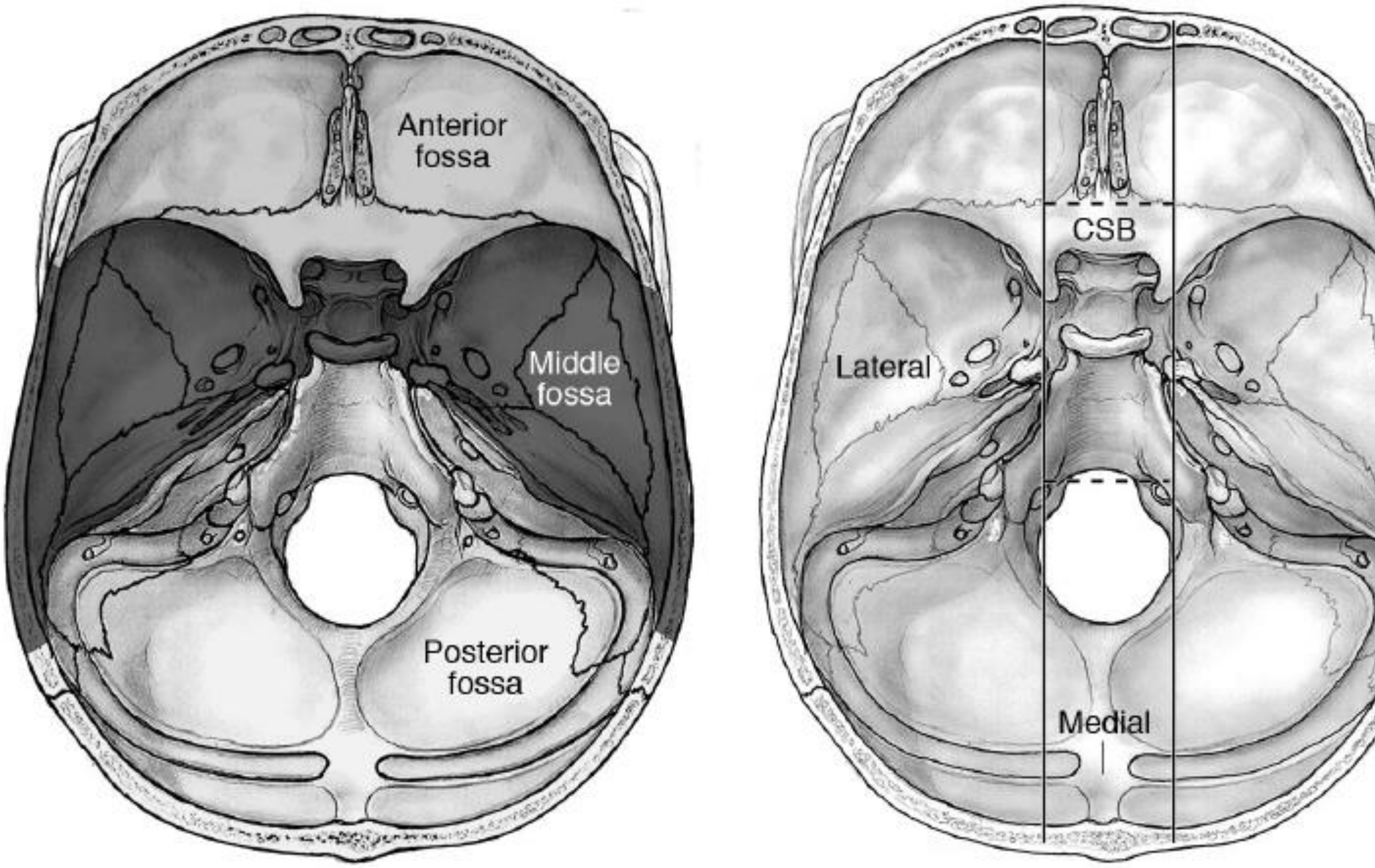


Fig. 2.3a,b (a) Skull base: anterior, middle, and posterior cranial fossae. (b) Lateral and median regions. CSB, central skull base (see also Fig. 5.7 on page 114).

Osteology of the Cranial Fossae

- Anterior skull base: formed by one ethmoidal, two frontal, and one sphenoid bones. The anterior skull base (ASB) is delimited anteriorly by the frontal bone and the posterior wall of the frontal sinus, and posteriorly by the lesser wings of the sphenoid bone. The lateral parts of the anterior skull base form the roof of the orbits, on which the frontal lobes of the brain lie. The median (central) part is formed by the crista galli, the cribriform plate of the ethmoid bone, and the planum of the sphenoid bone.
- Middle skull base: formed by one sphenoid and two temporal bones. The middle skull base (MSB) is delimited anteriorly by the lesser wings of the sphenoid bones, and posteriorly by the surface of the petrous part of the temporal bone. The temporal lobe lies in the middle cranial fossa. The central part of the middle cranial fossa is defined as the sella turcica (part of the sphenoid bone).

The sellar compartment contains the hypophysis. It is separated from the suprasellar compartment (brain) by a meningeal sheet, the diaphragma sellae, which has an opening at the center called the ostium of the diaphragma sellae. The pituitary stalk crosses through this opening. The lateral parts of the sellar compartments are defined as “parasellar compartments.” This is the location of the cavernous sinus, which is crossed by the cranial nerve (CN) VI and the internal carotid artery (ICA). The lateral wall of the cavernous sinus is also lined by CN III, IV, V_1, and V_2.

Surgical Anatomy Pearl

For each skull base foramen, it is very important to remember its neurovascular relationships. Tables 2.1 and 2.2 summarize the foramina of the endocranial surface and the exocranial surface of the skull base with its contents, respectively. Table 2.3 summarizes the foramina and other structures visible on the splanchnocranium (Fig. 2.4).

- Posterior skull base: formed by the occipital and temporal bones. This fossa is delimited anteriorly by the posterior walls of the petrous bone and posteriorly by the grooves for the transverse sinuses. It contains the foramen magnum, in which the medulla oblongata continues downward into the spinal cord.

Sellar and Parasellar Compartments

- The pituitary fossa is in the central part of the sphenoid bone, at the center of the skull. The sellar region is delimitated anteriorly by the jugum sphenoidale, which is the most posterior border of the planum sphenoidale, anterolaterally by the extension of the lesser sphenoid wings (anterior clinoid processes, ACPs), laterally by the greater sphenoid wings, posterolaterally by the posterior clinoid processes (PCPs) and petrous apex, and posteriorly by the clivus.
- The ACP forms the anterolateral bony protuberance; the optic canal runs medial to it. The optic strut is the medial attachment of the ACP, forming part of the optic canal and separating the carotid sulcus from the optic canal.
- The portion of the ICA passing between the optic strut and the superior surface of the ACP is the clinoidal segment of the ICA.1
- Chiasmatic groove (sulcus): a depression between the tuberculum sellae, the planum sphenoidale, and the optic foramina.
- Anterolaterally to the sella and ACP lie the superior orbital fissures on each side. The cavernous sinus extends from the petrous apex to the superior orbital fissure (SOF).2
- The normal average size of the pituitary fossa is 13 × 17 × 15 mm, with an average volume of 1,100 mm3.

Surgical Anatomy Pearl

An anatomic variant is the presence of the middle clinoid process, which can bridge the ACP. In such a situation, the carotid artery would run through a caroticoclinoid foramen.

Table 2.1 Foramina of the Skull Base: Endocranial Surface and Its Contents

Foramen cecum	Emissary vein from the superior sagittal sinus to frontal sinus and nose; eventually anterior falcine artery
Foramina of the cribriform plate	Olfactory nerve bundles from the nasal mucosa to the olfactory bulb
Anterior, middle (variable), and posterior ethmoidal foramina	Anterior, middle (whenever present the middle foramina) and posterior ethmoid arteries and veins
Optic canal	CN II and ophthalmic artery
Superior orbital fissure	CNs III, IV, VI, V_1, superior and inferior ophthalmic veins, orbital branches of the MMA, sympathetic fibers (that enter mainly with nasociliary nerve), parasymphathetic fibers (entering with CN III)
Inferior orbital fissure	Venous channels connecting orbital venous system with pterygoid plexus, small nameless arterial branches, branches from pterygo palatine ganglion and zygomatic nerve from infraorbital nerve
Foramen rotundum	CN V_2, accompanied by some emissary veins and an arterious branch from the internal maxillary artery
Foramen ovale	CN V_3, lesser superficial petrosal nerve, accessory meningeal artery branch from the maxillary artery
Foramen spinosum	Middle meningeal artery and vein, meningeal recurrent branch of V_3
Foramen lacerum	Meningeal branches from the ascending pharyngeal artery, as well as the nerve of pterygoid canal, cartilage
Vidian canal	Vidian nerve (formed by the GSPN and the deep petrosal nerve), veins, and two arteries
Hiatus for greater petrosal foramen	Greater superior petrosal nerve

Hiatus for lesser petrosal nerve	Lesser superior petrosal nerve
Internal acoustic canal	CNs VII–VIII, labyrinthine artery
Jugular foramen	CNs IX, X, XI, convergence of inferior petrosal sinus and sigmoid sinus into the internal jugular vein, Jacobson's nerve (tympanic branch of CN IX), Arnold's nerve (auricular branch of CN X), posterior meningeal artery (from the VA)
Hypoglossal canal	CN XII with meningeal artery
Foramen magnum	Medulla oblongata, vertebral arteries, spinal roots of CN XI, anterior spinal artery, posterior spinal arteries, and posterior meningeal arteries

Abbreviations: CN, cranial nerve; GSPN, greater superficial petrosal nerve; MMA, middle meningeal artery; VA, vertebral artery.

Table 2.2 Foramina of the Exocranial Surface of the Skull Base

Carotid canal	ICA surrounded by the sympathetic plexus
Greater palatine foramen	Greater palatine nerve (from V_2) and vessels
Lesser palatine foramen	Lesser palatine nerve (from V_2) and vessels
Sphenopalatine foramen	Nasopalatine nerve (from V_2), nasal nerve (from V_2), sphenopalatine artery
Stylomastoid foramen	CN VII
Foramen magnum	See Table 2.1
Petrotympanic fissure	Anterior tympanic branch of the internal maxillary artery

Abbreviation: ICA, internal carotid artery.

Table 2.3 Foramina of the Splanchnocranium

Supraorbital foramen/incisura	Supraorbital nerve (from V_1), supraorbital vein and artery
Infraorbital canal and foramen	Infraorbital nerve (from V_2), infraorbital vein and artery
Zygomaticotemporal foramen	Zygomaticotemporal nerve and vessels
Zygomaticofacial foramen	Zygomaticofacial nerve and vessels
Incisive foramen	Nasopalatine nerve (from V_2) and vessels
Mandibular foramen	Inferior alveolar nerve (from V_3)
Mental foramen	Mental nerve (from V_3)

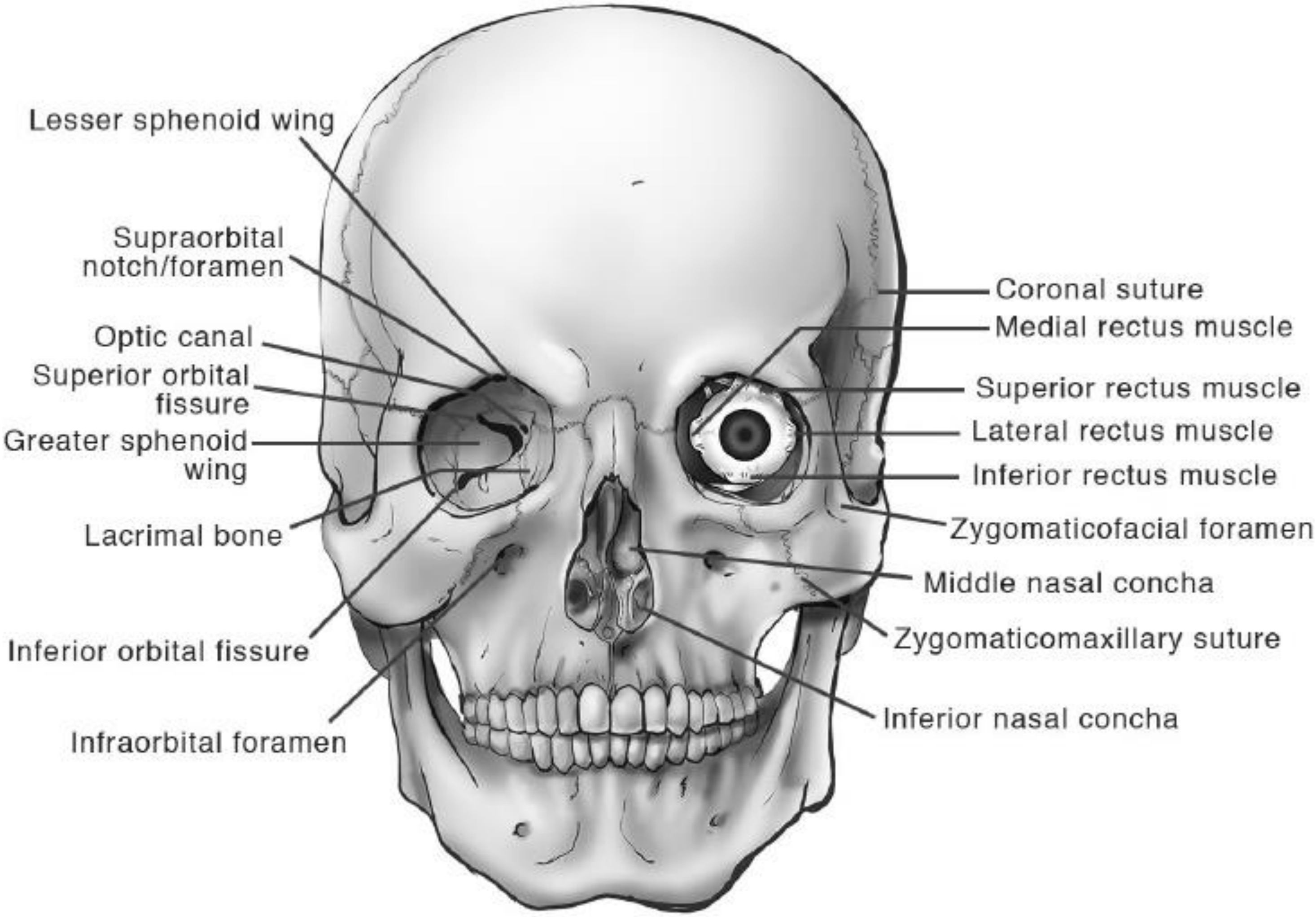


Fig. 2.4 Anatomic structures of the splanchnocranium and orbits.

Parasellar Region

The parasellar region encompasses the anatomic compartments around the sella:

Parasellar compartments: cavernous sinuses

Suprasellar compartment: region above the diaphragma sella, with the suprasellar cistern and its contents

Retrosellar compartment: clivus

- The pituitary fossa contains the pituitary gland. The pituitary gland is formed by an anterior part (adenohypophysis), a more orange-colored posterior lobe (neurohypophysis), and an often cystic intermediate lobe.
  - The anterior lobe forms the pars tuberalis at the lower part of the pituitary stalk.
  - The inferior surface of the gland conforms to the shape of the sellar floor.
  - The superior part can be more flat or concave around the stalk. The stalk crosses the diaphragma into the ostium of the diaphragma sellae.

Cavernous Sinuses

The cavernous sinuses are lateral to the sphenoid sinus, sella turcica, and pituitary gland (Fig. 2.5). Each cavernous sinus sits in the central aspect of the middle fossa and is lateral to the sella.

- Cavernous sinus (CS) is the historical definition of the lateral sellar compartment; it is part of the extradural neural axis compartment (EDNAC), which extends from the coccyx to the orbit.2 The name incorrectly suggests that the CS is a “sinus,” but it is not a sinus like the superior sagittal sinus; rather, it is a multiloculated network of lacunae on the lateral compartment of the sellar region.

- The CS is one component of the basal venous system, which consists of a valveless network of interconnected venous channels. Should an obstruction occur in one region, venous flow can decant into a collateral system and so allow venous drainage. These veins include anterior and posterior intercavernous sinuses, the petroclival plexus, the superior and inferior ophthalmic veins, the sphenoparietal sinus, the superior and inferior petrosal sinuses, a variety of emissary veins that can enlarge in the event of occlusion, and some variable veins from the brain (e.g., *vena Vasaliana*).

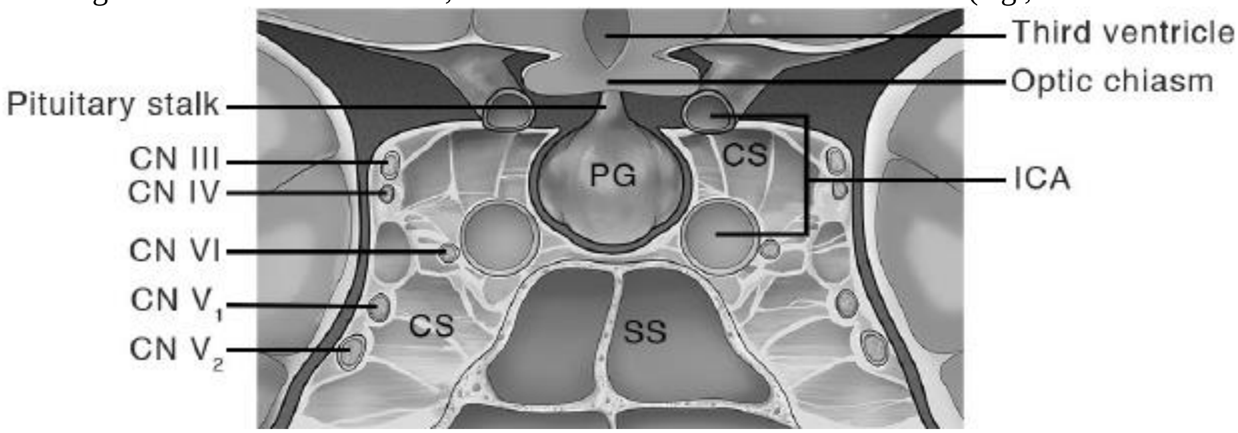


Fig. 2.5 Cavernous sinus (CS), coronal section. ICA, internal carotid artery; SS, sphenoidal sinus.

Anatomic Boundaries: Dural Layers of the Cavernous Sinus

- Lateral wall: A double layer of dural mater, the outer layer is continuous with the internal layer of the dura of the middle cranial fossa and tentorium, whereas the inner layer of the lateral wall is formed by the epineurium of CNs III, IV, and V. The outer layer of the middle fossa dura separates at the lateral margin of the cavernous sinus to continue as the periosteum and to form the floor and medial wall of the cavernous sinus. There is a cleavage plane between the medial and lateral layers, which may be dissected without entering the venous compartment of the CS[3] (see Chapter 21).
- Medial wall: layer of dura/periosteum.
- Roof: The third or distal ring of dura around the ICA forms the carotico-oculomotor membrane.[4,5] The clinoid and carotid triangles are part of the roof as well. The roof of the CS has the shape of a trapezium, extending from the diaphragma sellae medially, to the anterior petroclinoid ligament laterally, from the base of the anterior clinoid process anteriorly, and to the posterior petroclinoid ligament posteriorly.[3] It provides a base for the cistern of the CN III.
- Posterior wall: dura of the clivus.
- Contents of the double layer of the lateral wall: CNs III and IV and the branches of the trigeminal nerve run within the double layer.
- Contents of the cavernous sinus: venous lacunae, CN VI, fat, cavernous ICA surrounded by sympathetic plexus, with its branches:
  - Meningohypophyseal trunk: Branches of this trunk are variable, but in pure form consist of the tentorial artery (also known as the artery of Bernasconi-Cassinari), dorsal meningeal artery (also known as the clival artery), and the inferior hypophyseal artery.
  - Inferolateral trunk: branches supplying the intracavernous nerves.
  - Capsular artery: McConnel's artery, present in 30% of cases.[6,7]
  - Ophthalmic artery: generally extracavernous, but in 3 to 8% it originates from the infraclinoidal segment of the ICA.[8]

Cranial nerve VI runs from the posterior part of the CS, passing through the Dorello canal, medially to the Meckel's cave and medial to the trigeminal root,[9] to the SOF, medial and superior to V_1.

Triangles of the Skull Base

Specific anatomic landmarks create triangular-shaped corridors, which are useful in understanding the anatomy of the region and in planning/performing surgical approaches. Quantitative studies have shown size and shape variants of the triangles, but it should be emphasized that the normal geometry and shape of these spaces may be distorted by pathology or during surgery.[10,11] Different authors describe different triangles, so a lack of uniform nomenclature often impairs communication and limits the usefulness of these triangle terms in the anatomy of this region. Anatomic landmarks of such triangles are described in Table 2.4[10–21] and demonstrated in Fig. 2.6. According to Dolenc,[18,20] there are 10 triangles in three subregions of the skull base:

- Parasellar subregion: anteromedial triangle, paramedial triangle, oculomotor trigone, Parkinson's triangle
- Middle cranial fossa subregion: anterolateral triangle, lateral triangle, posterolateral (also called Glasscock's triangle), posteromedial (also called Kawase's triangle)
- Paraclival subregion: inferomedial triangle, inferolateral (trigeminal triangle)

2.2 Temporal Bone Anatomy

The temporal bone is a complex structure that contributes to the cranial cavity, the sensory organs of hearing and vestibular balance, the temporomandibular joint (TMJ), and provides an intraosseous pathway for CNs VII and VIII. It connects with the parietal, occipital, sphenoid, and zygomatic bones.

Osteology

There are four distinct bony components based on the embryological development of the temporal bone:

- Squamous: contributes to the lateral wall of the middle fossa and has an anterior projection of bone called the zygomatic process that articulates with the zygomatic bone.
  - Inferior surface of the zygomatic root forms an articulating surface of the TMJ called the glenoid fossa.
  - Surgical landmark: temporal line or crest, a horizontal ridge of bone along the inferior-most aspect of the origin of the temporalis muscle, which signifies the level of the floor of the middle cranial fossa (approximately 5 mm). The spine of Henle is the suprameatal bony prominence located at the posterosuperior margin of the external acoustic meatus.

Table 2.4 Triangles of the Skull Base[10–21]

Definition/Position*	Borders	Contents
Parasellar Triangles		
Clinoidal (anteromedial)	1. Lateral border of the extradural CN II 2. Medial border of the CN III 3. Tentorial edge, with the posterior border on the dural ring	1. Clinoidal ICA (identifiable after ACP removal) 2. Venous channels of the anteromedial CS 3. Proximal dural ring Note: Exposure of this triangle requires extradural ACP removal
Supratrochlear (or paramedial, or superior)	1. CN III 2. CN IV 3. Tentorial edge (dura between the entry point of the CNs III and IV)	1. Horizontal segment of the intracavernous ICA 2. MHT 3. Inferolateral trunk branches 4. CN VI (proximal segment)
Oculomotor (or medial)	1. Anterior petroclinoid dural fold 2. Posterior petroclinoid dural fold 3. Interclinoid dural fold	1. CN III (from the porus oculomotorius) 2. Proximal siphon, horizontal segment of ICA
Infratrochlear Parkinson's triangle	1. CN IV 2. CN V_1 3. Tentorial edge and anterior clival dura	1. Horizontal segment of the cavernous ICA 2. MHT 3. CN VI 4. Sympathetic fibers Note: Originally described as the main entry access to the CS
Middle Fossa Triangles		

Definition/Position*	Borders	Contents
Anteromedial14 Anterolateral18	1. CN V_1 2. CN V_2 (the apex of these two sides is on the GG) 3. A line connecting the SOF and the FR	1. Dura and floor of the MSB 2. Venous trabecular channels of the inferolateral CS 3. Superior ophthalmic vein 4. CN VI Note: Opening the floor of the triangle may lead into the sphenoid sinus
Anterolateral[14] Lateral loop18 Far lateral17	1. CN V_2 (anteromedial border) 2. CN V_3 (posterior side) 3. A line connecting the FR with the FO	1. Lateral sphenoid wing 2. Sphenoid emissary vein 3. Cavernous-pterygoid venous anastomosis
Posterolateral Glasscock’s triangle	1. CN V_3 2. GSPN 3. A line between the FS and the arcuate eminence	1. FS 2. Posterior loop and horizontal petrous segment of the ICA 3. Labyrinthine branch of the MMA 4. GSPN and LSPN ✖ The opening of this triangular space, by drilling from the FS and medially along the posterior margin of CN V_3, exposes the horizontal intrapetrous ICA
Posteromedial Kawase’s triangle Rhomboid area	1. Posterior border of the GG, CN V_3 2. GSPN 3. A line connecting the hiatus of the GSPN and the posterior aspect of the CN V, approximately at the arcuate eminence Note: The most posterior aspect of this triangle is the superior petrosal sinus	1. Petrous Apex 2. Posterior edge of the petrous ICA 3. Cochlea (laterally) Note: Bone removal from this area leads to anterior petrosectomy (Kawase approach); it connects the middle and posterior cranial fossae
Posterior Fossa Triangles		
Inferomedial paraclival (or posteroinferior)17,18,21	1. Posterior dural fold of the dural entry of CN IV under the tentorium 2. A line from the dural entries of the CN VI and PCP 3. Petrous apex	1. Porous abducens (dural opening into Dorello’s canal, where the CN VI enters the CS) 2. Gruber’s ligament (posterior petroclinoid fold) 3. Basilar venous plexus
Trigeminal (inferolateral paraclival)18	1. Line between the entry point of the CN IV and VI 2. Line between the entry point of the CN VI and the superior petrosal vein, below the trigeminal nerve 3. Line between the entry point of the CN IV and the entry point of the petrosal vein into the SPV	The superior part of the trigeminal triangle is the tentorial part, where the petrous vein enters the superior petrosal vein, while the inferior part (osseous triangle) represents the posterior extension of Kawase’s triangle in the MSB

Definition/Position*	Borders	Contents
Premeatal21	1. Medial lip of the IAC 2. Carotid genu 3. Geniculate ganglion	1. Cochlea
Postmeatal21	1. Geniculate ganglion 2. Lateral lip of the IAC 3. Intersection of the arcuate eminence with the petrous ridge	1. IAC Note: It defines the bone between the SSC and the IAC

Abbreviations: CS, cavernous sinus; FO, foramen ovale; FR, foramen rotundum; FS, foramen spinosum; GG, Gasser ganglion; GSPN, greater superficial petrosal nerve; IAC, internal auditory canal; ICA, internal carotid artery; LSPN, lesser superficial petrosal nerve; MHT, meningohypophyseal trunk; MMA, middle meningeal artery; MSB, middle skull base; PCP, posterior clinoid process; SOF, superior orbital fissure; SPV, superior petrosal vein; SSC, superior semicircular canal.

*Some definitions vary, according to different authors

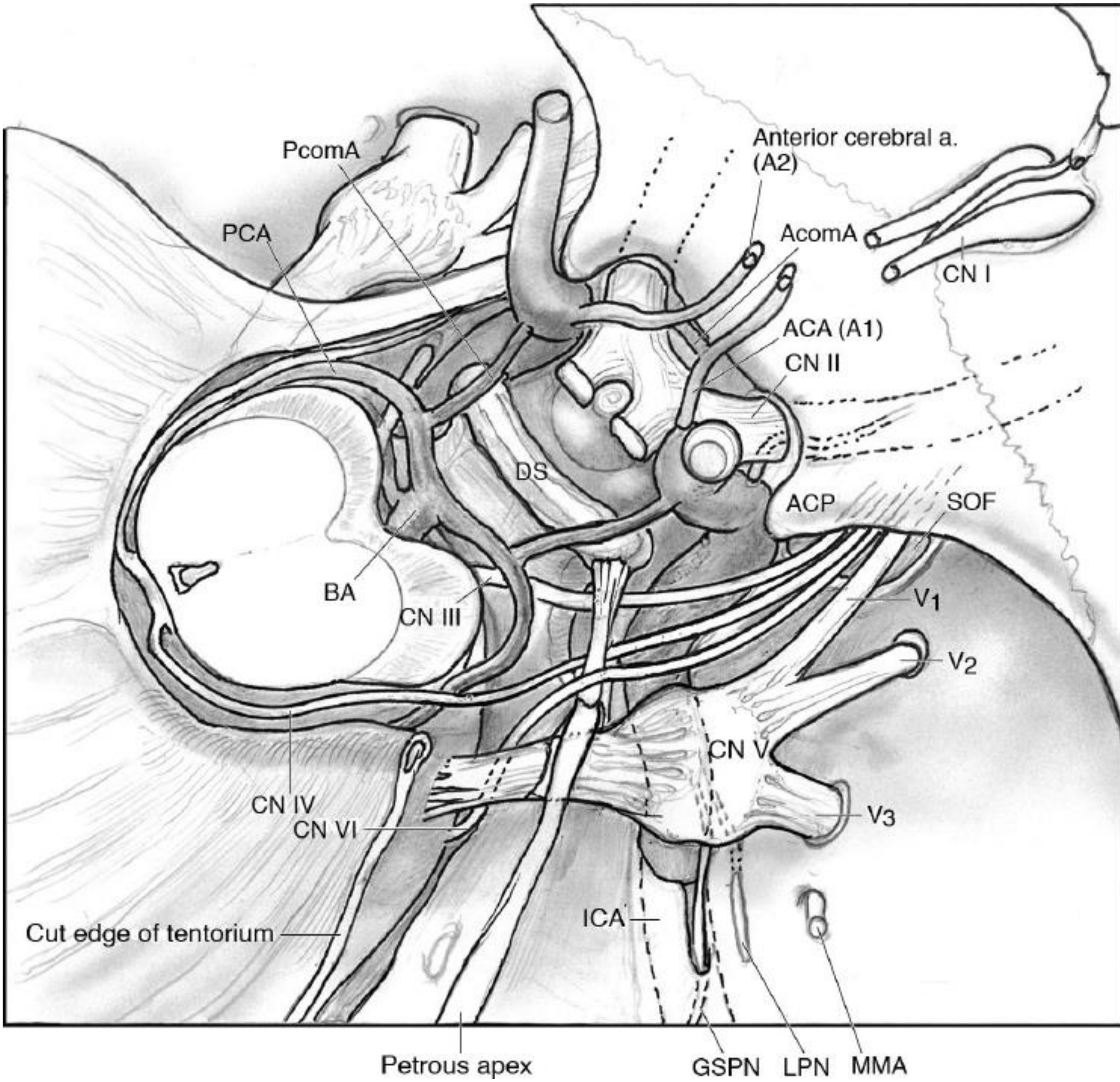


Fig. 2.6 Anatomic landmarks of the parasellar region. Compare the anatomic landmarks with the description of the skull base triangles in Table 2.4. ACA, anterior cerebral artery; AcomA, anterior communicating artery; ACP, anterior clinoid process; BA, basilar artery; CN, cranial nerve; DS, dorsum sellae; GSPN, greater superficial petrosal nerve; ICA, internal carotid artery; LPN, lesser petrosal nerve; MMA, middle meningeal artery; PcomA, posterior communicating artery; PCA, posterior cerebral artery; SOF, superior orbital fissure.

- Mastoid: a variably pneumatized bulbous bone (in the adult), the pneumatized cells of which are in direct communication with the middle ear via the aditus ad antrum (orifice of the mastoid antrum into the epitympanic recess).

    - Koerner septum: Formed by the petrosquamous lamina, it is a thin bony septum that travels posteriorly from the epitympanum, separating the mastoid cavity into medial and lateral compartments.
    - Muscular attachments:
        - Sternocleidomastoid at the mastoid tip.
        - Posterior belly of the digastric muscle at a sulcus just posterior to the stylomastoid foramen, often called the “digastric groove.”
- Tympanic: forms approximately three quarters of the bony external auditory canal in the adult (anterior wall, floor, and part of the posterior wall and roof).
    - Surgical landmark: tympanomastoid suture line—the landmark for the exocranial facial nerve as the line curves inferiorly from the external auditory canal (EAC) in close proximity with the stylomastoid foramen.
    - Anatomic landmark: petrotympanic suture—the chorda tympani exits from its intraosseous course through the suture/fissure.
- Petrous: forms the substrate of the middle and inner ear (Fig. 2.7) and has numerous surface landmarks as follows:
    - Styloid process: a long bony process, 18 to 51 mm in length, that serves as an attachment point for muscles (stylohyoid, styloglossus, stylopharyngeus) and ligaments (stylohyoid, stylomandibular).22

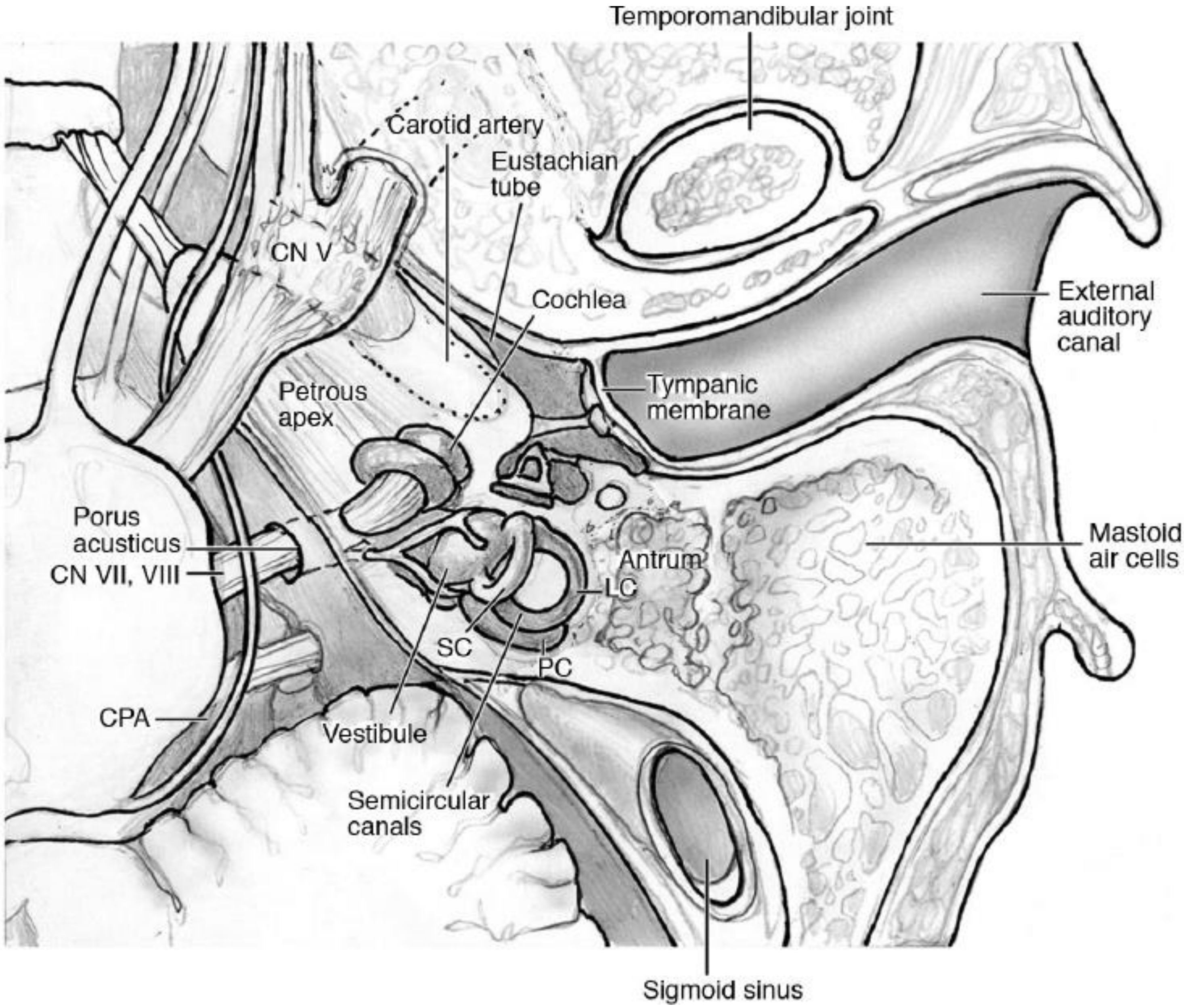


Fig. 2.7 Representation of the axial section of the petrous bone, showing the anatomic relationships with the middle fossa and cerebellopontine angle (CPA). Semicircular canals: SC, superior canal; PC, posterior canal; LC, lateral canal.

    - Located anterior to the stylomastoid foramen (exit point of the facial nerve).
- Jugular fossa: Located medial to the styloid process and inferior to the middle ear cavity, the fossa is occupied by the internal jugular vein and nerves.
- Carotid canal: located directly anterior to the jugular fossa but is separated by a small wedge of bone. In the horizontal segment, the bone can be nonexistent on the superior surface.
- Sigmoid sulcus: The sulcus of the sigmoid sinus lies on the posterior intracranial surface and along the anterior limit of the posterior fossa.
- Arcuate eminence: Located superomedially on the intracranial surface, it signifies the superior semicircular canal, lateral to which is the roof of the middle ear and mastoid.
- Subarcuate fossa: situated superiorly and just posterior to the IAC and sometimes transmits the subarcuate artery.
- Depression of the trigeminal nerve (pars compacta): located on the superior surface of the petrous apex.

- Internal auditory canal (IAC): located on the medial aspect of the petrous portion. The medial opening is termed the *porus acusticus internus*, whereas the lateral end is termed the *fundus.*
  - The fundus is divided into an upper and lower part by the horizontal crest (Fig. 2.8). The upper part is divided in two quadrants by a vertical bar ("Bill's bar"). Considering four quadrants of the fundus (but anatomically the two lower ones are not separated by any bony structures), their contents are:
    - Anterosuperior: facial and intermedius nerves
    - Anteroinferior: cochlear division of CN VIII

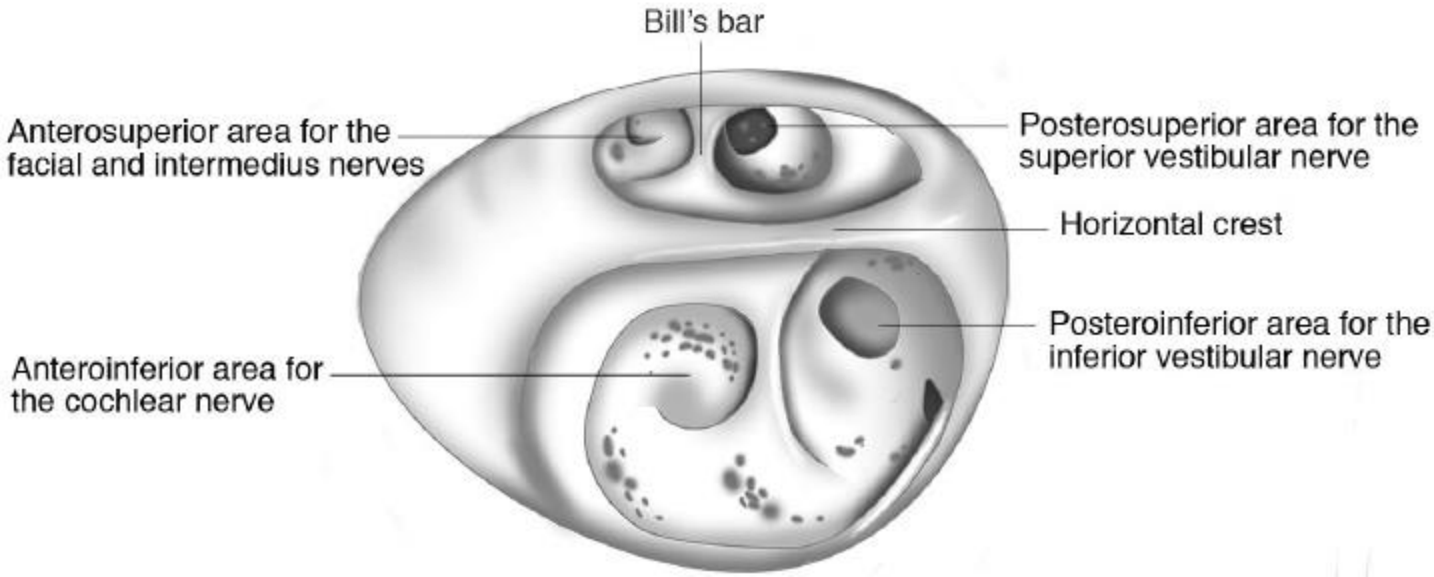


Fig. 2.8 Fundus of the internal auditory canal (IAC), right side. (Adapted from Koos WT, Matula C, Lang J. Color Atlas of Microneurosurgery of Acoustic Neurinomas. New York: Thieme; 2002.)

    - Posterosuperior: superior vestibular division of CN VIII
    - Posteroinferior: inferior vestibular division of CN VIII
- Groove of the endolymphatic duct: located posterolateral to the IAC within the posterior fossa and houses the endolymphatic duct and sac.

The Ear

- External ear: includes the auricle, the EAC, and the tympanic membrane.
  - EAC: in adults, lateral one third is fibrocartilage; medial two thirds are bony, composed of the tympanic portion (anterior wall, floor, and part of the posterior wall and roof) and the mastoid portion of the temporal bone (remainder of the posterior wall and roof).
  - Tympanic membrane (TM): typically measures 10 mm in size and is anchored to the EAC via the tympanic sulcus.
- Middle ear: an air-filled, mucous membrane–lined cavity containing the ossicles. The middle ear directly communicates with the mastoid cavity via the aditus ad antrum posteriorly, and the nasopharynx via the pharyngotympanic tube anteriorly.
  - Boundaries:
    - Anterior: pharyngotympanic tube (eustachian tube)
    - Posterior: mastoid cavity
    - Medial: otic capsule and promontory
    - Lateral: tympanic membrane
    - Superior: tegmen tympani (thin layer of bone separating the contents of the middle cranial fossa from the middle ear)
    - Inferior: jugular wall (floor)
  - Divisions of the middle ear23,24
    - Epitympanum: also referred to as the attic and is the area superior to the level of the TM. The epitympanum communicates with the mastoid cavity via the aditus ad antrum

        - Prussak's space (superior recess): important region in acquired cholesteatoma.
            - Subtended by the *scutum* and *pars flaccida* laterally, the neck of the malleus medially, and the lateral malleolar ligament superiorly.
    - Mesotympanum: The area at the level of the TM and houses the majority of the ossicular chain.
        - Ossicles: responsible for conductive hearing within the middle ear and amplify oscillations between the TM and the oval window.
            - Malleus: composed of a head (articulates with incus), neck, anterior process, lateral process, and manubrium (attached to the TM).
            - Incus: composed of a body (articulates with malleus), short process, long process, and lenticular process (articulates with stapes).
        - Stapes: composed of head/capitellum (articulates with incus), an anterior and posterior crus, and a footplate (attached to the oval window).
        - Suspensory ossicular ligaments: superior, lateral, and posterior malleal, and posterior incudal.
    - Hypotympanum: area inferior to the level of the TM and contains the orifice of the pharyngotympanic tube (eustachian tube).
- Inner ear: consists of the bony labyrinth (otic capsule) and the membranous labyrinth that contains endolymph and is surrounded by perilymph. The bony labyrinth is very dense and represents the hardest bone in the body. The labyrinth consists of continuous subunits including the vestibule and three semicircular canals.
  - Cochlea: Snail-shaped structure that tapers in width from base to apex during its 2½ to 2¾ turns; the basal, middle, and apical turns are separated by interscalar septa.
    - Communicates with the middle ear at the oval window, which is abutted by the stapes footplate, and the round window membrane at the basal end of the cochlea
    - Promontory: bulge of the basal turn of the cochlea that protrudes into the middle ear cavity that is visible on standard otoscopy through the TM.
        - Jacobson's nerve (branch of CN IX) runs over the middle ear surface of the promontory.
    - *Modiolus*: highly porous crown-shaped bone at the core of the cochlea that enables passage of the auditory nerve fibers from the cochlear nerve to the organ of Corti.
    - Cochlear aqueduct: a narrow bony passage that extends from the basal turn of the cochlea to the subarachnoid space in the posterior fossa that enables communication of perilymph and cerebrospinal fluid (CSF).
  - Vestibule: ovoid-shaped structure that is situated posterior to the cochlea but is connected via the *ductus reuniens.*
    - Within the vestibule are two end organs termed maculae, one oriented in the horizontal plane (utricle) and the other in the vertical plane (saccule).
    - Relationships
        - Anterior: cochlea
        - Posterior: mastoid air cells
        - Medial: posterior cranial fossa, into which the endolymphatic duct and sac extend
        - Lateral: middle ear cavity (anterior) and mastoid air cells (posterior)
  - Semicircular canals: three orthogonally oriented semicircular canals that project from the vestibule in a posterosuperior direction. Each semicircular canal has a dilated end, termed the ampulla, containing the receptors. The semicircular canals are the anterior (superior), posterior (dorsal), and horizontal (lateral).
  - The anterior and posterior semicircular canals are vertically oriented and share a common *crus*, which opens into the superomedial part of the vestibule. The horizontal semicircular canal, however, has two separate openings into the vestibule.

Contents

- Musculature: Both the tensor tympani and stapedius muscles contract reflexively in response to loud noises to reduce excessive oscillation at the tympanic membrane and oval window, respectively.

- Stapedius
    - Origin: within the pyramidal eminence (bony structure situated on posterior wall of middle ear)
    - Insertion: head of the stapes
    - Innervation: CN VII
- Tensor tympani
    - Origin: within the superior aspect of the cartilaginous part of the eustachian tube
    - Insertion: following a sharp turn at the terminus of the cochleariform process, inserts on the neck of the malleus
    - Innervation: CN V_3

• Neural Structures
- Sensory organs: anatomy described (see Inner Ear).
    - Cochlea: anatomic structure responsible for the sensation of hearing via the organ of Corti, the primary sensory structure containing both inner and outer hair cells.
    - Utricle and saccule: otolith organs within the vestibule responsible for the sensation of linear acceleration of the head in space.
    - Semicircular canals: three orthogonally oriented structures responsible for vestibular function, specifically for the sense of angular acceleration/velocity (head rotation).
- Auditory and vestibular nerves (CN VIII): course through the IAC from the *porus acusticus* to the *fundus* and abuts the labyrinth.
    - Cochlear nerve: traverses the modiolus to the cochlear end organ, the organ of Corti
    - Superior vestibular nerve: supplies the anterior and horizontal semicircular canals and the utricle
    - Inferior vestibular nerve: supplies the posterior semicircular canal and saccule
- Facial nerve (CN VII) (see Chapter 3, page 83).
- Greater superficial petrosal nerve: originates as the first branch of the facial nerve from the geniculate ganglion and carries presynaptic parasympathetic nerve fibers to the pterygopalatine fossa ganglion.
    - Travels anteriorly and medially within the petrous portion of the temporal bone and emerges on its anterior surface via the hiatus for the greater petrosal nerve.
- *Chorda tympani*: conveys special sensory innervation to the anterior two thirds of the tongue and to the soft palate along with parasympathetic innervation to all salivary glands below the level of the oral fissure.
    - Typically branches from the mastoid segment of the facial nerve just prior to its exit from the skull at the stylomastoid foramen.
    - Ascends through the posterior canaliculus (*canaliculus chordae tympani*), which opens into the middle ear, and then arcs upward to cross the pars flaccida of the TM and passes between the neck of the malleus and the long process of the incus to reach the entrance of the anterior canaliculus (canal of Huguier or Civinini) above the insertion of the *tensor tympani*.
    - The anterior canaliculus runs within the medial part of the petrotympanic fissure and exits into the infratemporal fossa.
- Nerve to stapedius: Innervates the stapedius muscle, as its name implies.
    - Branches early from the mastoid segment of the facial nerve.

• Vascular
- External ear: arterial supply from the following branches of the ECA and venous drainage follows the arteries:
    - Anterior auricular branches of the superficial temporal artery
    - Posterior auricular artery
    - Occipital artery
- Middle ear: primary arterial blood supply from the tympanic branch of the maxillary artery and the mastoid branch of either the posterior auricular or occipital arteries.
    - Other arterial contributions from smaller branches of the following:

        - Artery of the pterygoid canal
        - Ascending pharyngeal artery
        - Middle meningeal artery
        - Tympanic branch of the ICA and rami caroticotympanici, whenever present
    - Venous drainage into the pterygoid plexus and the superior and inferior petrosal sinuses.
- Inner ear: arterial supply is divided into vessels providing blood to the bony labyrinth and the membranous labyrinth, and venous drainage follows the arteries primarily into the inferior petrosal or sigmoid sinuses.
    - Bony
        - Anterior tympanic branch of the maxillary artery
        - Stylomastoid branch of the posterior auricular artery
        - Petrosal branch of the middle meningeal artery
    - Membranous: Supplied by the labyrinthine artery which divides into:
        - Cochlear branch
        - Vestibular branch

2.3 Topographic Anatomy of the Posterior Skull Base

Cerebellopontine Angle

The cerebellopontine angle (CPA) is the anatomic space between the petrous bone and the petrosal cerebellar surface folding around the pons and middle cerebellar peduncle, containing the posterior cranial fossa nerves (Figs. 2.7 and 2.9).[25] The structures in the CPA can be summarized as follows:

- Upper neurovascular complex: formed by the trochlear and trigeminal nerves, superior cerebellar artery (SCA) and its branches, and the petrosal veins complex.
    - The motor root of the trigeminal nerve arises rostral to the sensory root. There are diffuse anastomoses between the sensory and motor component of the nerve, posteriorly to the ganglion of Gasser.
    - The veins of the cerebellopontine fissure draining into the superior petrosal sinus are generally lateral to the trigeminal nerve.
    - The superior petrosal veins drain into the superior petrosal sinus[26,27]: above and lateral to the IAC (type I), between the lateral limit of the trigeminal nerve and the medial limit of the facial nerve at the IAC (type II), and above and medial to Meckel’s cave (type III). Type II is the commonest arrangement, and type III is related to the best outcome in most retrosigmoid approaches that do not need to access regions medial to the entrance to Meckel’s cave.[27]
- Middle neurovascular complex: It includes the pons, middle cerebellar peduncle, cerebellopontine fissure, cerebellar petrosal surface, anterior inferior cerebellar artery (AICA), and CNs VI to VIII.
- Lower neurovascular complex: It includes the medulla, inferior cerebellar peduncle, cerebellomedullary fissure, vertebral artery and posterior inferior cerebellar artery (PICA), and glossopharyngeal, vagus, and spinal accessory nerves converging into the jugular foramen. The hypoglossal nerve is more medial and reaches the hypoglossal canal posteriorly to the vertebral artery.

Surgical Anatomy Pearl

All the inferior cranial nerves arise from rootlets exiting the brainstem in the post-olivary sulcus.

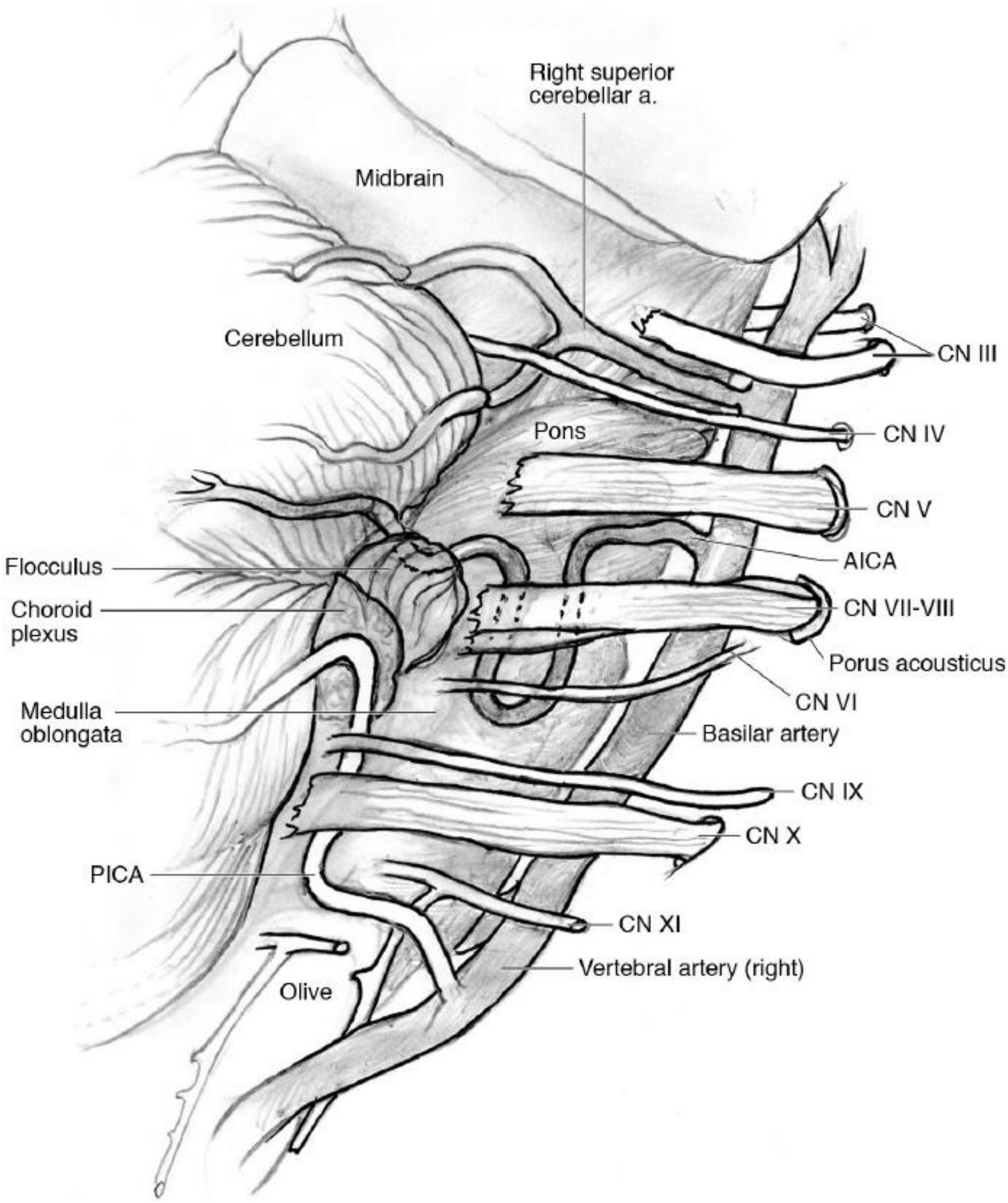


Fig. 2.9 Cerebellopontine angle anatomy (right side). AICA, anterior inferior cerebellar artery; CN, cranial nerve; PICA, posterior inferior cerebellar artery.

Foramen Magnum

The foramen magnum (FM) is oval-shaped and is delimited anteriorly by the clivus, laterally by the occipital condyles, and posteriorly by the anterior border of the occipital bone. The region of the FM includes the following:

- Cerebellar tonsils and inferior vermis
- Brainstem and rostral aspect of spinal cord
- CNs IX to XII
- Upper cervical nerves (C1 and C2)
- C1-C2 complex
- Vertebral arteries
- Posterior inferior cerebellar arteries
- Anterior and posterior spinal arteries
- Meningeal branches of the vertebral, external and internal carotid arteries
- Veins and dural sinuses of the craniovertebral junction
- Dentate ligaments

The hypoglossal canal is located above the occipital condyle.

Jugular Foramen

The jugular foramen is located on the floor of the posterior fossa, bordered anterolaterally and posteromedially, by the petrous bone and occipital bone, respectively. It is often morphometrically described as a triangular canal with exo- and endocranial openings that are located medial to the mastoid tip and tympanomastoid suture. The jugular spine or process splits the jugular foramen into the following two parts:

- Pars nervosa: smaller, anteromedial part that contains the CN IX and the inferior petrosal sinus.
- Pars venosa (pars vascularis): larger, posterolateral part that contains the internal jugular vein, jugular bulb, CNs X and XI, and the posterior meningeal branch of the ascending pharyngeal artery.

2.4 Meningeal Folds

Anatomy of the Tentorium Cerebelli

The tentorium is a fold of dura mater forming the roof of the posterior fossa that separates the cerebellum from the cerebrum. Its free margin is the incisura, which is crossed by the brainstem and the cerebral peduncles. It slopes downward, like a tent, from its apex at the level of the posterior side of the incisura, to its attachment to the bones.

- Anterior borders: at the level of the petrous ridge on the posterior aspects of the petrous bone, where a tentorial division encloses the superior petrosal sinus.

The attachments of the tentorium on the petrous bone and clinoid processes form the anterior and posterior petroclinoid and interclinoid folds, resulting in the oculomotor triangle.28

- Lateral and posterior borders: the tentorium attaches to the internal occipital protuberance and laterally to the temporal bone, to the edges of the osseous groove crossed by the transverse sinus.
  - The falx cerebri fuses perpendicularly to the tentorium over its midline. The falcotentorial junction encloses the straight sinus, which receives venous blood from the vein of Galen and the inferior sagittal sinus. The straight sinus terminates posteriorly into the convergence of the sinuses at the level of the torcular herophili.
  - The tentorial incisura has (a) anterior space, which is anterior to the brainstem, extending around the optic chiasm; (b) middle space, which is lateral to the brainstem, related to the hippocampal formation laterally; and (c) posterior space, which is posterior to the midbrain, in the region of the pineal gland and vein of Galen.28
  - The average width of the incisura is about 30 mm, and the anteroposterior diameter is an average of 52 mm.
  - The topographic neurovascular relationships of the tentorium and the tentorial incisura are with CNs III and IV, ICA, posterior cerebral artery (PCA), SCA, anterior choroidal artery, basal vein of Rosenthal, internal cerebral veins, vein of Galen, and straight sinus with the lateral and sagittal sinuses in the posterior part, at the level of the torcular.

Falx Cerebri (Cerebral Falx)

The falx cerebri is a thick fold of dura mater, attached anteriorly to the crista galli and posteriorly to the tentorium. Its superior margin is attached to the inner surface of the calvaria, and forms the superior sagittal sinus, whereas its inferior margin is free, containing the inferior sagittal sinus. The falx divides the two cerebral hemispheres.

Falx Cerebelli

The falx cerebelli is a dural fold below the tentorium cerebelli, projecting into the posterior cerebellar notch and into the vallecula of the cerebellum between the two cerebellar hemispheres.

Diaphragma Sellae

The diaphragma sellae is a horizontal meningeal fold attaching to the four clinoid processes, forming the roof of the sella turcica. It has an opening in the middle (ostium of the diaphragma sellae), crossed by the pituitary stalk (infundibulum). It separates the supradiaphragmatic space from the infradiaphragmatic space, where the pituitary gland lies.

2.5 Veins and Dural Venous Sinuses

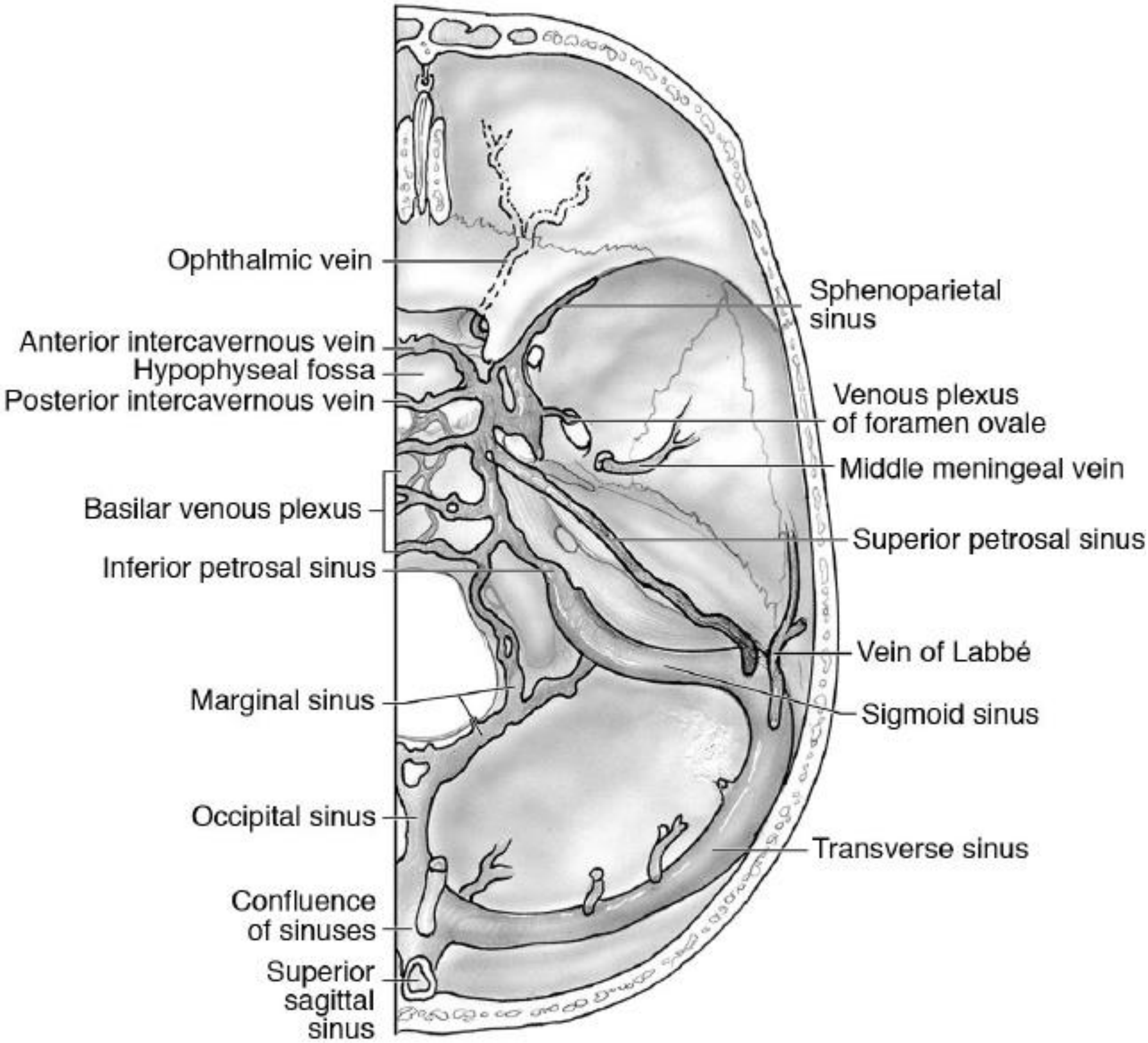
See Fig. 2.10 and Chapter 26.

Transverse Sinus

The transverse sinus comprises symmetrical sinuses that drain blood from the superior sagittal sinus and from the straight sinus into the sigmoid sinuses. They begin at the internal occipital protuberance and, after a curvilinear course, reach the base of the petrous portion of the temporal bone.

Sigmoid Sinus

The sigmoid sinus is a paired sinus, beginning at the temporal bone, reaching the jugular foramen and draining into the internal jugular vein. It drains blood coming from the transverse sinus and petrosal sinuses, as well as from the vein of Labbé.



The Anatomy of the Occipital Bone

The occipital bone is the trapezoid-shaped bone at the lower-back of the cranium (skull). The occipital bone houses the back part of the brain and is one of seven bones that come together to form the skull. It is located next to five of the cranium bones.

As a person ages, their occipital bones will fuse to the other bones of their skull. Your sphenoid bone, which is located in the middle of your skull, will fuse with the occipital bone between the ages of 18 and 25. Then, between the ages of 26 and 40, the parietal bones at the top of your head and occipital bone will fuse together.

At the base of your skull there is a large oval opening in the occipital bone that is called the foramen magnum. This opening allows for passage of the spinal cord. The occipital bone is the only cranial bone to connect to the cervical spine. It has many important functions, but its most important role is in protecting your brain.

Like other bones in your skull, the occipital bone is flat, and it has many attachments and features, which is why it is often described in parts.

Foramen Magnum

The foramen magnum is curved externally and hollow inside. It is the passageway of the central nervous system through the skull that connects the brain to the spinal cord.[1]

The structures that pass through the foramen magnum are:

- Brainstem, also called the medulla oblongata
- Spinal branch of your accessory nerve, the nerve that provides motor function to your neck, shoulders, and back
- Anterior and posterior spinal arteries
- Vertebral artery
- Spinal nerves

The foramen magnum is divided into four parts: one basilar part, two condylar parts, and a squamous part. All these four are part of the opening of the foramen magnum.

Basilar Part

The basilar part is at the front of the foramen magnum and sits next to the dense area of the temporal bone of your skull surrounding the inner ear. Towards the front, the basilar part fuses to the sphenoid bone to form the tribasilar bone during puberty. The pharyngeal tubercle leading to the pharynx (airway) is found on the lower surface of the basilar part.

Condylar Parts

The two condylar parts are located adjacent to the foramen magnum. They are oval-shaped and connect to the first cervical vertebra. Next to them are the condylar canals where the condylar emissary veins connect the external vertebral venous plexuses to the sigmoid sinuses. The hypoglossal nerve (the 12th cranial nerve) spears through the condylar part of the occipital bone.

Squamous Part

The squamous part of the largest part of the occipital bone. It is situated above and behind the foramen magnum and curved downward on each side. There are two curved lines on each side: the highest nuchal line and the superior nuchal line. There is also a middle line running through the nuchal plane called the inferior nuchal line. The nuchal plane is rough and irregular to attach to several muscles, including the muscles of the head and neck.

The internal surface of the squamous part is bowl-shaped and divided into four depressions of the cruciform eminence. The two upper depressions are triangular-shaped and embed the occipital lobes of the cerebrum, the largest part of the brain. The lower two depressions are rectangular and contain the hemispheres of the cerebellum, the part of the brain that receives information.

Along this internal surface of the occipital bone, there is a point of intersection of the four divisions of the cruciform eminence. This point is called the internal occipital protuberance and runs from the superior angle of the bone to a deep grove, called the sagittal sulcus, which hides part of the superior sagittal sinus and is attached to the falx cerebri. The superior sagittal sinus allows blood to drain from the adjacent parts of the anterior hemisphere to the sinuses. At the upper part is the internal occipital crest, which houses the transverse sinuses.

The union of the transverse and sagittal sinuses— the confluence of the sinuses—is indicated by a depression on either side of the protuberance.

Function

The occipital bone has a variety of functions. The most important role it plays is in protecting your brain. Specifically, it protects the brain's visual processing center. It also acts as the connecting pathway from the brain to the spine.

As the occipital bone connects with the first vertebra—the area called the atlas—it forms the atlantooccipital joint. This junction helps you to nod and shake your head throughout the day. The atlas is also the direct link between the spine and skull.

Because of its location, the occipital bone affects all your body's movements, as well as your flexibility, stability, and balance. It also plays a part in your ability to see and interact with the world.

Associated Conditions

When a person is born, their occipital bone is not completely hardened, and it takes up to six years for the hardening to fully complete.[2] Any problems with the development of occipital bone can lead to health issues.

For example, if the occipital bone is misaligned, this also causes misalignment of the spine, causing pain.

The occipital bone is sensitive to the birthing process and in some instances can become injured or damaged during childbirth. The occipital bone can also be affected by other traumas or injuries, such as automobile accidents, sports injuries, and falls, resulting in mental health or chronic health problems.

When the occipital bone is functioning or moving incorrectly, a number of mental and physical health problems may develop. This may include:

- Headaches, especially migraines
- Neck, shoulder, and back pain
- Balance and coordination problems
- Vision difficulties
- Lowered immune functioning

- Sensory processing disorders
- Nervous system problems

Treatment

As your brain's protector, your occipital bone plays an important role in your overall health and life quality. It is therefore important to investigate the cause of head and spine symptoms you may be experiencing, especially pain and problems with function and movement. Your doctor can recommend a variety of treatments, from medications to physical therapy and surgery.

Temporal bone

The temporal bones are a pair of bilateral, symmetrical bones that constitute a large portion of the lateral wall and base of the skull . They are highly irregular bones with extensive muscular attachments and articulations with surrounding bones.

There are a number of openings and canals in the temporal bone through which structures enter and exit the cranial cavity. The temporal bone also houses the structures forming the middle and inner ear.

When the skull is viewed from a posterior aspect, the temporal bones can be seen on the lateral extremities of the skull, with a rounded prominence, the mastoid process, being the most prominent feature visible. The temporal bone is composed of several parts, these being the squamous part, the zygomatic process, the petromastoid part, the tympanic part, the styloid process.

Key facts

Squamous part	Outer surface: attachment of the temporal muscle, forms part of the temporal fossa, groove for the middle temporal artery Inner surface: forms the lateral part of the middle cranial fossa, impressions of the temporal cerebral lobe Processes and fossae: *zygomatic process* (via its own articular surface joints with the zygomatic bone and creates zygomatic arch); *Mandibular fossa* (articulation surface for the head of mandible for temporomandibular joint) Borders: *superior* - squamosal suture with the parietal bone, *antero-inferior* - articulation with the greater wing of the sphenoid bone
Mastoid part	Outer surface: attachment to the occipital and posterior auricular muscles, perforated by numerous foramina with the mastoid foramen as the largest one (through it the transverse sinus passes to the dura mater) Inner surface: deep sigmoid sulcus for the sigmoid sinus Processes and fossae: *mastoid process* for attaching the sternocleidomastoid, splenius capitis and longissimus capitis muscles; *Mastoid notch* for insertion of the posterior belly of the digastric muscle Borders: *superior* - serrated edge for the articulation with the mastoid angle of the parietal bone, *posterior* - also serrated for articulation with the inferior border of the occipital bone, *anterior* - fused with the squama Spaces: mastoid cells that communicate with the tympanic antrum

Petrous part	Base: fused with the internal surfaces of the squamous and mastoid parts Apex: presents the anterior opening of the carotid canal and forms the postero-lateral border of the foramen lacerum Anterior surface: forms the posterior part of the middle cranial fossa; contains arcuate eminence, tegmen tympani, groove and hiatus for greater petrosal nerve, hiatus for the lesser superficial petrosal nerve, termination of the carotid canal, trigeminal impression Posterior surface: froms the anterior part of the posterior cranial fossa; contains internal acoustic opening Inferior surface: quadrangular area, opening of the carotid canal, jugular fossa Content: acoustic labyrinth
Tympanic part	Posterior surface: forms the anterior wall, the floor and part of the posterior wall of the external acoustic meatus; contains the tympanic sulcus (for the attachment of the tympanic membrane) Anterior surface: forms the posterior part of the mandibular fossa and a part of the external acoustic meatus Borders: lateral, superior, inferior (its lateral part - vaginal process - splits to enclose the root of the styloid process) Processes: styloid process
Joints	Occipitomastoid, squamosal, sphenosquamosal, zygomaticotemporal sutures; temporomandibular joint
Muscle attachments	Temporal fossa: origin of the temporalis muscle Mastoid process: attachment of the sternocleidomastoid, splenius capitis, longissimus capitis, digastric muscles Styloid process: stylopharyngeus, styloglossus, stylohyoid muscles
Foramina	Foramen lacerum (great petrosal nerve), carotid canal (interal carotid artery), internal acoustic meatus (CN VII, CN VIII, labyrinthine artery), jugular foramen (internal jugular vein, CN IX, CN X, CN XI, posterior meningeal artery)
Clinical significance	Mastoiditis, meningitis

All of the constitutive parts of the temporal bone will be explained through this article.

Contents

3. Muscular attachments
4. Foramina
5. Clinical notes

+ Show all

Divisions of the temporal bone

Squamous part

Squamous part of temporal bone (Pars squamosa ossis temporalis)

The squamous part is the anterior superior portion of the temporal bone that forms the lateral part of the middle cranial fossa. It has the appearance of a large flattened plate. Its external surface is smooth and slightly convex. Above the external acoustic meatus, there is a groove on the external surface of the bone for the middle temporal artery. The internal surface of the squamous part is concave shaped. Its surface has impressions that follow the groove and contour of the temporal lobe of the cerebrum that rests against it. There is also a groove on this surface for the middle meningeal vessels.

There is an anterior projection from the squamous part of the temporal bone, the zygomatic process. This is located on the lower portion of the squamous part. It initially projects laterally, then turns to pass anteriorly to articulate with the temporal process of the zygomatic bone to form the zygomatic arch. There is a small tubercle inferior to the zygomatic process at its root: the articular process.

The mandibular notch (fossa), the socket for articulation of the temporal bone with the head of the mandible , is also present on the squamous part of the temporal bone.

Petromastoid part

Mastoid part

Mastoid process of temporal bone (Processus mastoideus ossis temporalis)

This part of the temporal bone is usually split into two: the petrous part and the mastoid part.

The mastoid part is the most posterior part of the temporal bone. Its outer surface is roughened by muscular attachments. There is a downward conical projection called the mastoid process from the mastoid part.

A number of muscles are attached to the mastoid process, these being the sternocleidomastoid , splenius capitis and longissimus capitis muscles. There is a depression on the medial surface of the mastoid process, the mastoid notch, onto which the posterior belly of the digastric is inserted. The medial surface of the mastoid process has a deep groove called the sigmoid sulcus, in which the sigmoid sinus is located.

Petrous part

Petrous part of temporal bone (Pars petrosa ossis temporalis)

The petrous part is a wedge shaped mass of bone located between the sphenoid and occipital bones within the cranial cavity. It is the most medial part of the temporal bone, and it is the landmark dividing the middle and posterior cranial fossae from each other. It has a base, an apex and three surfaces: anterior, posterior and inferior. It also has three borders: superior, anterior and posterior. The acoustic labyrinth is located within the petrous part.

The anterior region of the petrous part forms the posterior limit of the middle cranial fossa. Its internal surface is grooved by the inferior temporal gyrus, as well as the trigeminal ganglion. The trigeminal impression is separated from another hollow posteriorly by a bony ridge. This hollow partially encloses the internal acoustic meatus and the cochlea.

Trigeminal impression of temporal bone (Impressio trigeminalis ossis temporalis)

The ridge is limited posteriorly by the arcuate eminence, which is raised superiorly by the superior semicircular canal. The lateral aspect of the petrous part articulates with the squamous part of the temporal bone. Between this articulation laterally and the arcuate eminence medially, is a thin plate of bone called the tegmen tympani. This bone forms the roof of the middle ear. The lateral and posterior semicircular canals lie deep to the posterior slope of the arcuate eminence.

The posterior area of the petrous part of the temporal bone contributes to the anterior limit of the posterior cranial fossa. It is continuous with the internal portion of the mastoid part. There is a depression below the arcuate eminence, the subarcuate fossa, which lies above the opening of the internal acoustic meatus.

The inferior surface is highly irregular and contributes to the external surface of the cranial base. Near the apex, there is a quadrangular area associated with the attachment of the levator veli palatini muscle and the pharyngotympanic tube. Posterior to this region is an opening for the carotid canal, and more posteriorly again is the jugular fossa.

The superior border is the longest border of the petrous part of the temporal bone. It is inside the cranial cavity, and is grooved by the superior petrosal sinus. The posterior border forms part of the fossa for the inferior petrosal sinus. The anterior border is attached laterally to the squamous part of the temporal bone; medially it articulates with the greater wing of the sphenoid bone. Two canals exit the skull at the junction between the petrous and squamous parts: the upper one containing the tensor tympani muscle, the lower one containing the pharyngotympanic tube.

Tympanic part

The tympanic part of the temporal bone is a curved plate immediately below the origin of the zygomatic process. Its concave posterior surface forms the anterior wall, floor and part of the posterior wall of the external acoustic meatus. The external acoustic opening is clearly visible on this part.

The tympanic part of the temporal bone fuses with the petrous part internally, and the squamous and mastoid parts posteriorly. Its posterior surface forms the anterior wall, floor and part of the posterior wall of the external acoustic meatus. The anterior surface forms the posterior part of the mandibular fossa, and its lateral part forms part of the external acoustic meatus. The inferior border is sharp, and forms the vaginal process of the styloid process. The central region is thin and often perforated. The stylomastoid foramen lies between the styloid process and the mastoid process. It is the terminal end of the facial canal, transmitting the facial nerve and the stylomastoid artery.

The styloid process is a narrow, pointed projection that extends downwards and anteriorly from the inferior surface of the temporal bone.

Its length is variable, but is usually on average 2.5cm in length. It is usually straight, but can sometimes have a curvature, usually on the anterior surface. Its proximal part is enclosed in the tympanic plate; the distal end is the site of a number of muscles and ligaments. The parotid gland lies lateral to the styloid process; the facial nerve crosses its base; the external carotid artery passes through the parotid gland crossing the tip of the styloid process; and medially is the attachment of the stylopharyngeus muscle, separating the styloid process from the internal jugular vein.

Joints

Squamous suture (Sutura squamosa)

The temporal bone articulates with a number of other flat bones of the skull at joints called sutures:

- the occipitomastoid suture separates the mastoid part of the temporal bone from the occipital bone posteriorly
- the squamosal suture separates the squamous part of the temporal bone from the parietal bone posteriorly and superiorly

- the sphenosquamosal suture separates the squamous part from the greater wing of the sphenoid bone anteriorly
- the zygomaticotemporal suture separates the zygomatic process of the temporal bone from the temporal process of the zygomatic bone, forming the zygomatic arch.

The temporal bone also articulates with the mandible at the temporomandibular joint . At this hinge joint, the rounded head of the mandible articulates with a socket formed by the mandibular fossa and the articular process of the temporal bone.

Muscular attachments

Stylopharyngeus (Musculus stylopharyngeus)

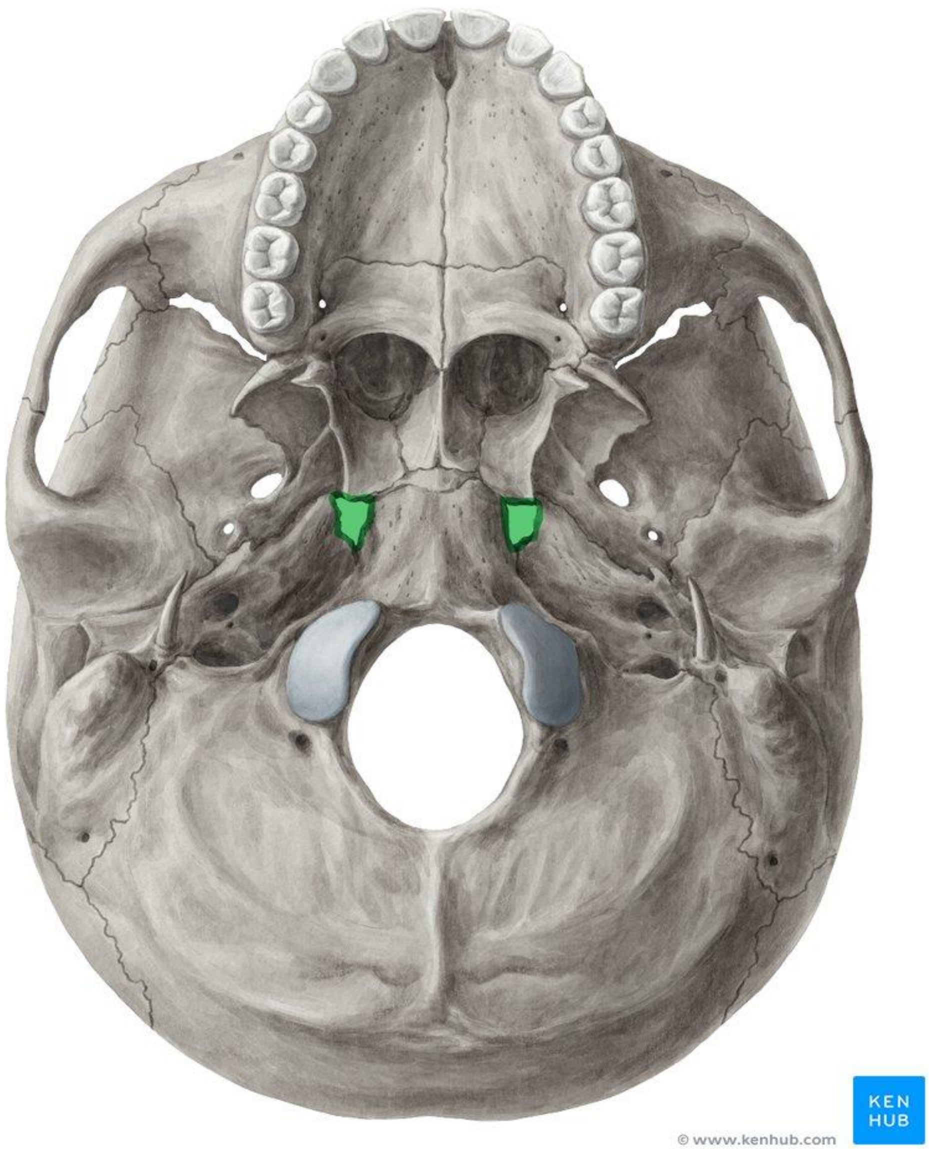
A number of muscles are attached to different features of the temporal bone. The temporalis muscle originates from the temporal fossa, which is formed partially by the lateral aspect of the temporal bone. The sternocleidomastoid, splenius capitis, longissimus capitis and digastric are all attached to the mastoid process of the temporal bone. Attaching to the styloid process are the:

- stylopharyngeus
- styloglossus
- stylohyoid muscles

Foramina

There are a number of openings in the temporal bone through which structures entering and exiting the cranial cavity pass.

- Anteromedially, the temporal bone forms the posterior boundary of the foramen lacerum, through which the greater petrosal nerve passes.



The internal acoustic meatus is another canal passing through the petrous part of the temporal bone between the posterior cranial fossa and the external acoustic meatus. Passing through this opening are the facial nerve (CN VII), the vestibulocochlear nerve (CN VIII) and the labyrinthine artery. The vestibulocochlear nerve terminates in the temporal bone. The facial nerve continuous outwards, exiting the temporal bone through the stylomastoid foramen.

Posteriorly, the petrous part of the temporal bone forms the anterior extremity of the jugular foramen. Formed at the jugular foramen where the sigmoid sinus exits the skull is the internal jugular vein. There are also a number of other structures passing through this opening. These include three of the cranial nerves: the glossopharyngeal nerve (CN IX), the vagus nerve (CN X) and the accessory nerve (CN XI). The posterior meningeal artery also passes through this opening

There are also some smaller openings in the temporal bone. There are two hiatuses through which the greater and lesser petrosal nerves exit the geniculate ganglion in the facial canal. There is also a mastoid foramen, through which emissary veins and sometimes a branch of the occipital artery pass.

Sphenoid bone

Sphenoid bone (Os sphenoidale)

The sphenoid bone is the most complex bone of the human body. Because of its shape, it is also known as the "wasp bone". It makes up most of the middle part of the base of the skull and contributes to the floor of the middle cranial fossa of the skull.
The soft tissue structures such are the cranial nerves and parts of the brain are associated with this bone and have intense relations to it. The sphenoid bone also takes part into the forming of the many of the foramina and canals of the cranium.

Key facts

Structure	Body (median portion) Two greater wings (lateral portion) Two lesser wings (anterior portion) Pterygoid processes (directed downwards)
Borders	Sphenofrontal suture with the frontal bone Sphenoparietal suture with the parietal bone Sphenosquamosal suture with the temporal bone Spheno-ocipital suture with the occipital bone (disappears by the age 25 and the bones fuse together)
Relations	Body: *anteriorly* contributes to the nasal cavity; *laterally* - optic canal; *superiorly* - sella turcica, the hypophyseal fossa, dorsum sellae Lesser wings: *superolaterally* - optic canal; *inferiorly* - lateral margin of the orbit; *superiorly* - cranial cavity; together with the body and greater wings builds the superior orbital fissure (superior ophthalmic vein; ophthalmic, abducent, oculomotor and trochlear nerves) Greater wings: *anteriorly* - posterior aspect of the lateral orbital wall; contain foramen ovale (madibular nerve, accessory meningeal artery, lesser petrosal nerve, emissary vein) and foramen spinosum (middle meningeal vessels, meningeal branch of the mandibular nerve) Pterygoid processes: contains pterygoid canal (major and deep petrosal nerves) and palatovaginal canal (pharyngeal nerve)

In this article you will find out all about the anatomy of the sphenoid bone, its parts, borders, and development.

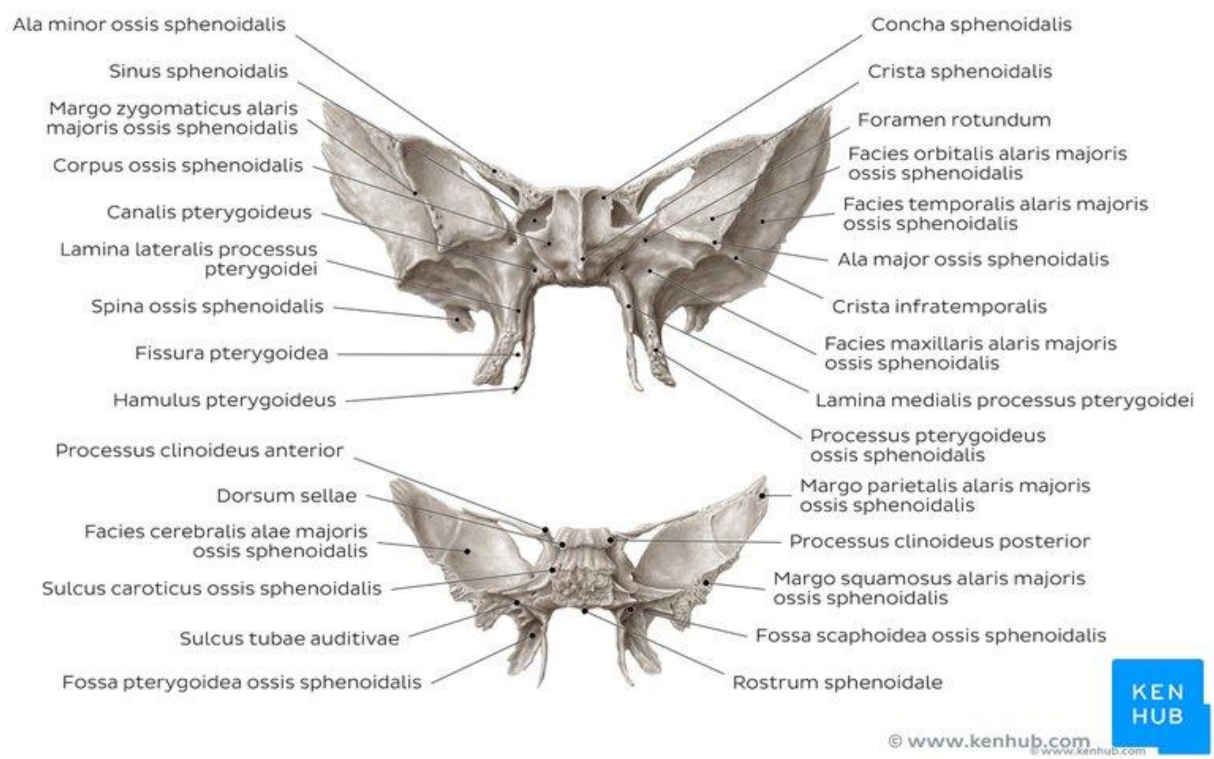
Contents

3. Greater wings
4. Pterygoid processes
2. Borders
3. Osseous development

+ Show all

Anatomy

There are four main parts to the sphenoid bone: the body (corpus), the lesser and greater wings (alae minores et majores) and the pterygoid processes.



Sphenoid bone

Body

The body is the most centrally positioned portion. Anteriorly it contributes to the nasal cavity, laterally it builds the medial wall of the optic canal. Superiorly the body forms the sella turcica, the hypophyseal fossa and the dorsum sellae.

Recommended video: Overview of the sphenoid bone

Anatomy and landmarks of the sphenoid bone.

They contain the anterior and posterior clinoid processes respectively. The clivus slopes posterior to the body. The sphenoidal sinuses are located in the sphenoid body behind the nasal cavity and divided by a septum.

Lesser wings

The lesser wings arise superolaterally from the sphenoid body where they form the optic canal (→ optic nerve, ophthalmic artery). The inferior surface participates in the lateral margin of the orbit while the superior surface forms part of the cranial cavity.

Lesser wing of sphenoid bone (Ala minor ossis sphenoidalis)

Greater wings

The greater wings arise posterolaterally from the body.

Greater wing of sphenoid bone (Ala major ossis sphenoidalis)

Their lateral surfaces form the infratemporal surfaces, their anterior surfaces make up part of the posterior aspect of the lateral wall of the orbit.

They contain two important openings near their roots:

- foramen rotundum, which transmits the maxillary nerve
- foramen ovale, which allows the passage of the mandibular nerve, accessory meningeal artery, lesser petrosal nerve and emissary vein (mnemonic *"MALE"*)
- foramen spinosum, that is traversed by the middle meningeal vessels, spinous nerve [branch of mandibular nerve]) lies at the posterior margin of the greater wings.

Between the body, lesser and greater wings is a large opening known as the superior orbital fissure where numerous nerves and vessels pass through (→ superior ophthalmic vein, ophthalmic nerve and its branches, abducent nerve, oculomotor nerve, trochlear nerve).

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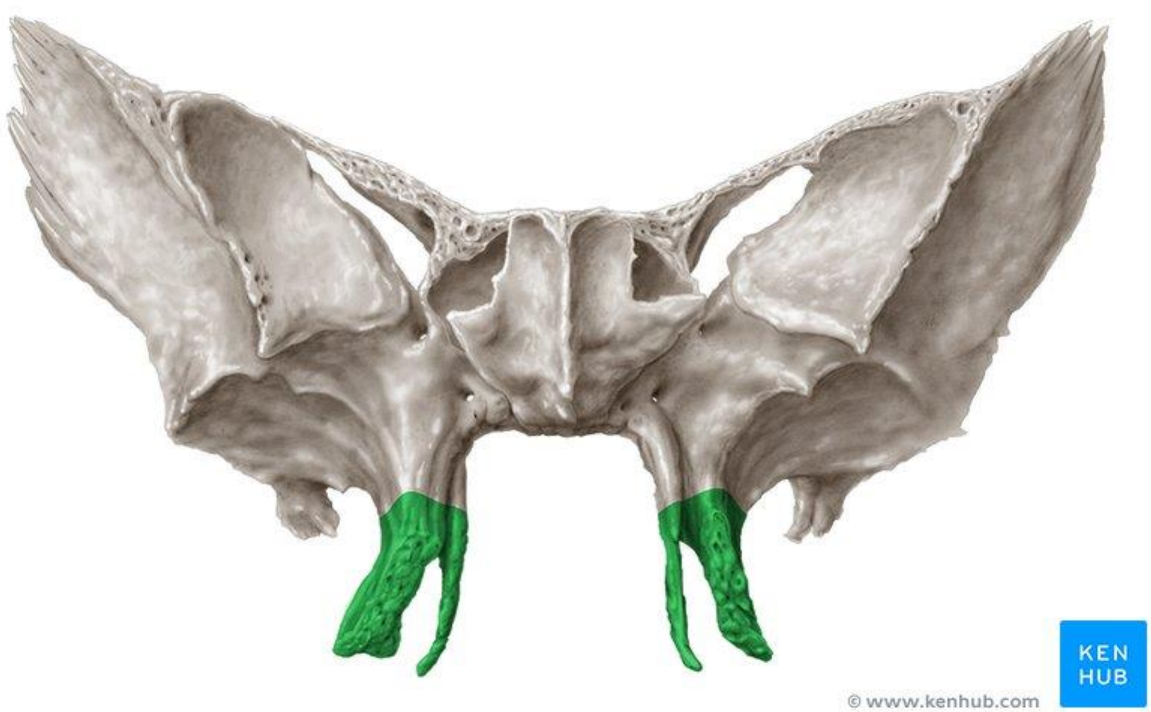
Pterygoid processes

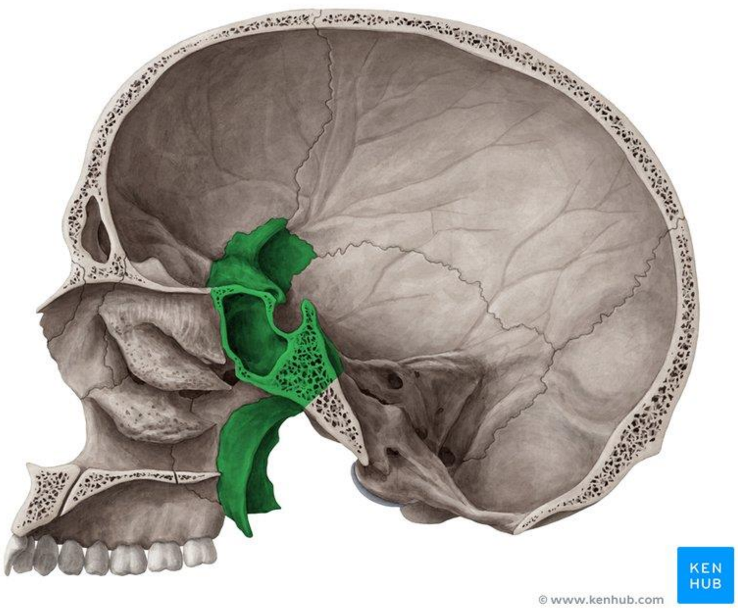
The pterygoid processes are extensions of the basal surface of the sphenoid body. The processes contain two canals known as the pterygoid canal (→ major petrosal nerve, deep petrosal nerve, vessels of pterygoid canal) and the palatovaginal (or pharyngeal) canal (→pharyngeal nerve). A hamulus extends bilaterally from each medial pterygoid plate.



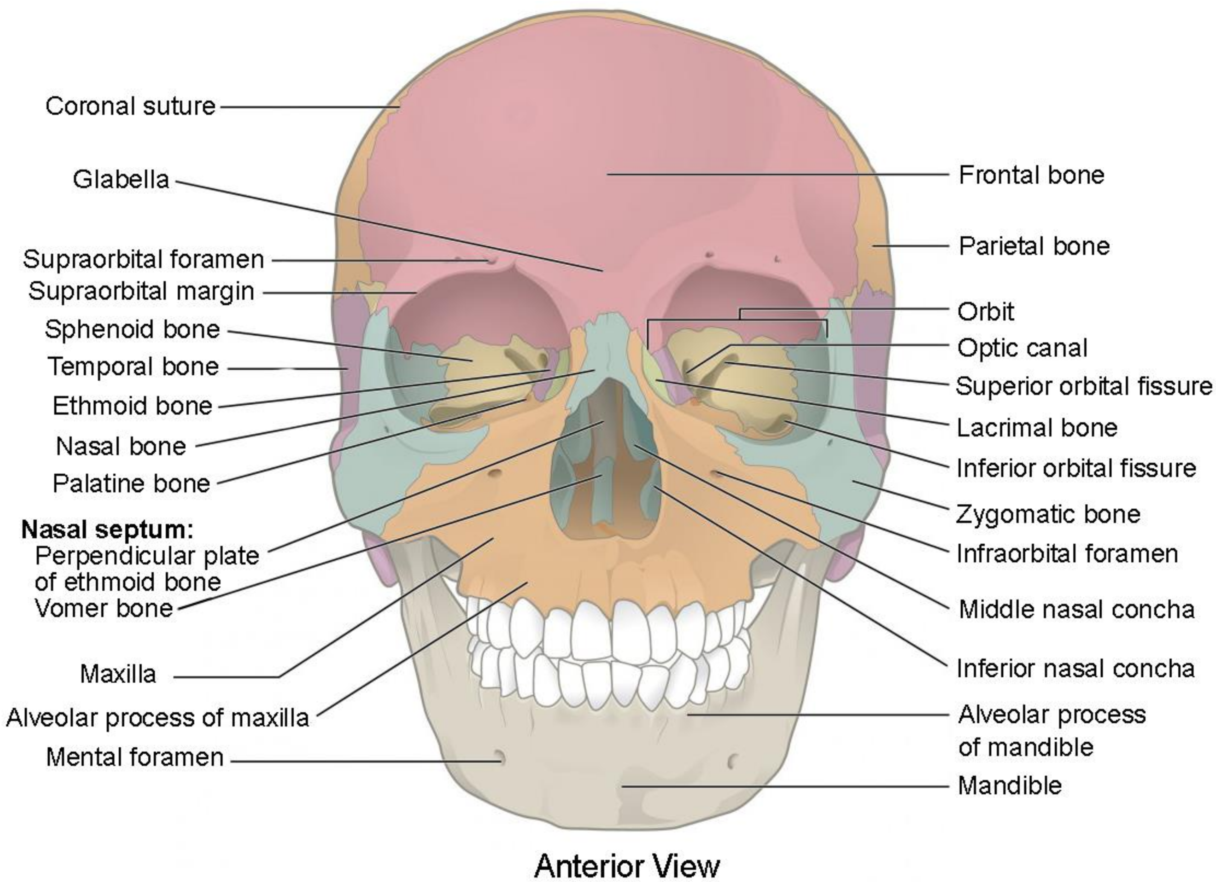
Pterygoid processes (ventral view)

Borders

The sphenoid bone has a common border with the frontal bone (via the sphenofrontal suture), the parietal bone (via the the sphenoparietal suture), the squamous part of the temporal bone (via the sphenosquamosal suture) and the occipital bone (via the spheno-occipital suture). As the sphenoid and occipital bone fuse during puberty ("tribasilar bone") the spheno-occipital suture disappears by the age of 25.



the structure of the bones of the facial skull anatomy



The **facial skeleton** comprises the *facial bones* that may attach to build a portion of the skull. The remainder of the skull is the braincase.

In human anatomy and development, the facial skeleton is sometimes called the *membranous viscerocranium*, which comprises the mandible and dermatocranial elements that are not part of the braincase.

Structure

In the human skull, the facial skeleton consists of fourteen bones in the face:

- Inferior nasal concha (2)
- Lacrimal bones (2)
- Mandible
- Maxilla (2)
- Nasal bones (2)
- Palatine bones (2)
- Vomer
- Zygomatic bones (2)

Variations

Elements of the *cartilaginous viscerocranium* (i.e., splanchnocranial elements), such as the hyoid bone, are sometimes considered part of the facial skeleton. The ethmoid bone (or a part of it) and also the sphenoid bone are sometimes included, but otherwise considered part of the neurocranium. Because the maxillary bones are fused, they are often collectively listed as only one bone. The mandible is generally considered separately from the cranium.

Development

The facial skeleton is composed of dermal bone and derived from the neural crest cells (also responsible for the development of the neurocranium, teeth and adrenal medulla) or from the sclerotome, which derives from the somite block of the mesoderm. As with the neurocranium, in Chondricthyes and other cartilaginous vertebrates, they are not replaced via endochondral ossification.

Variation in craniofacial form between humans is largely due to differing patterns of biological inheritance. Cross-analysis of osteological variables and genome-wide SNPs has identified specific genes that control this craniofacial development. Of these genes, DCHS2, RUNX2, GLI3, PAX1 and PAX3 were found to determine nasal morphology, whereas EDAR impacts chin protrusion.

The skull is a bony structure that supports the face and forms a **protective cavity** for the brain. It is comprised of many bones, formed by intramembranous ossification, which are joined together by **sutures** (fibrous joints). These joints fuse together in adulthood, thus permitting brain growth during adolescence.

The bones of the skull can be divided into two groups: those of the **cranium** (which can be subdivided the skullcap known as the calvarium, and the cranial base) and those of the **face**.

The Cranium

The **cranium** (also known as the neurocranium), is formed by the superior aspect of the skull. It encloses and protects the brain, meninges and cerebral vasculature.

Anatomically, the cranium can be subdivided into a **roof** (known as the calvarium), and a **base:**

- **Calvarium:** Comprised of the frontal, occipital and two parietal bones.
- **Cranial base:** Comprised of six bones – the frontal, sphenoid, ethmoid, occipital, parietal and temporal bones. These bones are important as they provide an articulation point for the 1st cervical vertebra (atlas), as well as the facial bones and the mandible (jaw bone).

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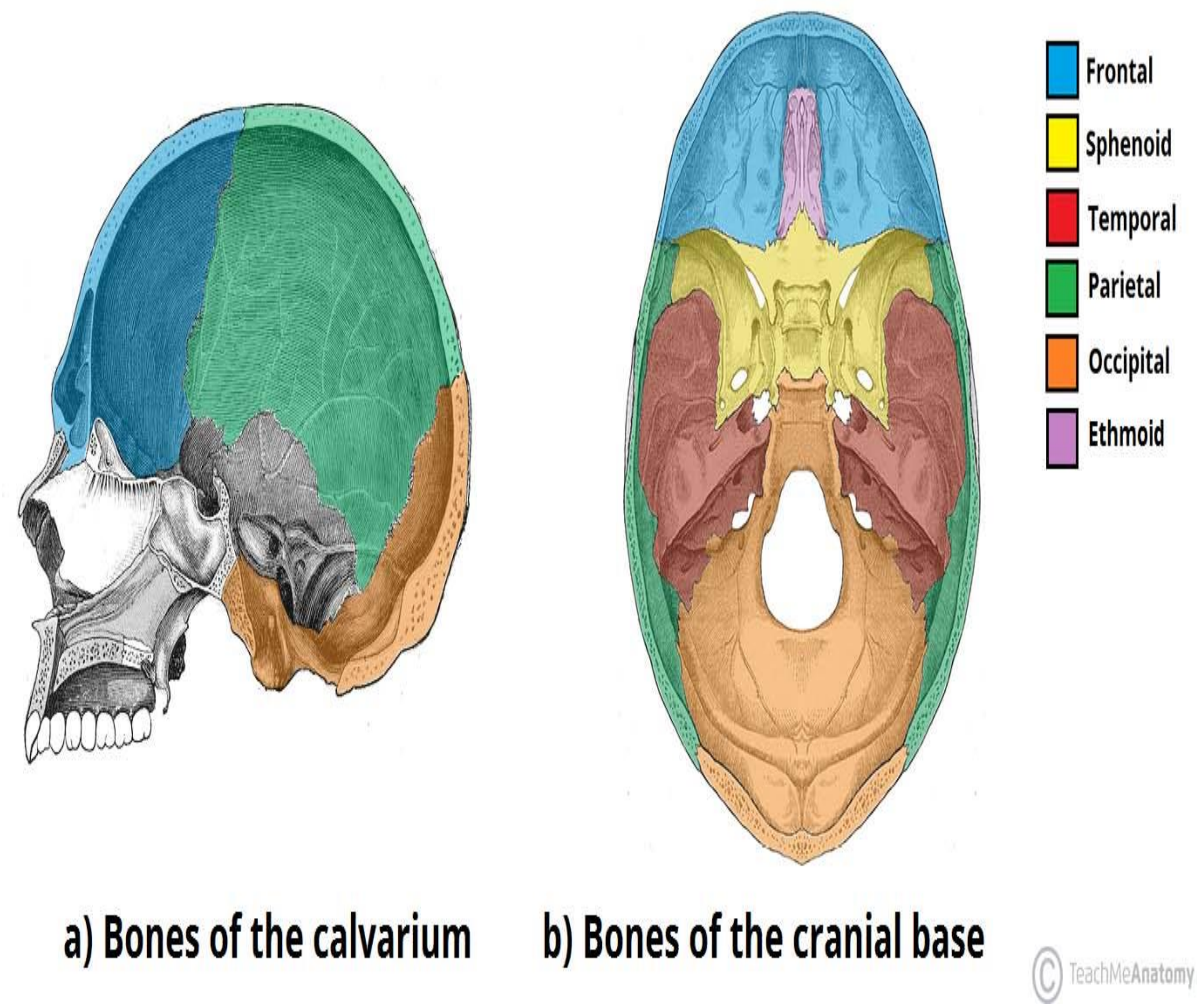


Fig 1 – Bones of the calvarium and cranial base.

The Face

The **facial skeleton** (also known as the viscerocranium) supports the soft tissues of the face. In essence, they determine our facial appearance.

It consists of 14 individual bones, which fuse to house the orbits of the eyes, nasal and oral cavities, as well as the sinuses. The frontal bone, typically a bone of the calvaria, is sometimes included as part of the facial skeleton.

The facial bones are:

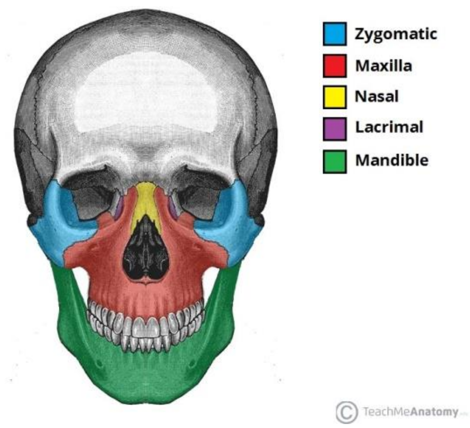


Fig 1.1 – Anterior view of the face, showing some of the bones of the nasal skeleton. The vomer, palatine and inferior conchae bones lie deep within the face.

Zygomatic (2) – Forms the cheek bones of the face, and articulates with the frontal, sphenoid, temporal and maxilla bones.

- **Lacrimal (2)** – The smallest bones of the face. They form part of the medial wall of the orbit.
- **Nasal (2)** – Two slender bones, located at the bridge of the nose.
- **Inferior nasal conchae (2)** – Located within the nasal cavity, these bones increase the surface area of the nasal cavity, thus increasing the amount of inspired air that can come into contact with the cavity walls.
- **Palatine (2)** – Situated at the rear of oral cavity, and forms part of the hard palate.
- **Maxilla (2) –** Comprises part of the upper jaw and hard palate.
- **Vomer –** Forms the posterior aspect of the nasal septum.
- **Mandible (jaw bone)** – Articulates with the base of the cranium at the temporomandibular joint (TMJ).

Sutures of the Skull

Sutures are a type of fibrous joint that are unique to the skull. They are immovable, and fuse completely around the age of 20.

By TeachMeSeries Ltd (2020)

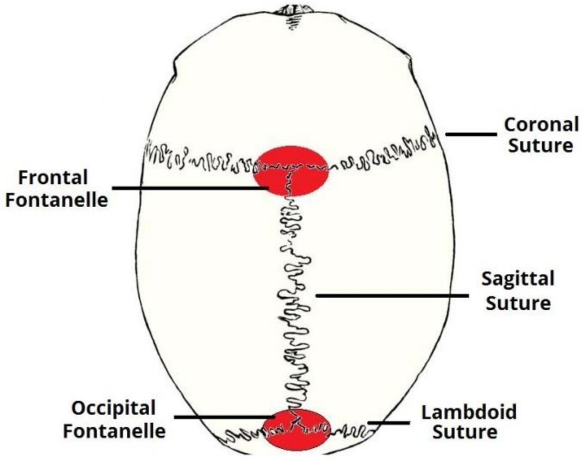


Fig 1.2 – The major fontanelles and sutures of the skull

Sutures are of clinical importance, as they can be points of potential weakness in both childhood and adulthood. The main sutures in adulthood are:

- **Coronal suture** which fuses the frontal bone with the two parietal bones.
- **Sagittal suture** which fuses both parietal bones to each other.
- **Lambdoid suture** which fuses the occipital bone to the two parietal bones.

In neonates, the incompletely fused suture joints give rise to membranous gaps between the bones, known as fontanelles. The two major fontanelles are the **frontal fontanelle** (located at the junction of the coronal and sagittal sutures) and the **occipital fontanelle** (located at the junction of the sagittal and lambdoid sutures).

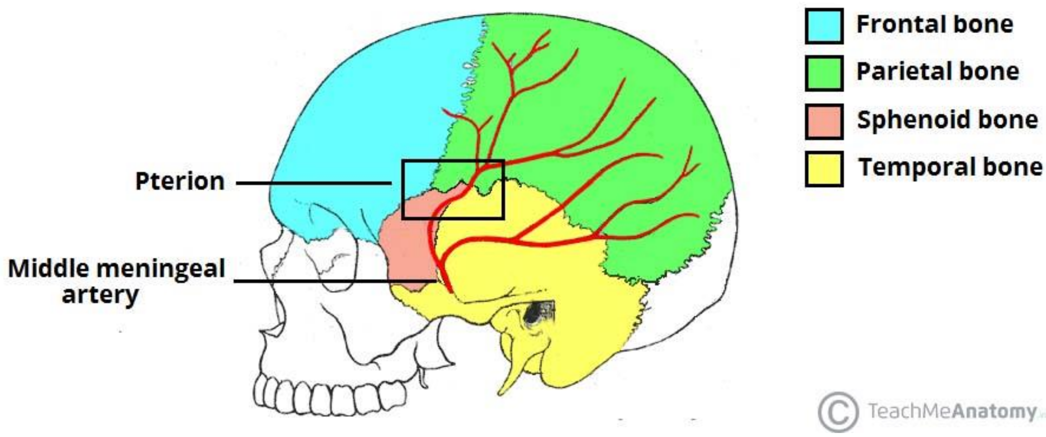
Clinical Relevance: Cranial Fractures

The majority of skull fractures result from blunt force or penetrating **trauma**, and can produce numerous signs and symptoms. The clinical features may be obvious, such as visible injuries and bleeding. There are also subtle signs of fracture, such as clear fluid draining from the ears and nose (cerebrospinal fluid leak indicative of base of skull fracture), poor balance and confusion, slurred speech and a stiff neck.

There are certain areas of the skull that are natural points of weakness:

- **The pterion:** a 'H-shaped' junction between temporal, parietal, frontal and sphenoid bones. The thinnest part of the skull. A fracture here can lacerate the middle meningeal artery (anterior branch), resulting in a extradural haematoma.

- **Anterior cranial fossa:** Depression of skull formed **sa:** Depression formeenoid, temporal and parietal



bones.

- **Posterior cranial fossa:** Depression formed by squamous and mastoid temporal bone, plus occipital bone.

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Fig 1.3 – Lateral view of the skull, showing the path of the meningeal arteries. Note the pterion, a weak point of the skull, where the anterior middle meningeal artery is at risk of damage.

Types of Fractures

There are four major types of cranial fracture:

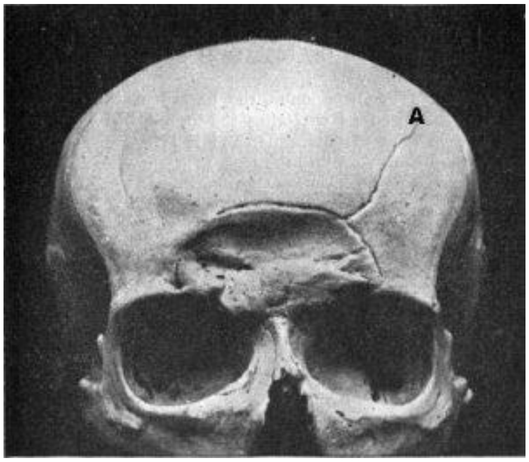


Fig 1. 4 – Skull showing depressed fracture of the frontal bone, with linear fracture marked A

Depressed – fracture of the bone with depression of the bone inwards. They occur as a result of a direct blow, causing skull indentation, with possible underlying brain injury.

Linear – a simple break in the bone, traversing its full thickness. They have radiating (stellate) fracture lines away from the point of impact. The most common type of cranial fracture.

Basal skull – affects the base of the skull. They characteristically present with bruising behind the ears, known as Battle's sign (mastoid ecchymosis) or bruising around the eyes/orbits, known as Raccoon eye's.

Diastatic – fracture that occurs along a suture line, causing a widening of the suture. They are most often seen in children.

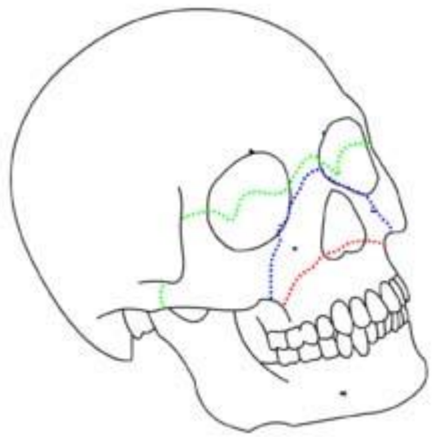


Fig 1.5 – Le fort classification of maxillary fractures

Clinical Relevance: Facial Fractures

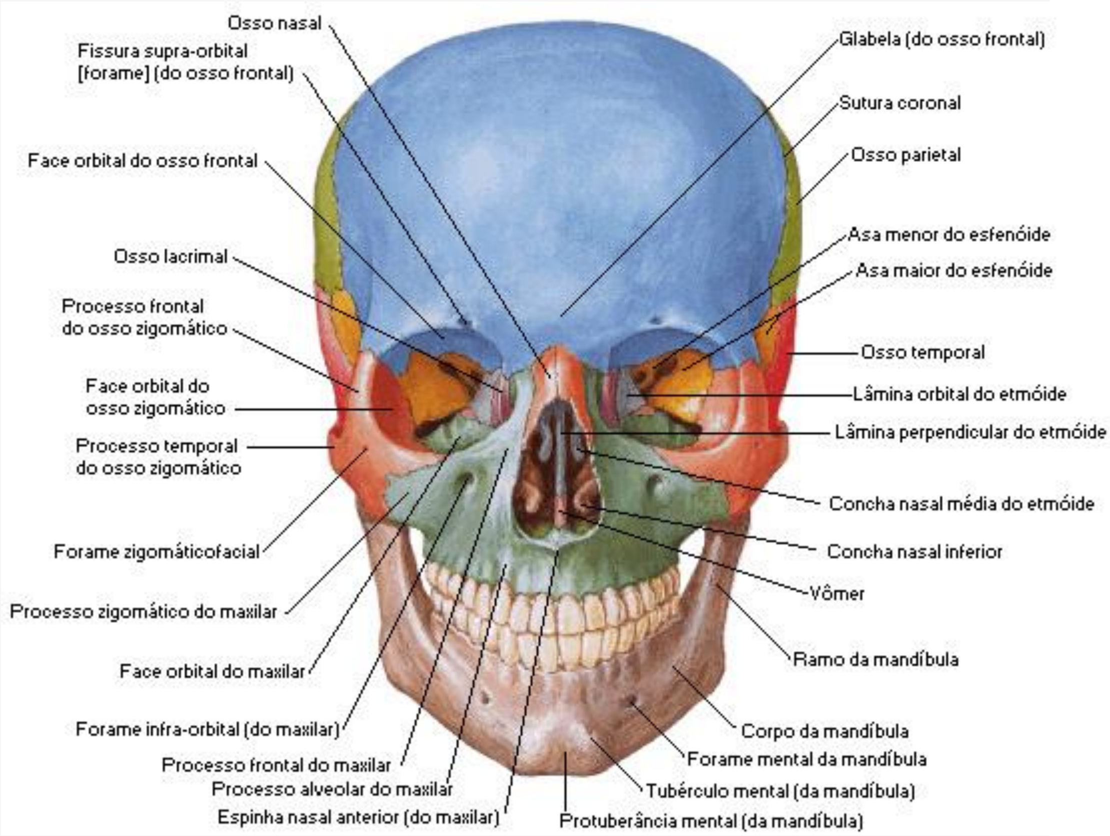
Facial fractures are common and generally **trauma** related, i.e. road traffic collisions, fights and falls. They are often associated with clinical features such as profuse bleeding, swelling, deformity and anaesthesia of the skin. The **nasal bones** are most frequently fractured, due to their prominent position at the bridge of the nose.

A **maxillofacial fracture** is one that affects the maxillae bones. This requires a trauma with a large amount of force. Facial fractures affecting the maxillary bones can be identified using the Le Fort classification, depending on the bones involved, ranging from 1 to 3 (most serious).

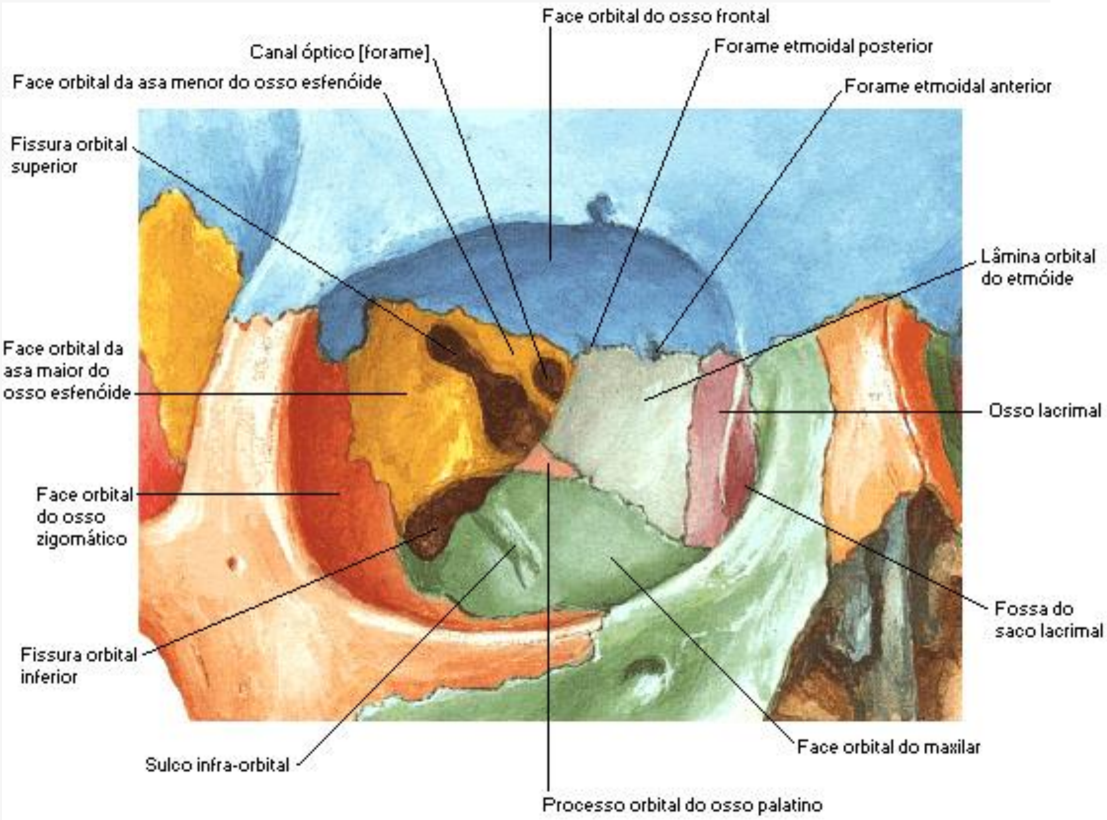
Skull as a whole

Anterior View of the Skull

PREVIOUS SKULL VIEW

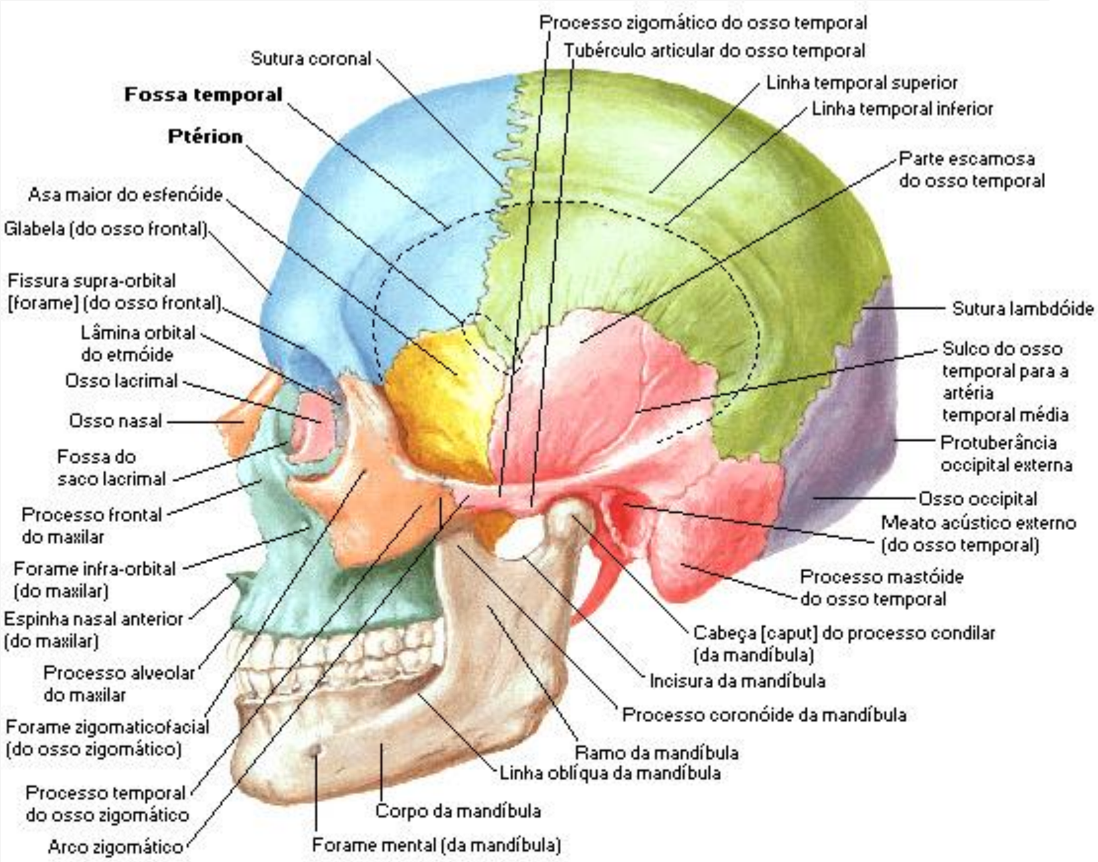


Orbital Bones

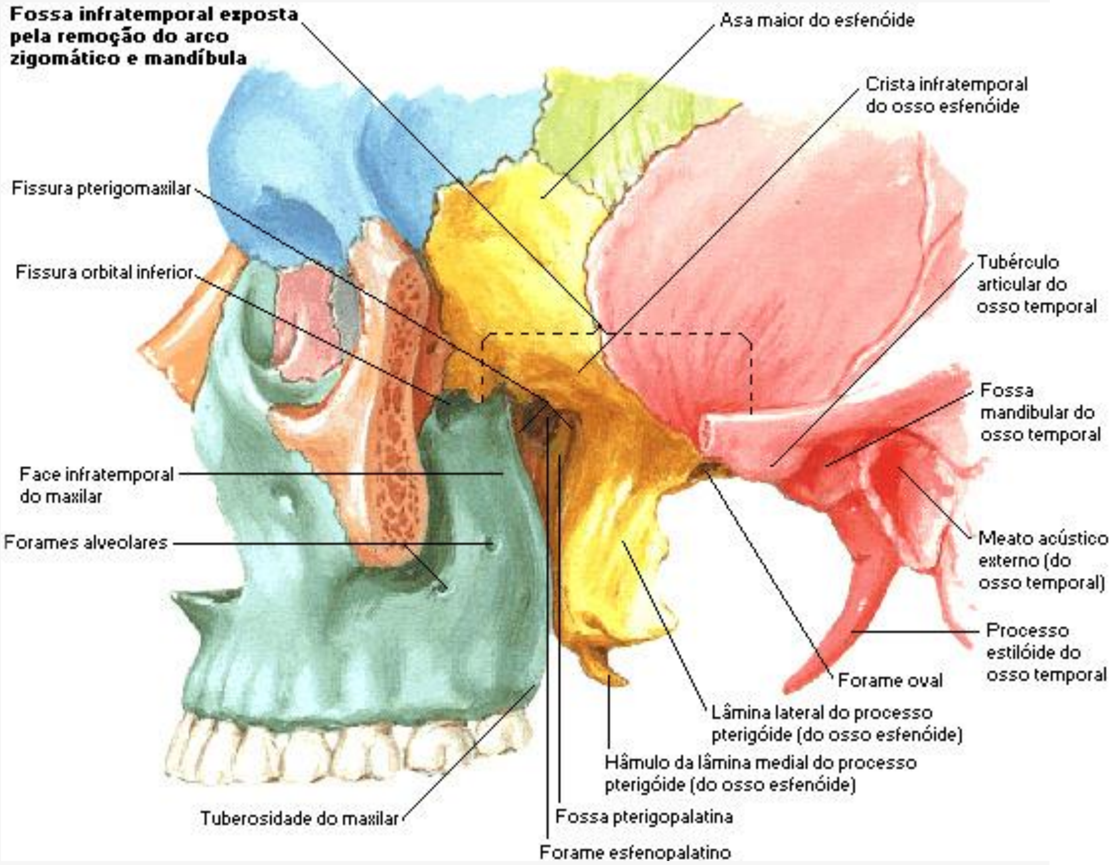


Skull Side View

SKULL SIDE VIEW



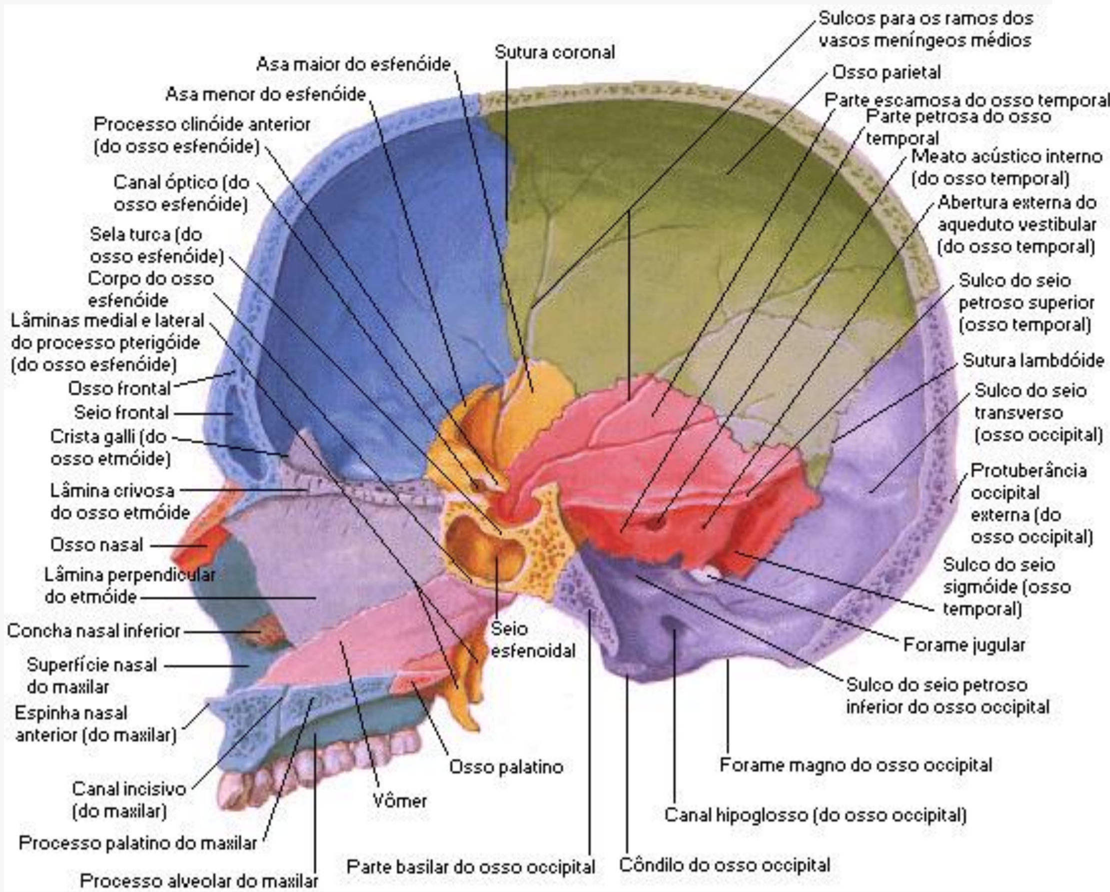
SKULL SIDE VIEW



Source: NETTER, Frank H .. Atlas of Human Anatomy. 2 ed. Porto Alegre: Artme

Medial View of the Skull

MEDICAL SKULL VIEW



Source: NETTER, Frank H .. Atlas of Human Anatomy. 2 ed. Porto Alegre: Artme

Top View of the Skull & #8211; Skullcap

The upper part of the skull is called the skull dome or calvaria.

It is crossed by **Four Sutures** (joints that allow minimal mobility to skull bones):

1 – **Coronal or Bregmatic Suture**: between the frontal and parietal bones

2 – **Sagittal Suture**: between the two parietals (median sagittal line)

3 – **Suture Lambdoid**: between the parietals and the occipital

4 – **Scaly Suture**: between the parietal and the temporal

Some Anthropometric Points of the Skull:

Bregma & #8211; joint point of sagittal and coronal sutures

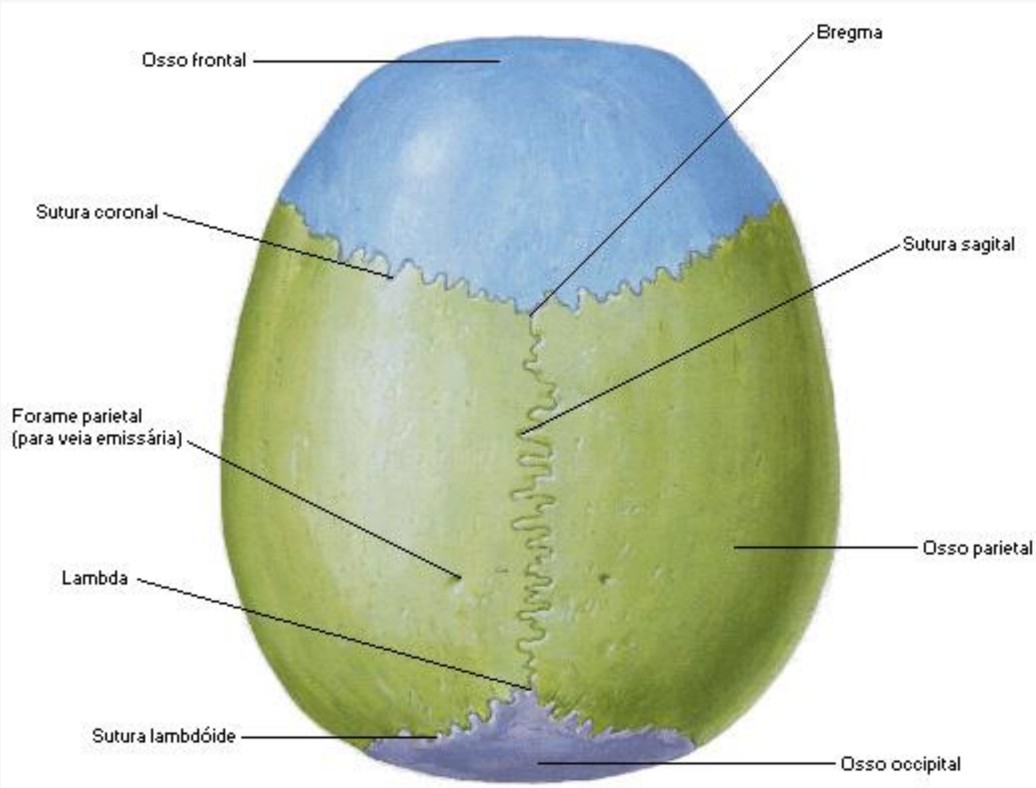
Lambda & #8211; junction point of the sagittal and lambdoid sutures

Vertex & #8211; highest part of the skull

Gonius & #8211; jaw angle

Pterius & #8211; junction point of the parietal, frontal, sphenoid and temporal bones

SKULL TOP VIEW & #8211; EXTERNAL FACE



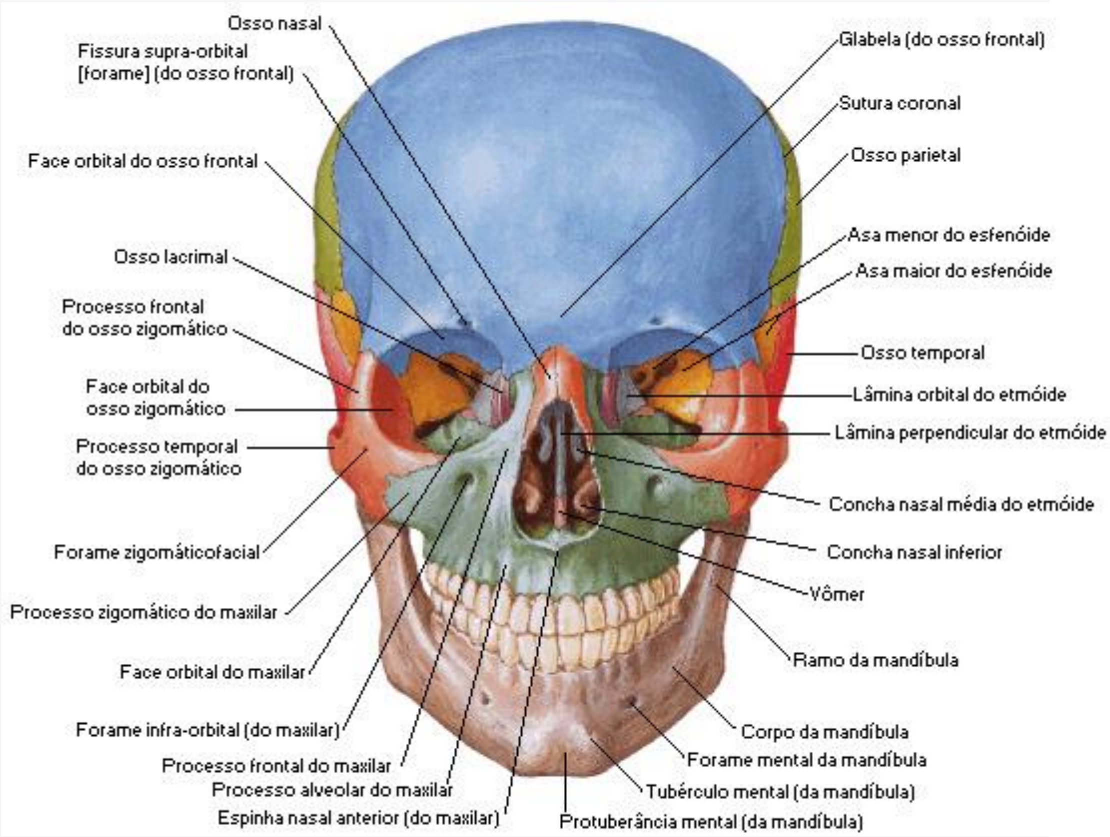
Cranial tanks

It is divided into 3 pits:

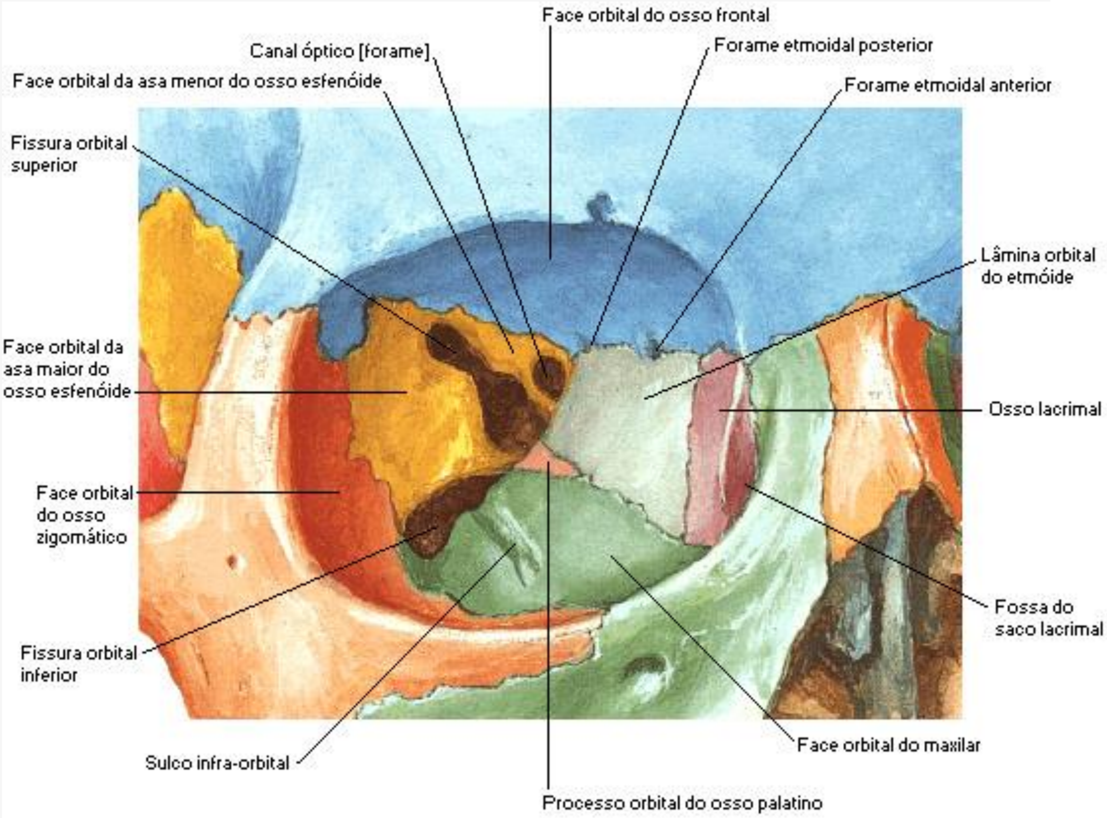
Anterior Fossa Medium Fossa Posterior Fossa

Anterior View of the Skull

PREVIOUS SKULL VIEW

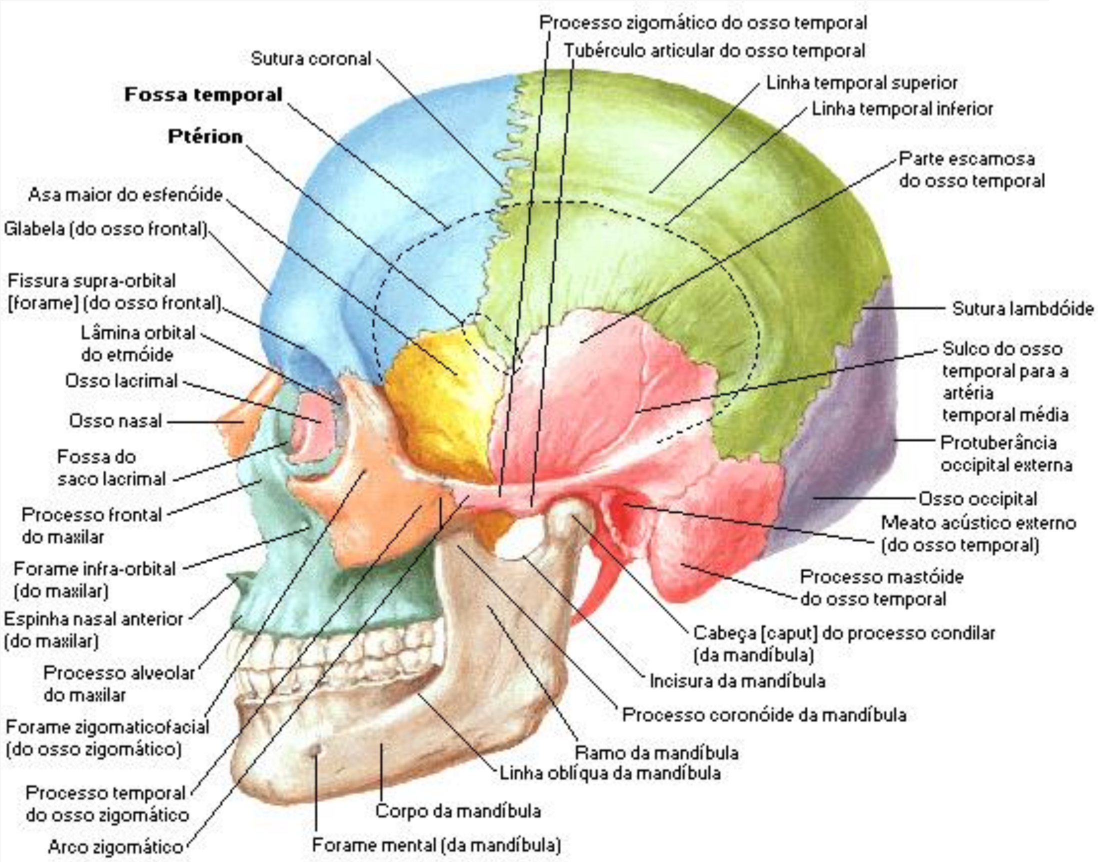


Orbital Bones

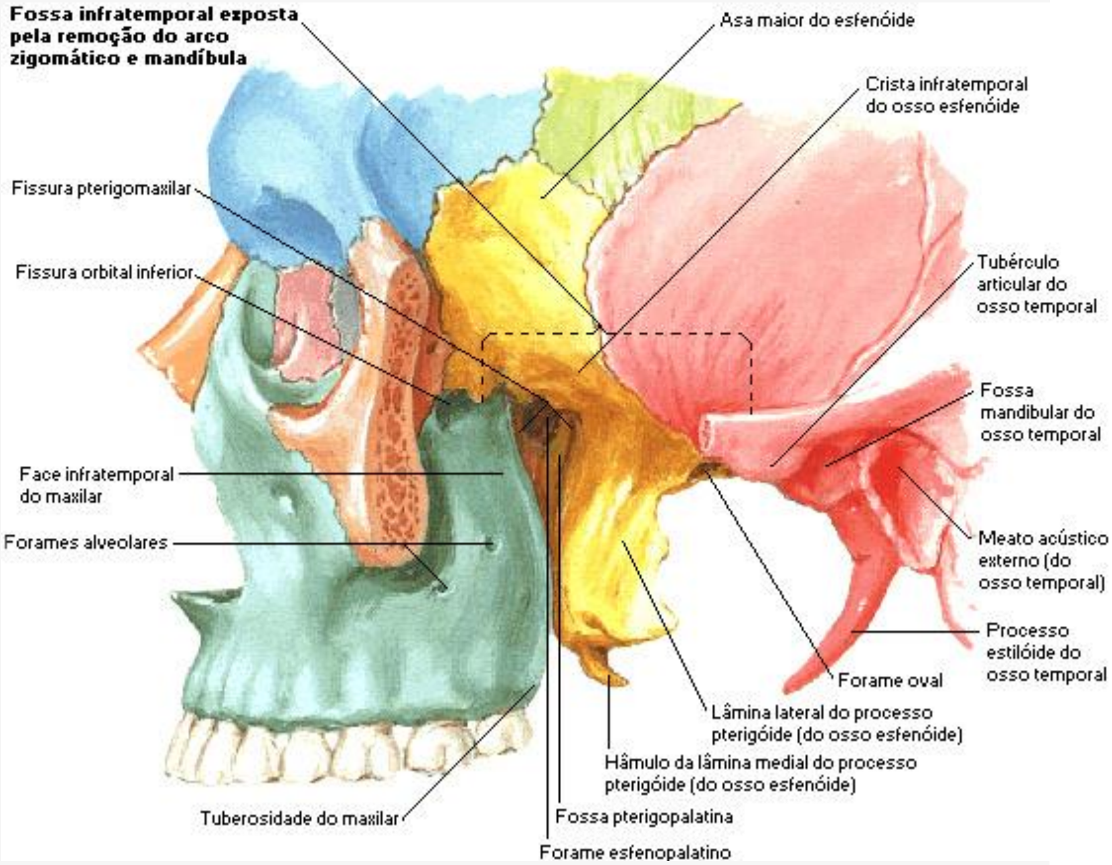


Skull Side View

SKULL SIDE VIEW

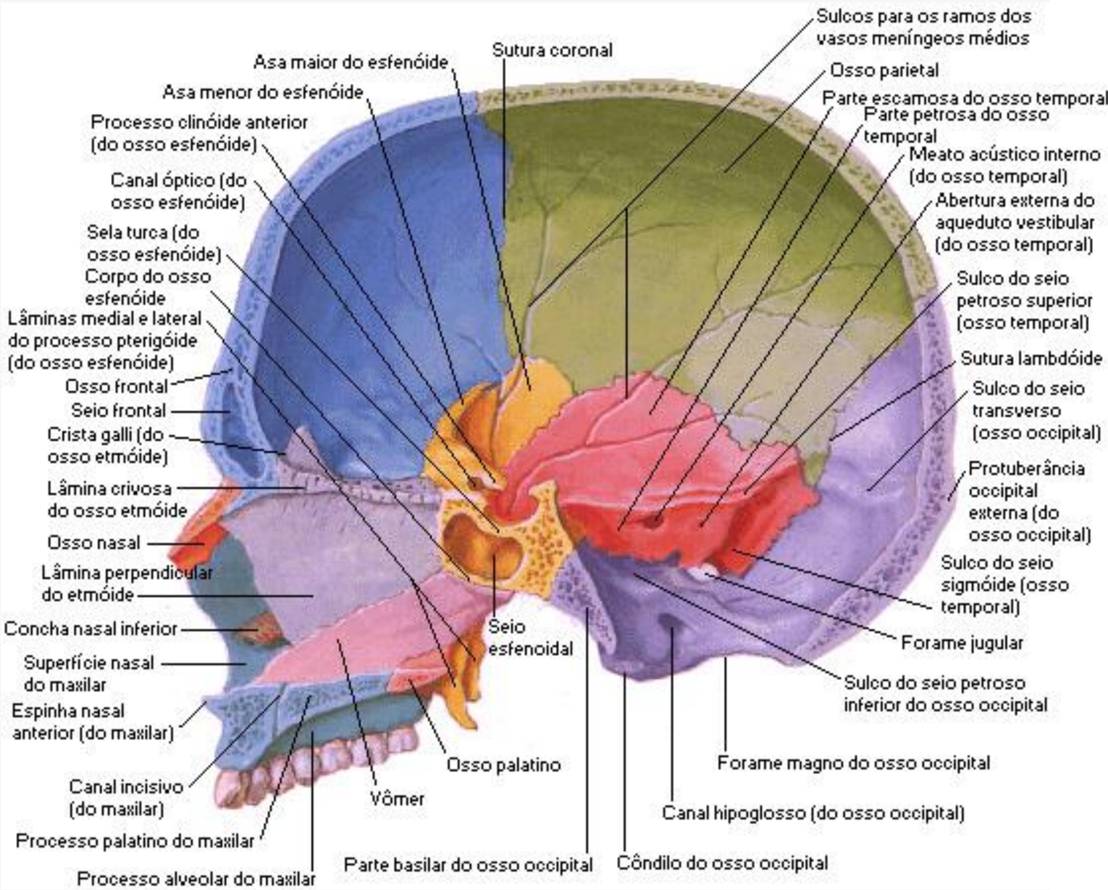


SKULL SIDE VIEW



Medial View of the Skull

MEDICAL SKULL VIEW



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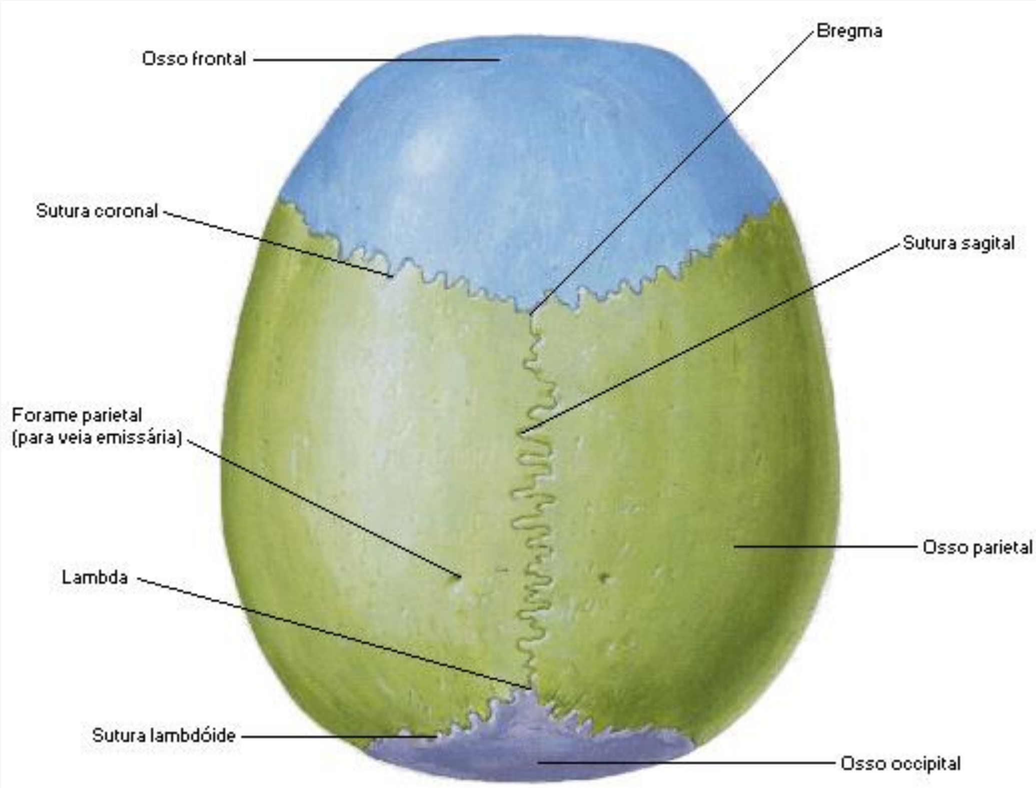
SKULL TOP VIEW & #8211; EXTERNAL FACE



Cranial tanks

It is divided into 3 pits:

Anterior Fossa Medium Fossa Posterior Fossa



Anterior Fossa

Limits:

Inner blade from front to back edge of minor sphenoid wing

Bones:

Frontal, Sphenoid and Ethmoid

Forams:

Blind foramen & #8211; passage of a small vein from the nasal cavity to the superior sagittal sinus

Screening Blade & #8211; 1st Cranial Pair Passage (Olfactory Nerve)

Optical Channel & #8211; Passage of the 2nd Cranial Pair (Optic Nerve) and Ophthalmic Artery

Middle Fossa

Limits:

Posterior edge of minor sphenoid wing to upper edge of petrous portion of thunderstorms

Bones:

Sphenoid and Temporal

Foramen:

Superior Orbital Fissure & #8211; Passage of the III Cranial Pair (Oculomotor Nerve), IV Cranial Pair (Trochl Nerve), V Cranial Pair (Trigeminal Nerve & #8211; Ophthalmic Branch), VI Cranial Pair (Abducent Nerve) and Ophthalmic Vein

Round Forame & #8211; V Cranial Pair Passage (Trigeminal Nerve & #8211; Jaw Branch)

Oval foramen & #8211; V Cranial Pair Passage (Trigeminal Nerve & #8211; Mandibular Branch)

Prickly foramen & #8211; Middle Meningeal Artery Bypass

Later or Torn Anterior & #8211; nothing is covered with fibrous tissue

Carotid Channel & #8211; Carotid artery passage

Posterior Fossa

Limits:

Upper edge of the temporal rock portion to the occipital bone internal lamina

Bones:

Temporal and Occipital

Foramen:

Internal Acoustic Meato & #8211; Passage of the VII Cranial Pair (Facial Nerve), VIII Cranial P (Vestibulocochlear Nerve)

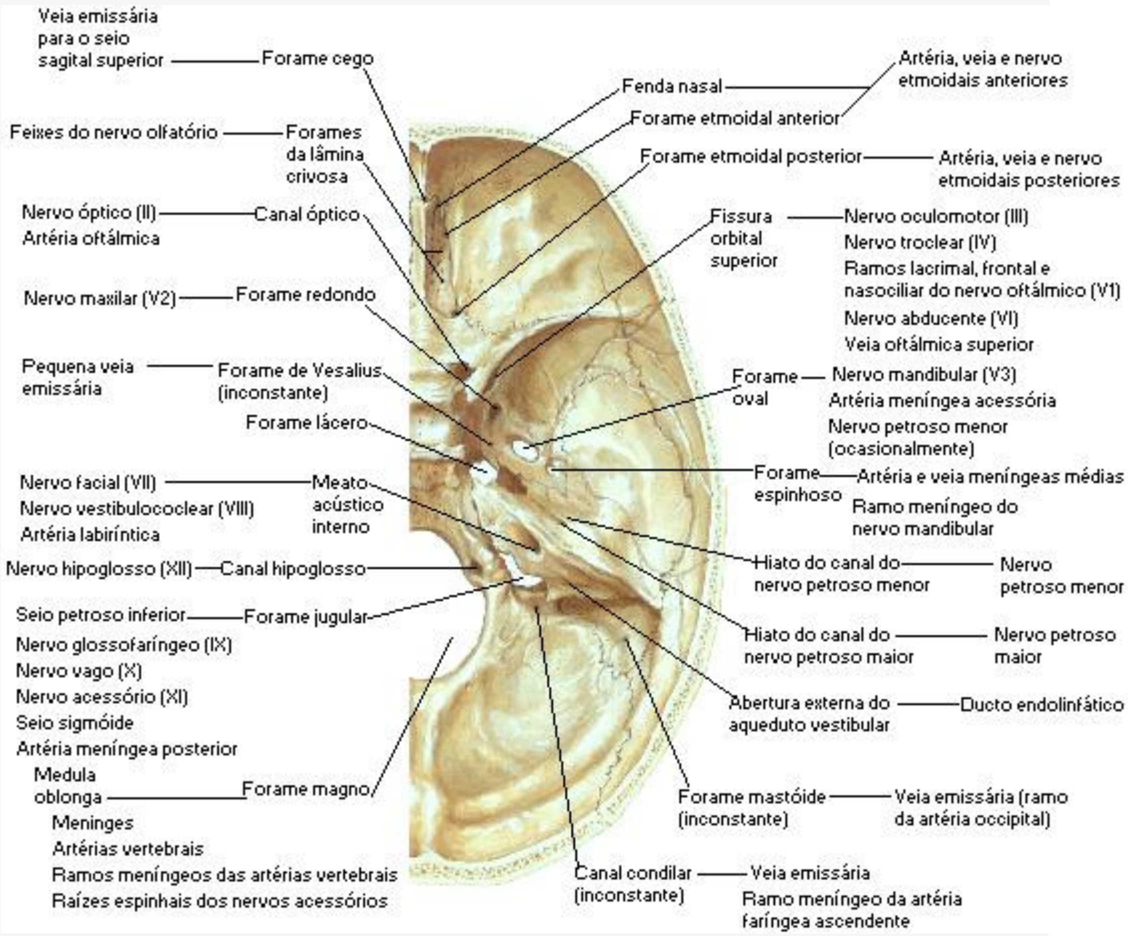
Jugular foramen & #8211; Passage of IX Cranial Pair (Glossopharyngeal Nerve), X Cranial Pair (Vague Nerve) a XI Cranial Pair (Accessory Nerve) and Internal Jugular Vein

Hypoglossal Channel & #8211; Passage of the XII Cranial Pair (Hypoglossal Nerve)

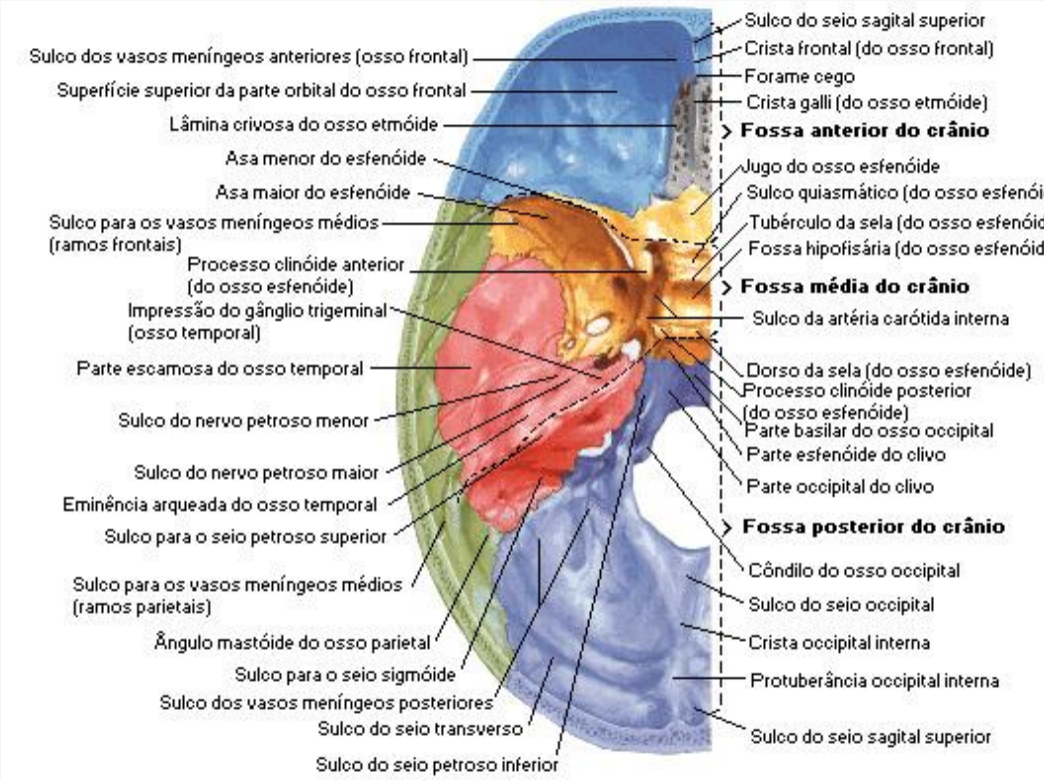
Condylar Canal & #8211; Fickle

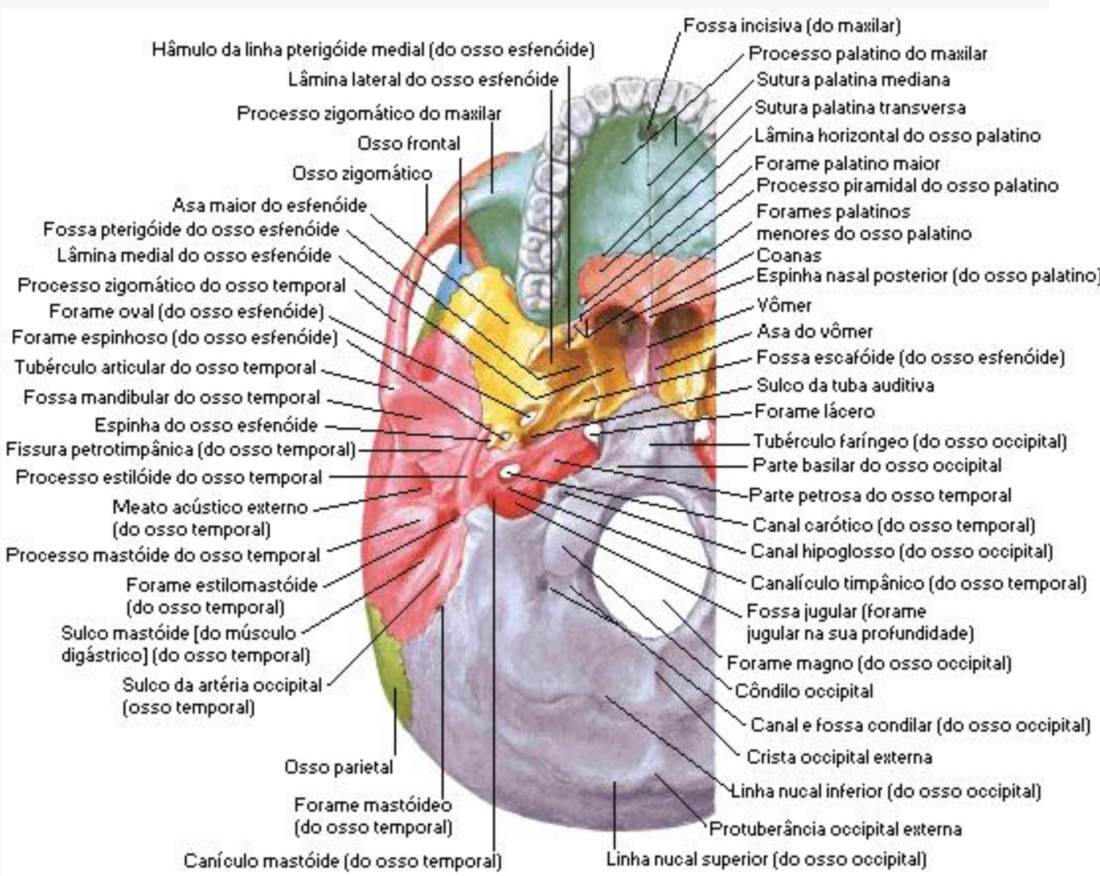
Forame Magno & #8211; Bulb passage, meninges, cerebrospinal fluid, vertebral arteries, spinal roots, and accesso nerve

CRANIAL PITCH STRUCTURES



CRANIAL CELLS BONES


Sulco do seio sagital superior
Crista frontal (do osso frontal)
Forame cego
Crista galli (do osso etmóide)
Fossa anterior do crânio
Jugo do osso esfenóide
Sulco quiasmático (do osso esfenóide)
Tubérculo da sela (do osso esfenóide)
Fossa hipofisária (do osso esfenóide)
Fossa média do crânio
Sulco da artéria carótida interna
Dorso da sela (do osso esfenóide)
Processo clinóide posterior (do osso esfenóide)
Parte basilar do osso occipital
Parte esfenóide do clivo
Parte occipital do clivo
Fossa posterior do crânio
Côndilo do osso occipital
Sulco do seio occipital
Crista occipital interna
Protuberância occipital interna
Sulco do seio sagital superior
Sulco dos vasos meníngeos anteriores (osso frontal)
Superfície superior da parte orbital do osso frontal
Lâmina crivosa do osso etmóide
Asa menor do esfenóide
Asa maior do esfenóide
Sulco para os vasos meníngeos médios (ramos frontais)
Processo clinóide anterior (do osso esfenóide)
Impressão do gânglio trigeminal (osso temporal)
Parte escamosa do osso temporal
Sulco do nervo petroso menor
Sulco do nervo petroso maior
Eminência arqueada do osso temporal
Sulco para o seio petroso superior
Sulco para os vasos meníngeos médios (ramos parietais)
Ângulo mastóide do osso parietal
Sulco para o seio sigmóide
Sulco dos vasos meníngeos posteriores
Sulco do seio transverso
Sulco do seio petroso inferior


Fossa incisiva (do maxilar)
Processo palatino do maxilar
Sutura palatina mediana
Sutura palatina transversa
Lâmina horizontal do osso palatino
Forame palatino maior
Processo piramidal do osso palatino
Forames palatinos menores do osso palatino
Coanas
Espinha nasal posterior (do osso palatino)
Vômer
Asa do vômer
Fossa escafóide (do osso esfenóide)
Sulco da tuba auditiva
Forame lácero
Tubérculo faríngeo (do osso occipital)
Parte basilar do osso occipital
Parte petrosa do osso temporal
Canal carótico (do osso temporal)
Canal hipoglosso (do osso occipital)
Canalículo timpânico (do osso temporal)
Fossa jugular (forame jugular na sua profundidade)
Forame magno (do osso occipital)
Côndilo occipital
Canal e fossa condilar (do osso occipital)
Crista occipital externa
Linha nucal inferior (do osso occipital)
Protuberância occipital externa
Linha nucal superior (do osso occipital)
Hâmulo da linha pterigóide medial (do osso esfenóide)
Lâmina lateral do osso esfenóide
Processo zigomático do maxilar
Osso frontal
Osso zigomático
Asa maior do esfenóide
Fossa pterigóide do osso esfenóide
Lâmina medial do osso esfenóide
Processo zigomático do osso temporal
Forame oval (do osso esfenóide)
Forame espinhoso (do osso esfenóide)
Tubérculo articular do osso temporal
Fossa mandibular do osso temporal
Espinha do osso esfenóide
Fissura petrotimpânica (do osso temporal)
Processo estilóide do osso temporal
Meato acústico externo (do osso temporal)
Processo mastóide do osso temporal
Forame estilomastóide (do osso temporal)
Sulco mastóide [do músculo digástrico] (do osso temporal)
Sulco da artéria occipital (osso temporal)
Osso parietal
Forame mastóideo (do osso temporal)
Caníulo mastóide (do osso temporal)

Nasal cavity

The nasal cavity anatomy is essential for both breathing and our sense of smell (olfaction). But did you know that 80% of taste actually comes from what we smell? That is why food is almost tasteless when our nose is clogged.

The nose is the most prominent part of the human face. It has internal and external parts. If you're in show business, the appearance of the external part is certainly very important. However besides esthetics, the external nose also functions to protect the inner nose and allows the entry of air. The internal part of the nose is termed the nasal cavity. It is involved in respiration, olfaction, speech and taste. In this page, we are going to study the nose anatomy, with a special focus on the anatomical importance of the nasal cavity structure.

Key facts about the anatomy of the nasal cavity

External nose	The external part of the nose consists of a root (superiorly), apex (inferiorly), dorsum, nares (nostrils) and the separating nasal septum. Bony component: nasal, maxillae and frontal bones Cartilaginous component: alar cartilages (major, minor), lateral processes, septal cartilage
Nasal cavity	Bones: nasal, maxilla, sphenod, vomer, palatine, lacrimal, ethmoid (*mnemonic*: Nerdy Medical Students are often Very PaLE) Apertures: nares, nasal conchae (superior, middle, inferior) Channels: inferior nasal meatus, middle nasal meatus, superior nasal meatus, sphenoethmoidal recess Regions: vestibule, respiratory region, olfactory region
Blood supply	External carotid artery and its branches: sphenopalatine, greater palatine, superior labial and lateral nasal arteries Internal carotid artery and its branches: anterior and posterior ethmoidal arteries
Nerve supply	Olfactory nerve: olfaction Trigeminal nerve: general sensation Facial nerve: serous glands secretion (parasympathetic) T1 level of spinal cord: regulation of mucosal blood flow (sympathetic)

Contents

3. Deviated septum

+ Show all

Nose

The external nasal anatomy is quite simple. It is a pyramidal structure, with its root located superiorly and apex sitting inferiorly. The root is continuous with the anterior surface of the head and the part between the root and the apex is called the dorsum of the nose. Inferior to the apex are the two nares (nostrils), which are the openings to the nasal cavity. The nares are separated by the nasal septum and are laterally bounded by the ala nasi (wings of the nostrils) which are the lateral processes of the septum.

The external nose is comprised of both bony and cartilaginous components. The bony part shapes the nose root, formed by the nasal, maxillae and frontal bones. The cartilaginous part is located inferiorly and is comprised of several alar, two lateral, and one septal cartilage:

- Alar cartilages; major alar cartilage forms the apex of the nose, minor alar cartilages support the ala nasi
- Lateral processes of the alar cartilage; form the dorsum of the nose
- Septal cartilage; bounds the nares medially

Note that the septal cartilage is attached to both the bony nasal septum (which is actually the perpendicular plate of the ethmoid bone) and the vomer bone. Both nasal septum and vomer are bony parts of the internal nose.

Nasal cavity

The internal part of the nose is the nasal cavity. The two nasal cavities sit within the external nose and the adjacent skull. The cavities open anteriorly to the face through the two nares. Posteriorly the cavities communicate with the nasopharynx by two apertures called choanae.

Besides the anterior and posterior apertures, each nasal cavity has a roof, floor, and lateral and medial walls. There are 12 cranial bones in total that contribute to the nasal cavity structure, which include the paired nasal, maxilla, palatine and lacrimal bones, as well as the unpaired ethmoid, sphenoid, frontal and vomer bones.Among all of them, the ethmoid bone is the most important element, for two reasons: first, it makes the greatest portion of the nasal skeletal framework by forming the roof and walls of the nasal cavities; and second, it contains ethmoidal cells which, as a group, are one of the four paranasal sinuses.

The nasal bones can easily be remembered by using this mnemonic: Nerdy Medical Students are often Very PaLE (Nasal, Maxilla, Sphenod, Vomer, Palatine, Lacrimal, Ethmoid)

Three bony shelves called the inferior, middle and superior nasal conchae are attached to the lateral walls and by projecting into the cavities, they divide both nasal cavities into four air channels:

- Inferior nasal meatus; between the floor and inferior concha
- Middle nasal meatus; between the inferior and middle concha
- Superior nasal meatus; between the middle and superior concha
- Sphenoethmoidal recess; between the superior concha and the nasal cavity roof

The nasal cavity is divided into three regions, aligned as if a three floor building. The vestibule is located just inside the anterior external opening of the nose (1st floor) and it contains hair follicles. The largest region is the respiratory region, which is lined with respiratory epithelium (2nd floor). Finally, there is the olfactory region, a small area located inside the skull at the superior apex of the cavity, which is lined with olfactory cells and receptors (3rd floor).

The two nasal cavities communicate with four bony recesses called the paranasal sinuses. They are named according to the bones they are placed within, as the: sphenoidal, maxillary, and frontal sinuses, and the ethmoidal cells. All of the sinuses are covered by respiratory mucosa and innervated by the trigeminal nerve (CN V).

To learn everything about the nasal cavity in a fun and engaging way, check out these articles, video tutorials and clinical case.


Clinical case: Schwannoma of the nasal cavityRead article

Blood supply

The nose is supplied by branches of both the external and internal carotid arteries. The external carotid artery sends the sphenopalatine, greater palatine, superior labial and lateral nasal arteries which mostly supply the vestibule and respiratory portions of the nasal cavity, as well as the surrounding parts of the external nose (apex and dorsum).The internal carotid artery gives off the anterior and posterior ethmoidal arteries which mostly supply the apex of the nasal cavity and the surrounding part of the external nose. Many of the external and internal carotid arterial branches anastomose at the anterior part of the medial wall. This particular spot is the place from where the most nosebleeds occur.

Learn more about the blood supply of the nose, and which part of the nose each branch supplies, from this resource:

Nerve supply

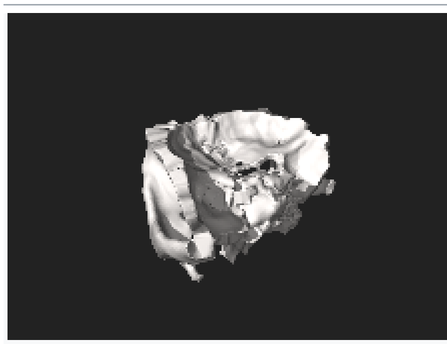
The nose is innervated by three cranial nerves:

- Olfaction is provided by the olfactory nerve (CN I)
- General sensation is carried by the trigeminal nerve (CN V)
- Serous glands in the nasal mucosa which produce fluid that constantly lubricates the nose walls are innervated by the parasympathetic fibers of the facial nerve (CN VII). Sympathetic innervation comes from T1 level of spinal cord and is intended for regulation of blood flow through mucosa

To learn everything about the nerves that supply the nose, and their branches, check out the following resources:

Orbit (anatomy)

In anatomy, the orbit **is the cavity or socket of the skull in which the eye and its appendages are situated. "Orbit" can refer to the bony socket,[1] or it can also be used to imply the contents.[2] In the adult human, the volume of the orbit is 30 millilitres (1.06 imp fl oz; 1.01 US fl oz), of which the eye occupies 6.5 ml (0.23 imp fl oz; 0.22 US fl oz).[3] The orbital contents comprise the eye, the orbital and retrobulbar fascia, extraocular muscles, cranial nerves II, III, IV, V, and VI, blood vessels, fat, the lacrimal gland with its sac and duct, the eyelids, medial and lateral palpebral ligaments, check ligaments, the suspensory ligament, septum, ciliary ganglion and short ciliary nerves.** Structure[edit]



3D model of Orbit with surrounding bones

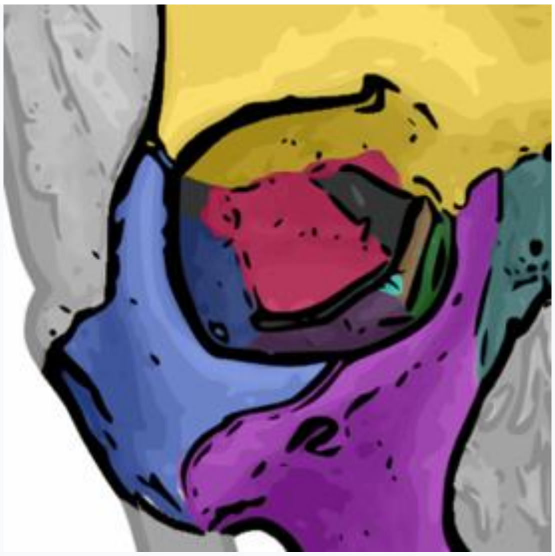
The orbits are conical or four-sided pyramidal cavities, which open into the midline of the face and point back into the head. Each consists of a base, an apex and four walls.[4]

Openings[edit]

There are two important foramina, or windows, two important fissures, or grooves, and one canal surrounding the globe in the orbit. There is a supraorbital foramen, an infraorbital foramen, a superior orbital fissure, an inferior orbital fissure and the optic canal, each of which contains structures that are crucial to normal eye functioning. The supraorbital foramen contains the supraorbital nerve, the first division of the trigeminal nerve or V1 and lies just lateral to the frontal sinus. The infraorbital foramen contains the second division of the trigeminal nerve, the infraorbital nerve or V2, and sits on the anterior wall of the maxillary sinus. Both foramina are crucial as potential pathways for cancer and infections of the orbit to spread into the brain or other deep facial structures.

The optic canal contains the [[]] (cranial nerve II) and the ophthalmic artery, and sits at the junction of the sphenoid sinus with the ethmoid air cells, superomedial and posterior to structures at the orbital apex. It provides a pathway between the orbital contents and the middle cranial fossa. The superior orbital fissure lies just lateral and inferior to the optic canal, and is formed at the junction of the lesser and greater wing of the sphenoid bone. It is a major pathway for intracranial communication, containing cranial nerves III, IV, VI which control eye movement via the extraocular muscles, and the ophthalmic branches of cranial nerve V, or V1. The second division of the trigeminal nerve enters the skull base at the foramen rotundum, or V2. The inferior orbital fissure lies inferior and lateral to the ocular globe at the lateral wall of the maxillary sinus. It is not as important in function, though it does contain a few branches of the maxillary nerve and the infraorbital artery and vein.[5] Other minor structures in the orbit include the anterior and posterior ethmoidal foramen and zygomatic orbital foramen.

Bony walls[edit]



The seven bones that form the orbit:
yellow = Frontal bone
green = Lacrimal bone
brown = Ethmoid bone
blue = Zygomatic bone
purple = Maxillary bone
aqua = Palatine bone
red = Sphenoid bone

teal = Nasal bone (illustrated but not part of the orbit)

The bony walls of the orbital canal in humans do not derive from a single bone, but a mosaic of seven embryologically distinct structures: the zygomatic bone laterally, the sphenoid bone, with its lesser wing forming the optic canal and its greater wing forming the lateral posterior portion of the bony orbital process, the maxillary bone inferiorly and medially which, along with the lacrimal and ethmoid bones, forms the medial wall of the orbital canal. The ethmoid air cells are extremely thin, and form a structure known as the lamina papyracea, the most delicate bony structure in the skull, and one of the most commonly fractured bones in orbital trauma. The lacrimal bone also contains the nasolacrimal duct. The superior bony margin of the orbital rim, otherwise known as the orbital process, is formed by the frontal bone.[6]

The roof (superior wall) is formed primarily by the orbital plate frontal bone, and also the lesser wing of sphenoid near the apex of the orbit. The orbital surface presents medially by trochlear fovea and laterally by lacrimal fossa.[7]

The floor (inferior wall) is formed by the orbital surface of maxilla, the orbital surface of zygomatic bone and the minute orbital process of palatine bone. Medially, near the orbital margin, is located the groove for nasolacrimal duct. Near the middle of the floor, located infraorbital groove, which leads to the infraorbital foramen. The floor is separated from the lateral wall by inferior orbital fissure, which connects the orbit to pterygopalatine and infratemporal fossa.

The medial wall is formed primarily by the orbital plate of ethmoid, as well as contributions from the frontal process of maxilla, the lacrimal bone, and a small part of the body of the sphenoid. It is the thinnest wall of the orbit, evidenced by pneumatized ethmoidal cells.[7]

The lateral wall is formed by the frontal process of zygomatic and more posteriorly by the orbital plate of the greater wing of sphenoid. The bones meet at the zygomaticosphenoid suture. The lateral wall is the thickest wall of the orbit, important because it is the most exposed surface, highly vulnerable to blunt force trauma.

Borders[edit]

The base, which opens in the face, has four borders. The following bones take part in their formation:

1. Superior margin: frontal bone and sphenoid
2. Inferior margin: maxillary bone, palatine and zygomatic
3. Medial margin: ethmoid, lacrimal bone, sphenoid (body of) and maxilla
4. Lateral margin: zygomatic and sphenoid (greater wing)

Function[edit]

The orbit holds and protects the eye.

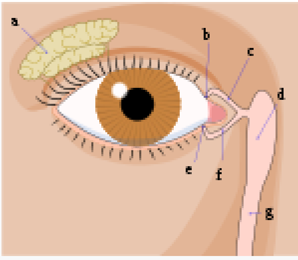
Eye movement[edit]

Main article: Eye movement

The movement of the eye is controlled by six distinct extraocular muscles, a superior, an inferior, a medial and a lateral rectus, as well as a superior and an inferior oblique. The superior ophthalmic vein is a sigmoidal vessel along the superior margin of the orbital canal that drains deoxygenated blood from surrounding musculature. The ophthalmic artery is a crucial structure in the orbit, as it is often the only source of collateral blood to the brain in cases of large internal carotid infarcts, as it is a collateral pathway to the circle of Willis. In addition, there is the optic canal, which contains the optic nerve, or cranial nerve II, and is formed entirely by the lesser wing of the sphenoid, separated from the supraorbital fissure by the optic strut. Injury to any one of these structures by infection, trauma or neoplasm can cause temporary or permanent visual dysfunction, and even blindness if not promptly corrected.[8] The orbits also protect the eye from mechanical injury.[4]

Clinical significance[edit]

In the orbit, the surrounding fascia allows for smooth rotation and protects the orbital contents. If excessive tissue accumulates behind the ocular globe, the eye can protrude, or become exophthalmic.[4]



Tear system:
a. tear gland / lacrimal gland,
b. superior lacrimal punctum,
c. superior lacrimal canal,
d. tear sac / lacrimal sac,
e. inferior lacrimal punctum,
f. inferior lacrimal canal,
g. nasolacrimal canal

Enlargement of the lacrimal gland, located superotemporally within the orbit, produces protrusion of the eye inferiorly and medially (away from the location of the lacrimal gland). Lacrimal gland may be enlarged from inflammation (e.g. sarcoid) or neoplasm (e.g. lymphoma or adenoid cystic carcinoma).[9]

Tumors (e.g. glioma and meningioma of the optic nerve) within the cone formed by the horizontal rectus muscles produce axial protrusion (bulging forward) of the eye.

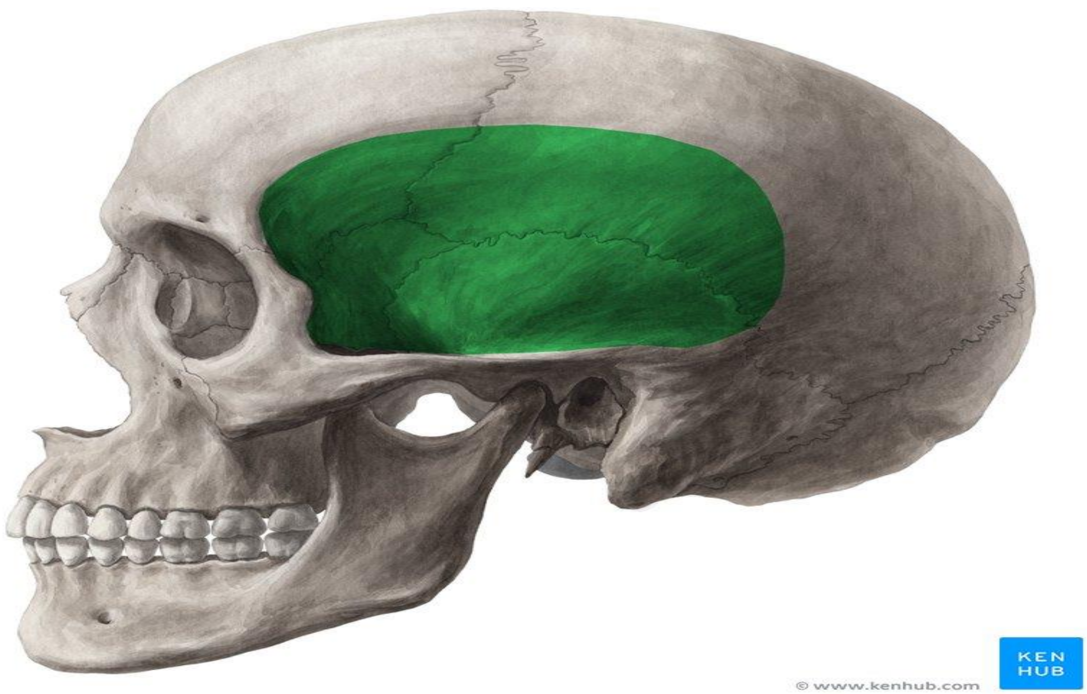
Graves disease may also cause axial protrusion of the eye, known as Graves' ophthalmopathy, due to buildup of extracellular matrix proteins and fibrosis in the rectus muscles. Development of Graves' ophthalmopathy may be independent of thyroid function

anatomy and topographic of thetemporal fossa

The temporal fossa is a depression on the temporal region and one of the largest landmarks on the skull. The temporal bone, the sphenoid bone, the parietal bone and the frontal bone contribute to its concave wall. It is superior to the infratemporal fossa which lies beneath the zygomatic arch.

Borders

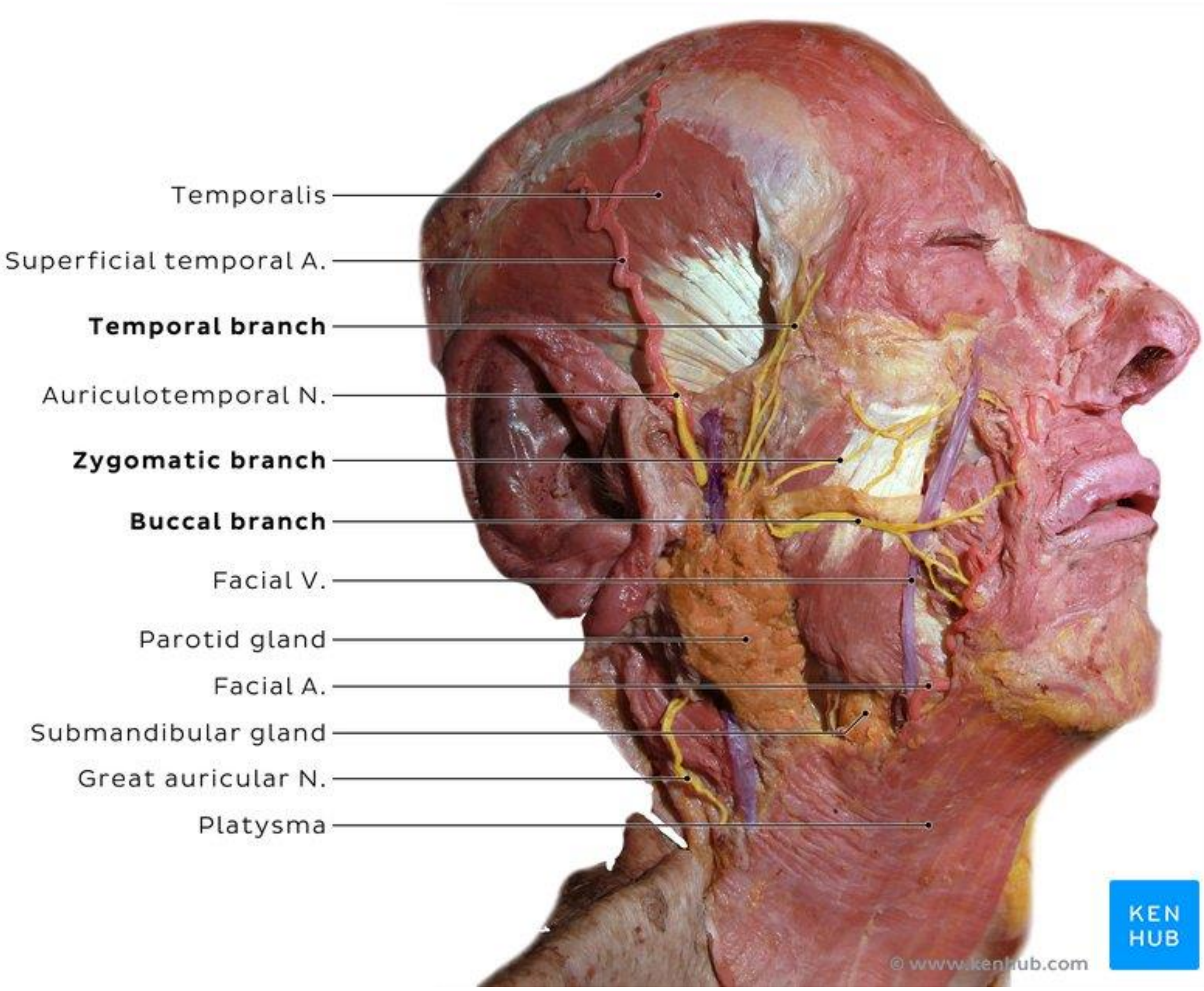
Both superiorly and posteriorly the temporal fossa is bordered by the superior temporal line (origin of the deep temporal fascia). The inferior border runs along the zygomatic arch. Lastly, the anterior border is marked by the frontal process of the zygoma and the zygomatic process of the frontal bone.



Contents

Muscles

The temporal fossa serves as a site of origin for the temporal muscle. It originates from the superior, anterior and posterior borders of the temporal fossa and resides within its concavity as the muscle fibers move towards their insertion point, which lies under the zygomatic arch.



Blood vessels

Middle temporal artery (Arteria temporalis media)

The superior temporal artery, a terminal branch of the external carotid artery, courses above the superficial temporal fascia. It branches off the medial temporal artery to the temporal muscle and two smaller arteries to the scalp (frontal and parietal branches).

The artery is accompanied by the superior temporal vein. The medial vein runs between the two layers of the temporal fascia.

Nerves

The fossa contains four branches from four different nerve bundles. The terminal branches include:

- a branch of the mandibular nerve (V3)
- the anterior and posterior branches of the deep temporal nerve
- the auriculotemporal nerve
- the temporal branches of the facial nerve.

anatomy and topographic of pterygopalatine fossa

The *pterygopalatine fossa* is a challenging topic in anatomy. First of all the name of that fossa and surrounding structures is difficult to remember; the second — fossa is localized deep in the middle of the skull in between 3 bones (*maxilla, palatine, and sphenoid*), and, finally, pterygoid fossa has six different connections to all main compartments of skull (two canals, two openings, and two fissures).

Side view of skull demonstrating the lateral entry into the *pterygopalatine fossa* — the *pterygomaxillary fissure.*

The list of terms:

Infero-lateral view of the skull shows multiple communications to the pterygopalatine fossa. Palatine canals connect fossa to the oral cavity, sphenopalatine foramen opens into the nasal cavity, and inferior orbital fissure communicates with the orbit.

The list of terms:

Dorsal and superior walls of the pterygopalatine fossa are exposed after removing bones of the face, as well as ethmoid and frontal bones. In order to have a view on pterygopalatine fossa, the skull has to be split like this::  Note the pterygoid canal and round opening *(foramen rotundum),* connecting fossa with the external base of the skull and middle cranial fossa respectively.

The list of terms:

Back view of the pterygopalatine fossa. Note the communication with the nasal cavity via *foramen sphenopalatinum* on the medial wall of the fossa.The **pterygopalatine fossa** is a bilateral, cone-shaped depression extending deep from the infratemporal fossa all the way to the nasal cavity via the sphenopalatine foramen.

It is located between the maxilla, sphenoid and **palatine** bones, and communicates with other regions of the skull and facial skeleton via several canals and foramina. Its small volume combined with the numerous structures that pass through makes this a complex region for anatomy students.

This article will discuss the **pterygopalatine fossa**, and consider the structures involved according to their respective foramina.

By TeachMeSeries Ltd (2020)

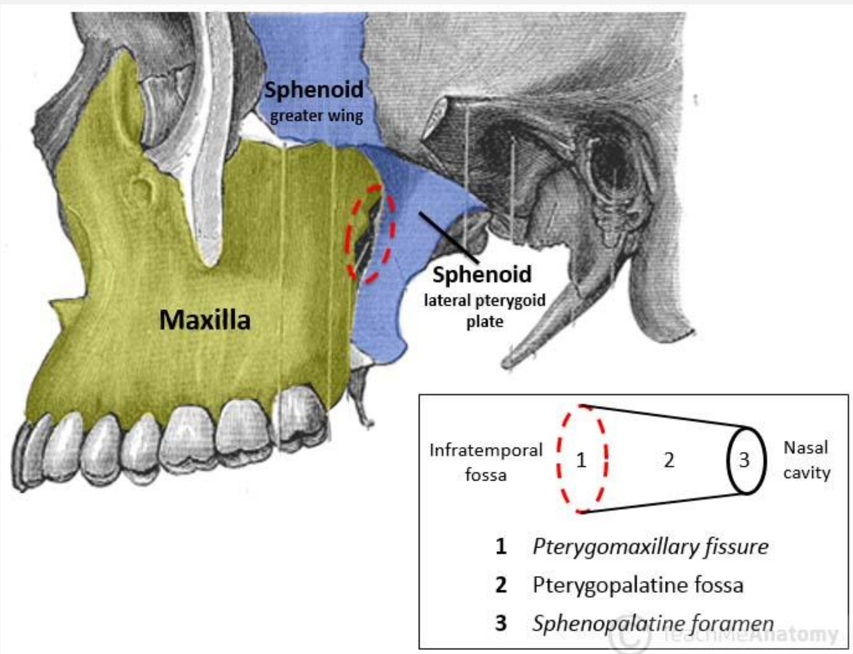


Fig 1.0 – Left infratemoporal fossa demonstrating the opening of the pterygopalatine fossa (circled in red). Note: the zygomatic arch has been removed in this image.

Borders

The borders of the pterygopalatine fossa are formed by the palatine, maxilla and sphenoid bones:

- **Anterior**: Posterior wall of the maxillary sinus.
- **Posterior**: Pterygoid process of the sphenoid bone.
- **Inferior**: Palatine bone and palatine canals.
- **Superior**: Inferior orbital fissure of the eye.
- **Medial**: Perpendicular plate of the palatine bone

- **Lateral**: Pterygomaxillary fissure

Contents

The Pterygopalatine Fossa contains many important neurovascular structures. Here we will discuss the maxillary nerve and its branches, the pterygopalatine ganglion and the maxillary artery and its branches.

Maxillary Nerve

The maxillary nerve is the second branch of the trigeminal nerve (CNV_2). It passes from the middle cranial fossa into the pterygopalatine fossa through the **foramen rotundum**.

The main trunk of the maxillary nerve leaves the pterygopalatine fossa via the **infraorbital fissure**. Here, it enters the infraorbital canal of the maxilla and exits below the orbit in the infraorbital foramen to contribute to the sensory innervation of the face (figures 2.0 & 2.1).

While in the pterygopalatine fossa, the maxillary nerve gives of numerous branches including the infraorbital, zygomatic, nasopalatine, superior alveolar, pharyngeal and the greater and lesser palatine nerves. The maxillary nerve also communicates with the **pterygopalatine ganglion** (discussed below) via two small trunks, the **pterygopalatine nerves** (figure 2.1). These nerves suspend the ganglion within the pterygopalatine fossa.

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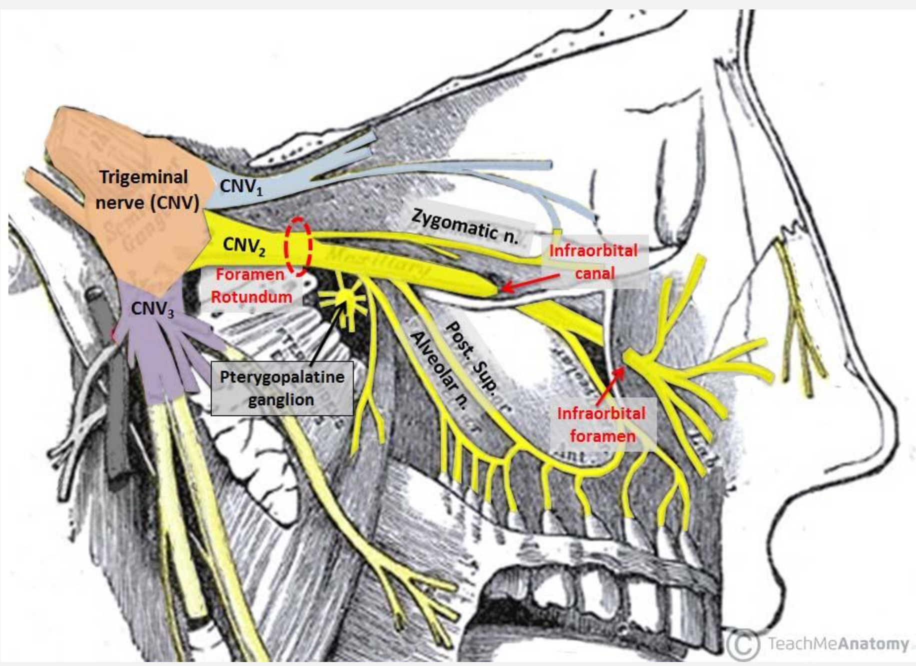

Fig 2.0 – The main trunk of the maxillary nerve (CNV2); showing the origin at the trigeminal nerve and its path to external facial structures.

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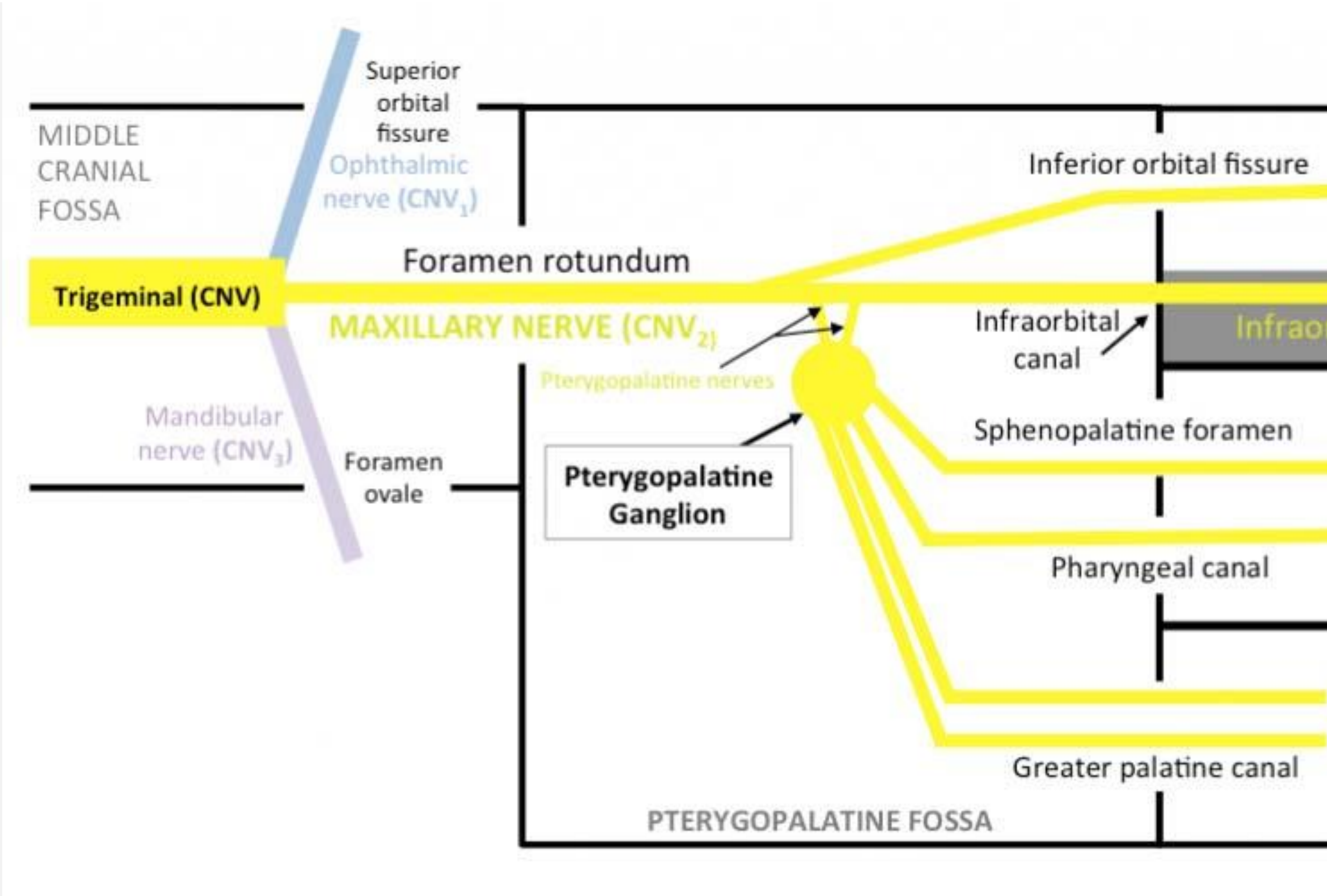

Fig 2.1 – The branches of the pterygopalatine ganglion and the maxillary nerve. Note: For simplicity, this schematic does not show: the contribution of the facial nerve (CNVII) to the pterygopalatine ganglion, the posterior superior alveolar nerves, or the nerve of the pterygoid canal.

Pterygopalatine Ganglion

The pterygopalatine ganglion sits deep within the pterygopalatine fossa near the sphenopalatine foramen. It is the largest parasympathetic ganglion related to branches of the maxillary nerve (via pterygopalatine branches) and is predominantly innervated by the **greater petrosal branch of the facial nerve (CNVII).**

Postsynaptic parasympathetic fibres leave the ganglion and distribute with branches of the maxillary nerve (CNV_2). These fibres are **secretomotor** in function, and provide **parasympathetic innervation** to the lacrimal gland, and muscosal glands of the oral cavity, nose and pharynx.

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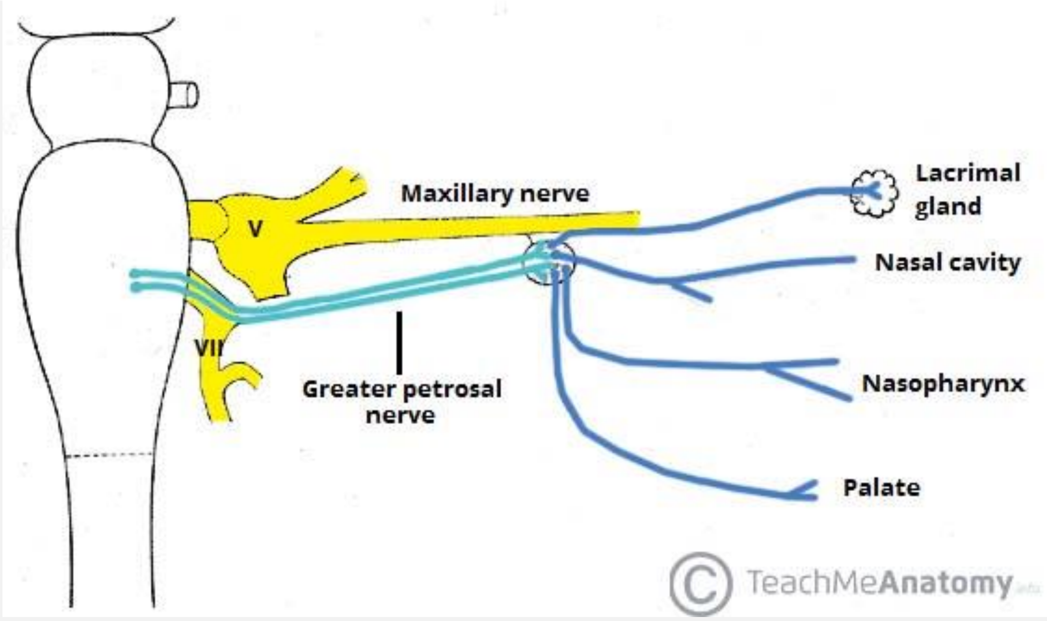

Fig 3.0 – The pterygopalatine ganglion and its branches.

Maxillary Artery

The maxillary artery is a terminal branch of the **external carotid artery**. The terminal portion of the maxillary artery lies within the pterygopalatine fossa. Here, it separates into several branches which travel through other openings within the fossa to reach the regions they supply.

These branches include, but are not limited to:

- **Sphenopalatine artery** (to the nasal cavity).
- **Descending palatine artery** – branches into greater and lesser palatine arteries (hard and soft palates).
- **Infraorbital artery** (lacrimal gland, and some muscles of the eye).
- **Posterior superior alveolar artery** (to the teeth and gingiva).

At their terminal ends, the sphenopalatine and greater palatine arteries anastomose at the nasal septum.

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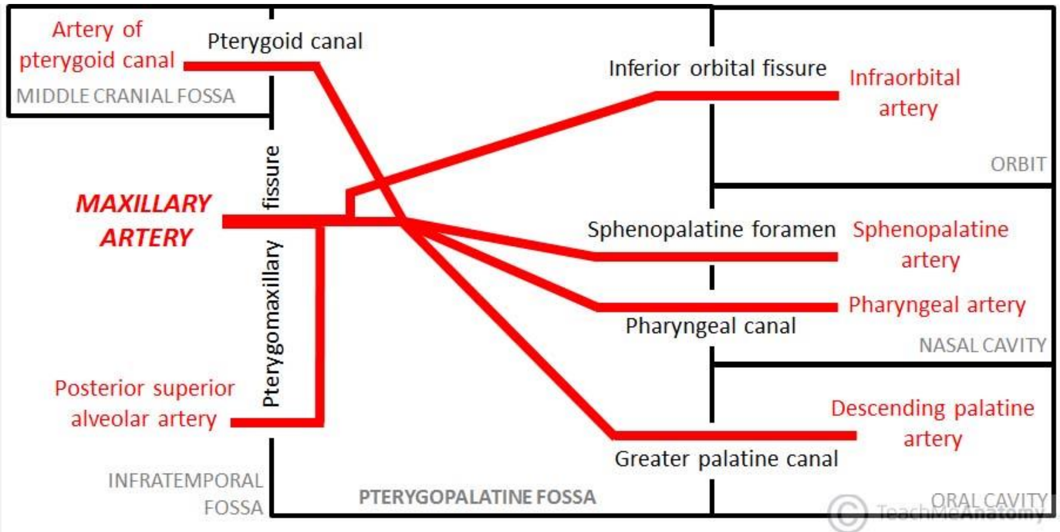


Fig 4.0 – Branches of the maxillary artery and their related foramina and cavities.

Foramina

There are seven openings (also known as foramina) that connect the pterygopalatine fossa with the orbit, nasal and oral cavities, middle cranial fossa and infratemporal fossa. The openings transmit blood vessels and nerves between these regions.

Pterygomaxillary Fissure

The pterygomaxillary fissure connects the **infratemporal fossa** with the pterygopalatine fossa (see figure 1). It transmits two neurovascular structures:

- **Posterior superior alveolar nerve** – a branch of the maxillary nerve. It exits through the fissure into the infratemporal fossa, where it goes on to supply the maxillary molars.
- **Terminal part of the maxillary artery** – enters the pterygopalatine fossa via the fissure.

Foramen Rotundum

The foramen rotundum connects the pterygopalatine fossa to the **middle cranial fossa**. It is one of three openings in the posterior boundary of the pterygopalatine fossa. It conducts a single structure, the **maxillary nerve.**

Pterygoid and Pharyngeal Canals

These two canals, along with the foramen rotundum, are the three openings in the posterior wall of the pterygopalatine fossa:

- **Pterygoid canal** – runs from the middle cranial fossa and through the medial pterygoid plate. It carries the nerve, artery and vein of the pterygoid canal.

- **Pharyngeal canal** – communicates with the nasopharynx. It carries the pharyngeal branches of the maxillary nerve and artery.

Inferior Orbital Fissure

The inferior orbital fissure forms the superior boundary of the pterygopalatine fossa and communicates with the **orbit**. It is a space between the sphenoid and maxilla bones.

The **zygomatic branch** of the maxillary nerve and the **infraorbital artery and vein** pass through the inferior orbital fissure.

Greater Palatine Canal

The greater palatine canal lies in the inferior boundary of the pterygopalatine fossa, and communicates with the **oral cavity**. The canal is formed by a vertical groove in the palatine bone which is closed off by an articulation with the maxilla. Branching from the greater palatine canal are the accessory **lesser palatine canals**.

The greater palatine canal transmits the descending palatine artery and vein, the **greater palatine nerve** and the **lesser palatine nerve**.

Sphenopalatine Foramen

This foramen is the only opening in the medial boundary. It connects the pterygopalatine fossa to the **nasal cavity** – specifically the superior meatus.

It is formed by the sphenopalatine notch at the superior aspect of the perpendicular plate of the palatine bone and the body of the sphenoid.

The sphenopalatine foramen transmits the **sphenopalatine artery and vein**, as well as the **nasopalatine nerve** (a large branch of the pterygopalatine ganglion – CNV_2).

connection of the vertebral column

Adjacent vertebral arches are connected by synovial joints called zygapophysial (facet) joints. They are formed between superior and inferior articular facets. These joints facilitate flexion and extension in the cervical and thoracic spines. They also permit rotational movements in the thoracic spine.

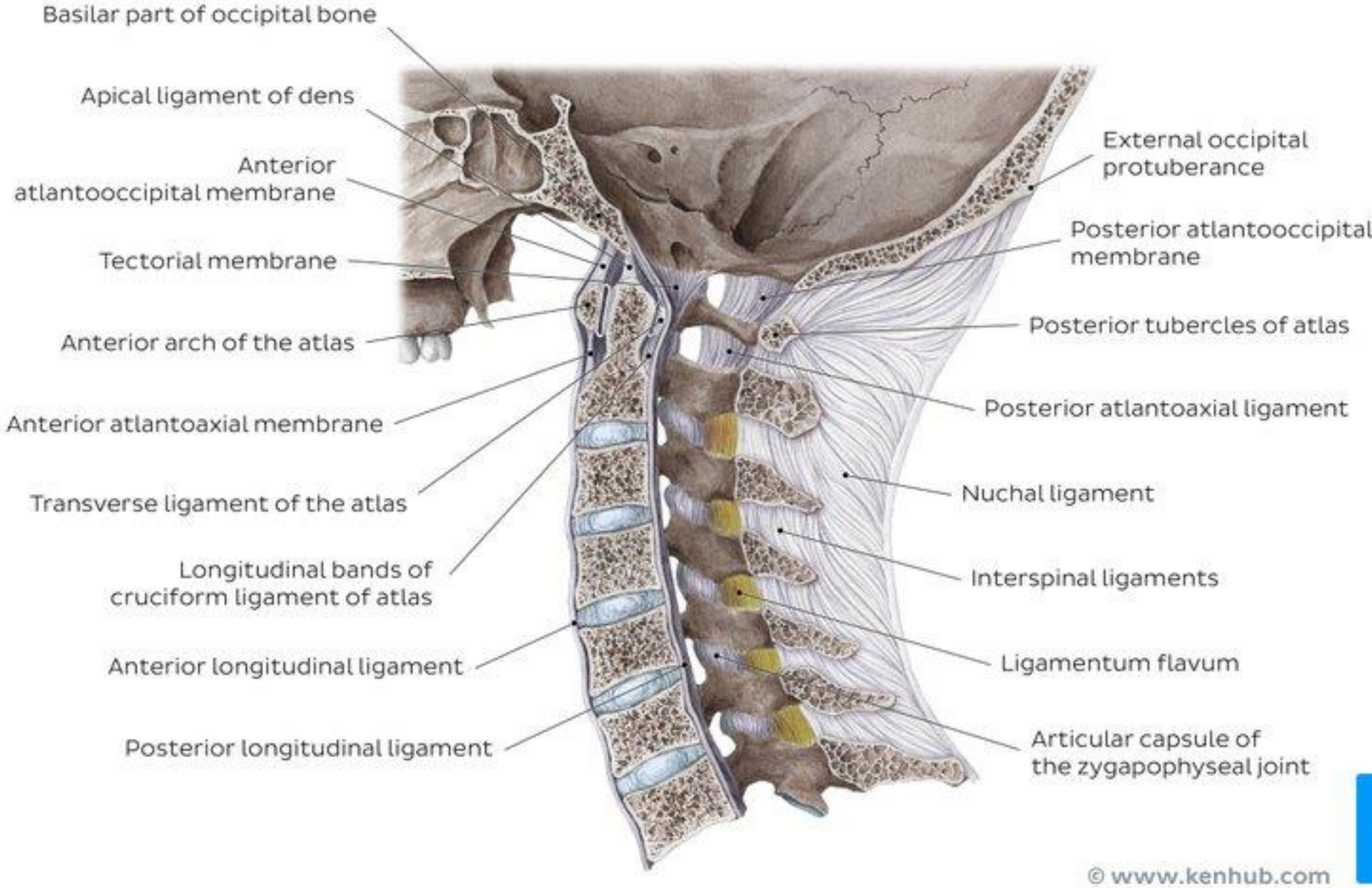
Ligamentum flavum

The vertebral arches are strengthened by several accessory ligaments:

- Ligamenta flava - connecting adjacent laminae. They prevent separation of the lamina during sudden flexion of the vertebral column.
- Interspinous ligaments - join spinous process of nearby vertebrae.
- Nuchal ligament - extends from the skull (occipital protruberance) to the spinous processes of C7 where it merges with the supraspinous ligament.
- Supraspinous ligament - a long band that connects the tips of the spinous processes.

Craniovertebral joints

There are two craniovertebral (synovial) joints formed between the skull and the atypical vertebrae of the cervical spine: atlanto-occipital and atlanto-axial. The atlanto-occipital joints are formed between the lateral masses of the atlas (C1) and the occipital condyles of the cranium. They permit flexion, extension, and sideways tilting of the head. Thanks to them, you can nod in approval. The atlanto-axial joints (two lateral, one median) are located between the C1 and C2 vertebrae. They facilitate a pivot motion of the head as in during a disapproving shake.



Craniovertebral joints and ligaments: Diagram

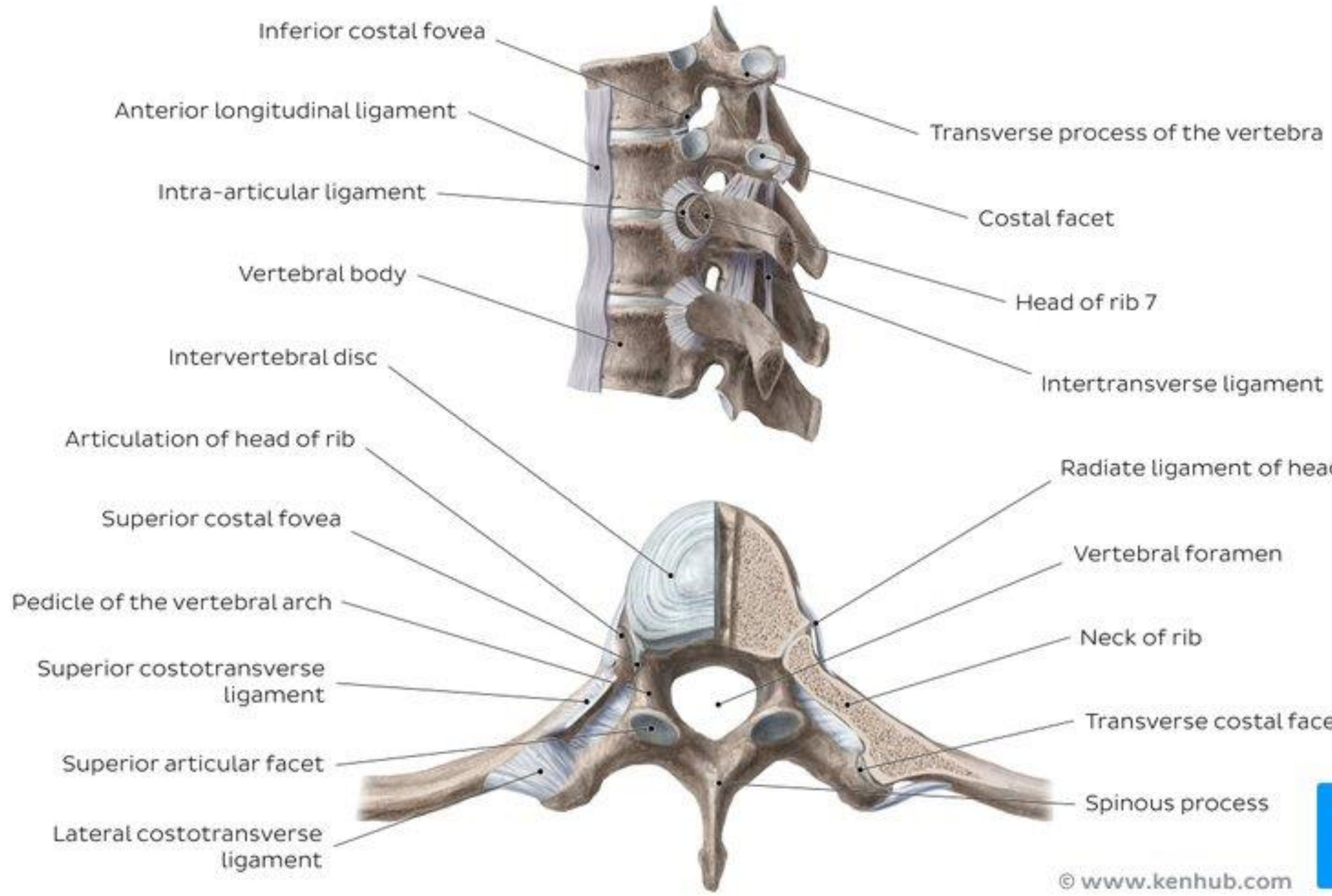
Several membranes and ligaments also connect the atlas, axis, and skull. The atlanto-occipital membrane (anterior, posterior) runs between the edges of the foramen magnum and the atlas, limiting the movement of the atlanto-occipital joints. The alar ligaments and tectorial membrane connect the axis to the occipital bone and floor of the cranial cavity, respectively. They prevent excessive rotation of the atlanto-axial joints. The cranium, atlas and axis are interconnected by the cruciate ligament of the atlas.

If you want to find out how craniovertebral joints and ligaments allow you to nod and shake your head, take a look at the following:

Craniovertebral ligamentsExplore study unit

Costovertebral joints

The costovertebral (synovial) joints represent the connection between the thoracic vertebrae and ribs. One type of costovertebral joints (costocorporeal joints) unite the head of ribs with the costal facets of two adjacent vertebral bodies (T2-T9), one superior and one inferior. The costocorporeal joints articulate with the costal facet of a single vertebra at T1, T10 and T11. They permit the ribs to rotate, ascend, and descend during breathing movements. The second type (costotransverse joints) forms between the rib tubercle and the transverse processes of the corresponding vertebra (T1-T10).



Costovertebral joints and ligaments: Diagram

The two joints are reinforced by three costotransverse ligaments (medial, lateral, superior). These run from the transverse processes to the neck and tubercle of the ribs, respectively. In addition, intra-articular and radiate ligaments of head of rib also support these joints. These extend to the sides of the vertebral bodies and the interconnecting intervertebral discs.

Costovertebral jointsExplore study unit

Sacroiliac joints

Sacroiliac joint (Articulatio sacroiliaca)

Last but not least, the sacrum of the vertebral column and the iliac bones are involved in forming the sacroiliac joints. They occur between the corresponding auricular surfaces and tuberosities of these two bones. The sacroiliac bones permit very little mobility, being involved in the transmission of weight from the upper to the lower body.

The stability of the sacroiliac joints is maintained by the sacro-iliac (anterior, interosseous, posterior), sacrotuberous, and sacrospinous ligaments. The latter two also connect to the coccyx in addition to the ilium and sacrum.

Do you want to test yourself on the anatomical structures that prevent the vertebral column from disintegrating? Check out the following!

Custom Quiz: Bones and ligaments of the vertebral columnStart quiz

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Spine curvature and movements

Flexion of vertebral column (Flexio columnae vertebralis)

While contortionists seem like they lack a vertebral column, the remaining humans definitely feel its capabilities and limitations. The spine is capable of six movements: flexion (bending forward), extension (bending backwards), lateral flexion (right/left), lateral extension (returning to normal from lateral flexion), and rotation (twisting). All of these movements are influenced by the previously mentioned joints and ligaments and by thoracic and back muscles. Movements in the cervical and lumbar regions of the spine are freer than the thoracic and sacral ones.

The adult spine has four curvatures:

- Cervical lordosis (posterior concavity)
- Thoracic kyphosis (anterior concavity)
- Lumbar lordosis
- Sacral kyphosis

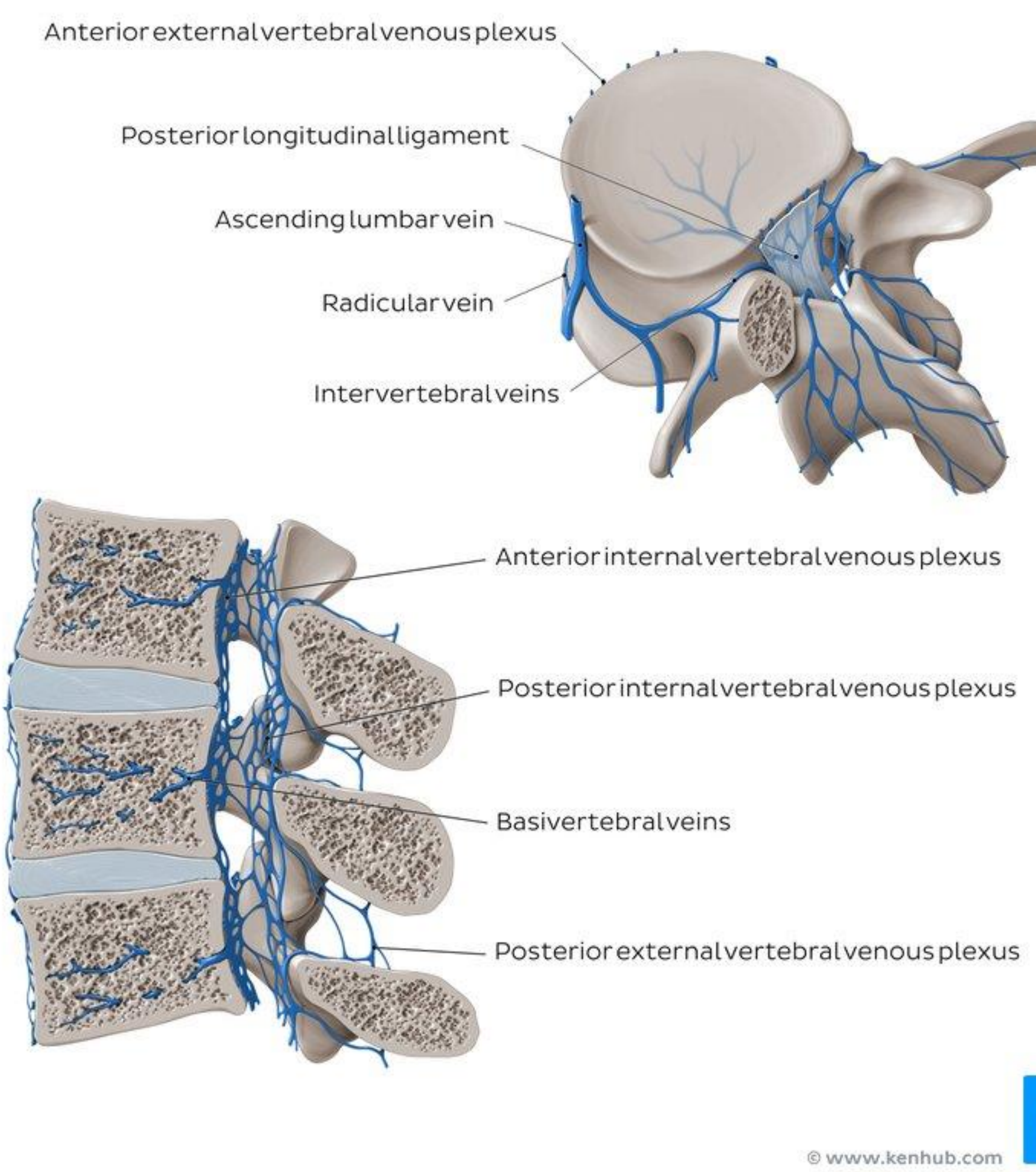
Kyphoses are primary curvatures while lordoses are secondary curvatures.

Nerves and vasculature

The blood supply of the vertebral column is provided by segmental arteries. They are named posterior intercostal, subcostal, lumbar, iliolumbar, and sacral arteries in the thoracic, lumbar, and sacral regions of the spine. All originate from the aorta except those in the cervical region and the iliolumbar artery. Segmental arteries of the cervical region stem from the vertebral and ascending cervical arteries instead and the iliolumbar artery is a branch of the posterior trunk of the internal iliac artery.

As the segmental arteries follow the course of the vertebrae, they provide equatorial branches to the vertebral body and posterior arteries to the vertebral arch. At the level of the lamina, spinal branches travel to the intervertebral foramina to enter the vertebral canal and supply its contents via vertebral canal arches (anterior, posterior).

Venous blood from the vertebral column is drained via spinal veins into vertebral venous plexuses (internal, external). Basivertebral veins drain the vertebral bodies into the internal vertebral venous plexus. The two vertebral venous plexuses empty into the intervertebral veins. In turn, these empty into the vertebral and segmental veins of the neck and trunk.



Veins of the vertebral column: Diagram

The vertebral column is innervated by the meningeal branches of the spinal nerves. They divide into ascending and descending branches that supply the vertebrae, intervertebral discs, and ligaments.

In vertebrate anatomy, ribs (Latin: costae) are the long curved bones which form the rib cage, part of the axial skeleton. In most tetrapods, ribs surround the chest, enabling the lungs to expand and thus facilitate breathing by expanding the chest cavity. They serve to protect the lungs, heart, and other internal organs of the thorax. In some animals, especially snakes, ribs may provide support and protection for the entire body.

Rib details

Ribs are classed as flat bones which usually have a protective role in the body. Humans have 24 ribs, in 12 pairs. All are attached at the back to the thoracic vertebrae, and are numbered from 1–12 according to the vertebrae they attach to. The first rib is attached to thoracic vertebra 1 (T1). At the front of the body most of the ribs are joined by costal cartilages to the sternum. The ribs connect to the vertebrae with two joints, the costovertebral joints.

The parts of a rib include the head, neck, body (or shaft), tubercle, and angle.

The head of the rib lies next to a vertebra. The ribs connect to the vertebrae with two costovertebral joints, one on the head and one on the neck. The head of the rib has a superior and an inferior articulating region, separated by a crest. These articulate with the superior and inferior costal facets on the connecting vertebrae. The crest gives attachment to the intra-articulate ligament that joins the rib to the vertebra of the same number, at the intervertebral disc. Another ligament, the radiate ligament joins the head of the rib to the both the body of the upper vertebra and to the body of the lower vertebra. The smaller middle part of the ligament connects to the intervertebral disc. This plane joint is known as the articulation of the head of the rib.

The other costovertebral joint is that between the tubercle on the neck and the transverse process of the joining thoracic vertebra of the same rib number, and this is known as the costotransverse joint. The superior costotransverse ligament attaches from the non-articular facet of the tubercle to the transverse process of the vertebra.

The neck of the rib is a flattened part that extends laterally from the head. The neck is about 3 cm long. Its anterior surface is flat and smooth, whilst its posterior is perforated by numerous foramina and its surface rough, to give attachment to the ligament of the neck. Its upper border presents a rough crest (crista colli costae) for the attachment of the anterior costotransverse ligament; its lower border is rounded.

A tubercle of rib on the posterior surface of the neck of the rib, has two facets (surfaces) one articulating and one non-articulating. The articular facet, is small and oval and is the lower and more medial of the two, and connects to the transverse costal facet on the thoracic vertebra of the same rib number. The transverse costal facet is on the end of the transverse process of the lower of the two vertebrae to which the head is connected. The non-articular portion is a rough elevation and affords attachment to the ligament of the tubercle. The tubercle is much more prominent in the upper ribs than in the lower ribs.

Rib cage

X-ray image of human chest, with ribs labelled

The first seven sets of ribs, known as "true ribs", are attached to the sternum by the costal cartilages. The first rib is unique and easier to distinguish than other ribs. It is a short, flat, C-shaped bone. The vertebral attachment can be found just below the neck at the first thoracic vertebra, and the majority of this bone can be found above the level of the clavicle. Ribs 2 through 7 have a more traditional appearance and become longer and less curved as they progress downwards. The following five sets are known as "false ribs", three of these sharing a common cartilaginous connection to the sternum, while the last two (eleventh and twelfth ribs) are termed floating ribs. They are attached to the vertebrae only, and not to the sternum or cartilage coming off of the sternum.

In general, human ribs increase in length from ribs 1 through 7 and decrease in length again through rib 12. Along with this change in size, the ribs become progressively oblique (slanted) from ribs 1 through 9, then less slanted through rib 12.

The rib cage is separated from the lower abdomen by the thoracic diaphragm which controls breathing. When the diaphragm contracts, the thoracic cavity is expanded, reducing intra-thoracic pressure and drawing air into the lungs. This happens through one of two actions (or a mix of the two): when the lower ribs the diaphragm connects to are stabilized by muscles and the central tendon is mobile, when the muscle contracts the central tendon is drawn down, compressing the cavity underneath and expanding the thoracic cavity downward. When the central tendon is stabilized and the lower ribs are mobile, a contraction of the diaphragm elevates the ribs, which works in conjunction with other muscles to expand the thoracic indent upward.

Development

Early in the developing embryo, somites form and soon subdivide into three mesodermal components – the myotome, dermatome, and the sclerotome. The vertebrae and ribs develop from the sclerotomes.

During the fourth week (fertilization age) costal processes have formed on the vertebral bodies. These processes are small, lateral protrusions of mesenchyme that develop in association with the vertebral arches. During the fifth week the costal processes on the thoracic vertebrae become longer to form the ribs. In the sixth week, the costovertebral joints begin to develop and separate the ribs from the vertebrae. The first seven pairs of ribs, the true ribs join at the front to the sternal bars. By the fetal stage the sternal bars have completely fused.

The ribs begin as cartilage that later ossifies – a process called endochondral ossification. Primary ossification centers are located near the angle of each rib, and ossification continues in the direction away from the head and neck. During adolescence secondary ossification centers are formed in the tubercles and heads of the ribs.

SHOULDER JOINT

The shoulder joint is called the glenohumeral joint. This is a ball-and-socket joint formed by the articulation between the head of the humerus and the glenoid cavity of the scapula (Figure 3). This joint has the largest range of motion of any joint in the body. However, this freedom of movement is due to the lack of structural support and thus the enhanced mobility is offset by a loss of stability.

The large range of motions at the shoulder joint is provided by the articulation of the large, rounded humeral head with the small and shallow glenoid cavity, which is only about one third of the size of the humeral head. The socket formed by the glenoid cavity is deepened slightly by a small lip of fibrocartilage called the **glenoid labrum**, which extends around the outer margin of the cavity. The articular capsule that surrounds the glenohumeral joint is relatively thin and loose to allow for large motions of the upper limb. Some structural support for the joint is provided by thickenings of the articular capsule wall that form weak intrinsic ligaments. These include the **coracohumeral ligament**, running from the coracoid process of the scapula to the anterior humerus, and three ligaments, each called a **glenohumeral ligament**, located on the anterior side of the articular capsule. These ligaments help to strengthen the superior and anterior capsule walls.

However, the primary support for the shoulder joint is provided by muscles crossing the joint, particularly the four rotator cuff muscles. These muscles (supraspinatus, infraspinatus, teres minor, and subscapularis) arise from the scapula and attach to the greater or lesser tubercles of the humerus. As these muscles cross the shoulder joint, their tendons encircle the head of the humerus and become fused to the anterior, superior, and posterior walls of the articular capsule. The thickening of the capsule formed by the fusion of these four muscle tendons is called the **rotator cuff**. Two bursae, the **subacromial bursa** and the **subscapular bursa**, help to prevent friction between the rotator cuff muscle tendons and the scapula as these tendons cross the glenohumeral joint. In addition to their individual actions of moving the upper limb, the rotator cuff muscles also serve to hold the head of the humerus in position within the glenoid cavity. By constantly adjusting their strength of contraction to resist forces acting on the shoulder, these muscles serve as "dynamic ligaments" and thus provide the primary structural support for the glenohumeral joint.

Injuries to the shoulder joint are common. Repetitive use of the upper limb, particularly in abduction such as during throwing, swimming, or racquet sports, may lead to acute or chronic inflammation of the bursa or muscle tendons, a tear of the glenoid labrum, or degeneration or tears of the rotator cuff. Because the humeral head is strongly supported by muscles and ligaments around its anterior, superior, and posterior aspects, most dislocations of the humerus occur in an inferior direction. This can occur when force is applied to the humerus when the upper limb is fully abducted, as when diving to catch a baseball and landing on your hand or elbow. Inflammatory responses to any shoulder injury can lead to the formation of scar tissue between the articular capsule and surrounding structures, thus reducing shoulder mobility, a condition called adhesive capsulitis ("frozen shoulder").

ELBOW JOINT

The elbow joint is a uniaxial hinge joint formed by the humeroulnar joint, the articulation between the trochlea of the humerus and the trochlear notch of the ulna. Also associated with the elbow are the humeroradial joint and the proximal radioulnar joint. All three of these joints are enclosed within a single articular capsule (Figure 4).

The articular capsule of the elbow is thin on its anterior and posterior aspects, but is thickened along its outside margins by strong intrinsic ligaments. These ligaments prevent side-to-side movements and hyperextension. On the medial side is the triangular ulnar collateral ligament. This arises from the medial epicondyle of the humerus and attaches to the medial side of the proximal ulna. The strongest part of this ligament is the anterior portion, which resists hyperextension of the elbow. The ulnar collateral ligament may be injured by frequent, forceful extensions of the forearm, as is seen in baseball pitchers. Reconstructive surgical repair of this ligament is referred to as Tommy John surgery, named for the former major league pitcher who was the first person to have this treatment.

The lateral side of the elbow is supported by the radial collateral ligament. This arises from the lateral epicondyle of the humerus and then blends into the lateral side of the annular ligament. The annular ligament encircles the head of the radius. This ligament supports the head of the radius as it articulates with the radial notch of the ulna at the proximal radioulnar joint. This is a pivot joint that allows for rotation of the radius during supination and pronation of the forearm.

HIP JOINT

The hip joint is a multiaxial ball-and-socket joint between the head of the femur and the acetabulum of the hip bone. The hip carries the weight of the body and thus requires strength and stability during standing and walking. For these reasons, its range of motion is more limited than at the shoulder joint.

The acetabulum is the socket portion of the hip joint. This space is deep and has a large articulation area for the femoral head, thus giving stability and weight bearing ability to the joint. The acetabulum is further deepened by the **acetabular labrum**, a fibrocartilage lip attached to the outer margin of the acetabulum. The surrounding articular capsule is strong, with several thickened areas forming intrinsic ligaments. These ligaments arise from the hip bone, at the margins of the acetabulum, and attach to the femur at the base of the neck. The ligaments are the **iliofemoral ligament**, **pubofemoral ligament**, and **ischiofemoral ligament**, all of which spiral around the head and neck of the femur. The ligaments are tightened by extension at the hip, thus pulling the head of the femur tightly into the acetabulum when in the upright, standing position. Very little additional extension of the thigh is permitted beyond this vertical position. These ligaments thus stabilize the hip joint and allow you to maintain an upright standing position with only minimal muscle contraction. Inside of the articular capsule, the **ligament of the head of the femur** (ligamentum teres) spans between the acetabulum and femoral head. This intracapsular ligament is normally slack and does not provide any significant joint support, but it does provide a pathway for an important artery that supplies the head of the femur.

The hip is prone to osteoarthritis, and thus was the first joint for which a replacement prosthesis was developed. A common injury in elderly individuals, particularly those with weakened bones due to osteoporosis, is a "broken hip," which is actually a fracture of the femoral neck. This may result from a fall, or it may cause the fall. This can happen as one lower limb is taking a step and all of the body weight is placed on the other limb, causing the femoral neck to break and producing a fall. Any accompanying disruption of the blood supply to the femoral neck or head can lead to necrosis of these areas, resulting in bone and cartilage death. Femoral fractures usually require surgical treatment, after which the patient will need mobility assistance for a prolonged period, either from family members or in a long-term care facility. Consequentially, the associated health care costs of "broken hips" are substantial. In addition, hip fractures are associated with increased rates of morbidity (incidences of disease) and mortality (death). Surgery for a hip fracture followed by prolonged bed rest may lead to life-threatening complications, including pneumonia, infection of pressure ulcers (bedsores), and thrombophlebitis (deep vein thrombosis; blood clot formation) that can result in a pulmonary embolism (blood clot within the lung).

KNEE JOINT

The knee joint is the largest joint of the body. It actually consists of three articulations. The **femoropatellar joint** is found between the patella and the distal femur. The **medial tibiofemoral joint** and **lateral tibiofemoral joint** are located between the medial and lateral condyles of the femur and the medial and lateral condyles of the tibia. All of these articulations are enclosed within a single articular capsule. The knee functions as a hinge joint, allowing flexion and extension of the leg. This action is generated by both rolling and gliding motions of the femur on the tibia. In addition, some rotation of the leg is available when the knee is flexed, but not when extended. The knee is well constructed for weight bearing in its extended position, but is vulnerable to injuries associated with hyperextension, twisting, or blows to the medial or lateral side of the joint, particularly while weight bearing.

At the femoropatellar joint, the patella slides vertically within a groove on the distal femur. The patella is a sesamoid bone incorporated into the tendon of the quadriceps femoris muscle, the large muscle of the anterior thigh. The patella serves to protect the quadriceps tendon from friction against the distal femur. Continuing from the patella to the anterior tibia just below the knee is the **patellar ligament**. Acting via the patella and patellar ligament, the quadriceps femoris is a powerful muscle that acts to extend the leg at the knee. It also serves as a “dynamic ligament” to provide very important support and stabilization for the knee joint.

The medial and lateral tibiofemoral joints are the articulations between the rounded condyles of the femur and the relatively flat condyles of the tibia. During flexion and extension motions, the condyles of the femur both roll and glide over the surfaces of the tibia. The rolling action produces flexion or extension, while the gliding action serves to maintain the femoral condyles centered over the tibial condyles, thus ensuring maximal bony, weight-bearing support for the femur in all knee positions. As the knee comes into full extension, the femur undergoes a slight medial rotation in relation to tibia. The rotation results because the lateral condyle of the femur is slightly smaller than the medial condyle. Thus, the lateral condyle finishes its rolling motion first, followed by the medial condyle. The resulting small medial rotation of the femur serves to “lock” the knee into its fully extended and most stable position. Flexion of the knee is initiated by a slight lateral rotation of the femur on the tibia, which “unlocks” the knee. This lateral rotation motion is produced by the popliteus muscle of the posterior leg.

Located between the articulating surfaces of the femur and tibia are two articular discs, the **medial meniscus** and **lateral meniscus**. Each is a C-shaped fibrocartilage structure that is thin along its inside margin and thick along the outer margin. They are attached to their tibial condyles, but do not attach to the femur. While both menisci are free to move during knee motions, the medial meniscus shows less movement because it is anchored at its outer margin to the articular capsule and tibial collateral ligament. The menisci provide padding between the bones and help to fill the gap between the round femoral condyles and flattened tibial condyles. Some areas of each meniscus lack an arterial blood supply and thus these areas heal poorly if damaged.

The knee joint has multiple ligaments that provide support, particularly in the extended position. Outside of the articular capsule, located at the sides of the knee, are two extrinsic ligaments. The **fibular collateral ligament** (lateral collateral ligament) is on the lateral side and spans from the lateral epicondyle of the femur to the head of the fibula. The **tibial collateral ligament** (medial collateral ligament) of the medial knee runs from the medial epicondyle of the femur to the medial tibia. As it crosses the knee, the tibial collateral ligament is firmly attached on its deep side to the articular capsule and to the medial meniscus, an important factor when considering knee injuries. In the fully extended knee position, both collateral ligaments are taut (tight), thus serving to stabilize and support the extended knee and preventing side-to-side or rotational motions between the femur and tibia.

The articular capsule of the posterior knee is thickened by intrinsic ligaments that help to resist knee hyperextension. Inside the knee are two intracapsular ligaments, the **anterior cruciate ligament** and **posterior cruciate ligament**. These ligaments are anchored inferiorly to the tibia at the intercondylar eminence, the roughened area between the tibial condyles. The cruciate ligaments are named for whether they are attached anteriorly or posteriorly to this tibial region. Each ligament runs diagonally upward to attach to the inner aspect of a femoral condyle. The cruciate ligaments are named for the X-shape formed as they pass each other (cruciate means “cross”). The posterior cruciate ligament is the stronger ligament. It serves to support the knee when it is flexed and weight bearing, as when walking downhill. In this position, the posterior cruciate ligament prevents the femur from sliding anteriorly off the top of the tibia. The anterior cruciate ligament becomes tight when the knee is extended, and thus resists hyperextension.

Joints

Injuries to the knee are common. Since this joint is primarily supported by muscles and ligaments, injuries to any of these structures will result in pain or knee instability. Injury to the posterior cruciate ligament occurs when the knee is flexed and the tibia is driven posteriorly, such as falling and landing on the tibial tuberosity or hitting the tibia on the dashboard when not wearing a seatbelt during an automobile accident. More commonly, injuries occur when forces are applied to the extended knee, particularly when the foot is planted and unable to move. Anterior cruciate ligament injuries can result with a forceful blow to the anterior knee, producing hyperextension, or when a runner makes a quick change of direction that produces both twisting and hyperextension of the knee.

A worse combination of injuries can occur with a hit to the lateral side of the extended knee (Figure 7). A moderate blow to the lateral knee will cause the medial side of the joint to open, resulting in stretching or damage to the tibial collateral ligament. Because the medial meniscus is attached to the tibial collateral ligament, a stronger blow can tear the ligament and also damage the medial meniscus. This is one reason that the medial meniscus is 20 times more likely to be injured than the lateral meniscus. A powerful blow to the lateral knee produces a “terrible triad” injury, in which there is a sequential injury to the tibial collateral ligament, medial meniscus, and anterior cruciate ligament.

Arthroscopic surgery has greatly improved the surgical treatment of knee injuries and reduced subsequent recovery times. This procedure involves a small incision and the insertion into the joint of an arthroscope, a pencil-thin instrument that allows for visualization of the joint interior. Small surgical instruments are also inserted via additional incisions. These tools allow a surgeon to remove or repair a torn meniscus or to reconstruct a ruptured cruciate ligament. The current method for anterior cruciate ligament replacement involves using a portion of the patellar ligament. Holes are drilled into the cruciate ligament attachment points on the tibia and femur, and the patellar ligament graft, with small areas of attached bone still intact at each end, is inserted into these holes. The bone-to-bone sites at each end of the graft heal rapidly and strongly, thus enabling a rapid recovery.

Knee Injury

A strong blow to the lateral side of the extended knee will cause three injuries, in sequence: tearing of the tibial collateral ligament, damage to the medial meniscus, and rupture of the anterior cruciate ligament.

ANKLE AND FOOT JOINTS

The ankle is formed by the **talocrural joint**. It consists of the articulations between the talus bone of the foot and the distal ends of the tibia and fibula of the leg (crural = “leg”). The superior aspect of the talus bone is square-shaped and has three areas of articulation. The top of the talus articulates with the inferior tibia. This is the portion of the ankle joint that carries the body weight between the leg and foot. The sides of the talus are firmly held in position by the articulations with the medial malleolus of the tibia and the lateral malleolus of the fibula, which prevent any side-to-side motion of the talus. The ankle is thus a uniaxial hinge joint that allows only for dorsiflexion and plantar flexion of the foot.

Additional joints between the tarsal bones of the posterior foot allow for the movements of foot inversion and eversion. Most important for these movements is the **subtalar joint**, located between the talus and calcaneus bones. The joints between the talus and navicular bones and the calcaneus and cuboid bones are also important contributors to these movements. All of the joints between tarsal bones are plane joints. Together, the small motions that take place at these joints all contribute to the production of inversion and eversion foot motions.

Like the hinge joints of the elbow and knee, the talocrural joint of the ankle is supported by several strong ligaments located on the sides of the joint. These ligaments extend from the medial malleolus of the tibia or lateral malleolus of the fibula and anchor to the talus and calcaneus bones. Since they are located on the sides of the ankle joint, they allow for dorsiflexion and plantar flexion of the foot. They also prevent abnormal side-to-side and twisting movements of the talus and calcaneus bones during eversion and inversion of the foot. On the medial side is the broad **deltoid ligament**. The deltoid ligament supports the ankle joint and also resists excessive eversion of the foot. The lateral side of the ankle has several smaller ligaments. These include the **anterior talofibular ligament** and the **posterior talofibular ligament**, both of which span between the talus bone and the lateral malleolus of the fibula, and the **calcaneofibular ligament**, located between the calcaneus bone and fibula. These ligaments support the ankle and also resist excess inversion of the foot.

Joints

The ankle is the most frequently injured joint in the body, with the most common injury being an inversion ankle sprain. A sprain is the stretching or tearing of the supporting ligaments. Excess inversion causes the talus bone to tilt laterally, thus damaging the ligaments on the lateral side of the ankle. The anterior talofibular ligament is most commonly injured, followed by the calcaneofibular ligament. In severe inversion injuries, the forceful lateral movement of the talus not only ruptures the lateral ankle ligaments, but also fractures the distal fibula.

Less common are eversion sprains of the ankle, which involve stretching of the deltoid ligament on the medial side of the ankle. Forcible eversion of the foot, for example, with an awkward landing from a jump or when a football player has a foot planted and is hit on the lateral ankle, can result in a Pott’s fracture and dislocation of the ankle joint. In this injury, the very strong deltoid ligament does not tear, but instead shears off the medial malleolus of the tibia. This frees the talus, which moves laterally and fractures the distal fibula. In extreme cases, the posterior margin of the tibia may also be sheared off.

Above the ankle, the distal ends of the tibia and fibula are united by a strong syndesmosis formed by the interosseous membrane and ligaments at the distal tibiofibular joint. These connections prevent separation between the distal ends of the tibia and fibula and maintain the talus locked into position between the medial malleolus and lateral malleolus. Injuries that produce a lateral twisting of the leg on top of the planted foot can result in stretching or tearing of the tibiofibular ligaments, producing a syndesmotic ankle sprain or “high ankle sprain.”

Most ankle sprains can be treated using the RICE technique: Rest, Ice, Compression, and Elevation. Reducing joint mobility using a brace or cast may be required for a period of time. More severe injuries involving ligament tears or bone fractures may require surgery.

The structure of the skull is a highly detailed and complex design. In all, there are 22 bones comprising the entire skull, excluding the 3 pairs of ossicles located in the inner ear. The bones of the skull are highly irregular. Most of the bones of the skull are held together by firm, immovable fibrous joints called sutures or synarthroses. These joints allow the developing skull to grow both pre- and postnatally.

The sutures of the skull are morphologically distinct, being divided into three main groups based on the margins of the articulating bones. At a simple suture, the margins of the articulating bones are smooth and meet end to end such as the median palatine suture. A bevelled suture is where the border of one bone overlaps that of the other like the parietotemporal suture. Conversely, the borders of the bones may have a number of projections that interdigitate with each other, giving a serrated appearance, such as in the sagittal suture. The complexity of the serrations of the sutures increases from internal to external.

The joints of the base of the skull are largely cartilaginous joints, or synchondroses. One such joint is the spheno-occipital synchondrosis, which is found between the body of the sphenoid anteriorly and the basilar part of the occipital bone posteriorly.

There are only two areas on the skull where synovial joints are present. The first is a pair of joints; the temporomandibular joints, where the mandible articulates with the skull on either side. The second synovial joint is the atlanto-occipital joint, where the base of the skull articulates with the vertebral column. Both these joints will be discussed further in this article. For the purpose of this article, the joints of the skull will be discussed by order of anatomical view, with the addition of the synovial joints being discussed separately.

The lambdoid suture can be found between the posterior border of the parietal bones and the anterolateral borders of the occipital bone . It is named so due to the lambdoid (λ) shape it forms with the coronal suture. It extends from the posterior extremity of the sagittal suture in a posteroinferior direction to meet the occipitomastoid suture from behind and the parietomastoid suture from above the mastoid process.

Sutural bones, also called wormian bones, are commonly found along the extent of the lambdoid suture. They form due to separate ossification centres to the lambdoid suture. A large interparietal bone, sometimes called the Inca bone, is often found between the posterior borders of the parietal bones.

The coronal suture lies between the posterior border of the frontal bone and the anterior margins of the left and right parietal bones. It projects inferiorly to meet the junction of the greater wing on the sphenoid bone and the squamous part of the temporal bone.

The sagittal suture runs in the midline, separating the left and right parietal bones from each other. It extends from the coronal suture anteriorly to the lambdoid suture posteriorly. The junction between the sagittal suture and the coronal suture is an area called the bregma, and was once a membranous portion of the developing skull called the anterior fontanelle.

The pterion is an H shaped region on the lateral aspect of the skull where a number of bones unite with each other. Participants of the pterion are the frontal bone, the parietal bone, the greater wing of the sphenoid bone, and the anterior of the squamous part of the temporal bone. Consequently, a number of sutures converge at the area. The sphenoparietal suture separates the superior surface of the greater wing of the sphenoid bone from the parietal bone above. The coronal suture joins the sphenoparietal suture superiorly, the sphenofrontal suture anteriorly, the sphenosquamous suture inferiorly, and the squamous suture posteriorly. Due to the extensiveness of the articulations at the pterion, this portion of the skull is weaker than other parts, and therefore more vulnerable to fracture.

The sphenosquamous suture is a vertical suture between the anterior margin of the squamous part of the temporal bone and the posterior margin of the greater wing of the sphenoid bone.

The squamous suture is a large horizontal suture that curves inferiorly as it passes towards the posterior aspect of the skull. It extends from the pterion anteriorly in a posteroinferior fashion to meet the parietomastoid suture. It separates the superior and posterior borders of the squamous part of the temporal bone from the posteroinferior angle of the parietal bone.

The parietomastoid suture lies between the inferior border of the angle of the parietal bone posteriorly and the mastoid process of the temporal bone. This suture is another common site for sutural bones to form.

The sphenoparietal suture is the articulation of the superior margin of the greater wing of the sphenoid bone and the parietal bone at the angle formed by the convergence of the coronal and squamous sutures at the pterion. The sphenoparietal suture separates the coronal and squamous sutures from each other at this point.

The sphenofrontal suture is an obliquely oriented suture extending anteroinferiorly between the lower margin of the frontal bone superiorly and the upper margin the greater wing of the sphenoid bone inferiorly.

The frontozygomatic suture is a horizontal suture lateral to the orbit. It lies between the frontal process of the zygomatic bone inferiorly and the zygomatic process of the frontal bone superiorly. There is a palpable depression at this suture.

The sphenozygomatic suture is the joint between the posteromedial aspect of the zygomatic bone anteriorly and the anterior margin of the greater wing of the sphenoid bone posteriorly.

The occipitomastoid suture is between the squamous part of the occipital bone and the mastoid process of the temporal bone. It extends anteroinferiorly towards the tip of the mastoid process.

The temporozygomatic suture is a vertical suture located just superior to the coronoid process of the mandible and inferior to the greater wing of the sphenoid bone when the skull is viewed from the lateral aspect. It is the site of articulation between the zygomatic process of the temporal bone posteriorly and the temporal process of the zygomatic bone anteriorly. The temporozygomatic suture completes the zygomatic arch.

The intermaxillary suture, which is located in the midline, is a vertical suture extending from the nasal aperture to the oral cavity below. It also extends posteriorly, and can be viewed as a horizontal suture on the anterior part of the hard palate, joining the palatine processes of the maxillae together in the roof of the mouth. The intermaxillary suture is continuous with the median palatine suture.

The zygomaticomaxillary suture is an oblique suture passing inferolaterally from the inferior aspect of the orbit, beginning just above the infraorbital foramen. It joins the thick, short zygomatic process of the maxilla and the zygomatic bone.

The frontonasal suture is located between the orbits on the superior aspect of the nose. It passes obliquely downwards from the midline, separating the upper border of the nasal bone from the inferior border of the nasal part of the frontal bone.

The internasal suture is a vertical, midline suture extending in a superior to inferior direction along the bridge of the nose. It extends from the frontonasal sutures superiorly to the superior aspect of the anterior nasal aperture. Where the internasal suture meets the frontonasal suture, there is a clear depression called the nasion which indicates the root of the nose. This depression is clearly visible on the surface.

The nasomaxillary suture is a vertical suture located between the lateral border of the nasal bone and the medial border of the frontal process of the maxilla. It extends inferiorly from the junction of the frontonasal and frontomaxillary sutures superiorly to the lateral margin of the anterior nasal aperture.

The frontomaxillary suture is an oblique suture between the frontal process of the maxilla, which extends upwards laterally to the lacrimal bone, and the nasal part of the frontal bone. It is continuous superiorly with the frontonasal suture.

The frontolacrimal suture is a small horizontal suture located in the medial wall of the orbit. It separates the frontal bone above from the superior border of the lacrimal bone below. It is a posterolateral continuation of the frontomaxillary suture.

The lacrimomaxillary suture is located in the medial wall of the orbit. It extends inferiorly and anteriorly towards the inferior border of the orbit, separating the anterior border of the lacrimal bone from the maxilla.

For descriptive purposes, the base of the skull is divided into anterior, middle and posterior regions.

Anterior

The anterior region of the base of the skull consists mainly of the hard palate, forming the roof of the oral cavity.

A midline suture, the median palatine suture, runs anteroposteriorly on the palate between the adjacent maxillary and palatine bones separating the palate into right and left sides. It is continuous anteriorly with the intermaxillary suture.

The transverse palatine suture is a transversely passing suture extending across the palate, separating the maxillae anteriorly from the palatine bones posteriorly.

Middle

The middle part of the cranial base extends from the posterior opening of the nares anteriorly as far as the anterior margin of the foramen magnum posteriorly.

The spheno-occipital synchondrosis is a cartilaginous joint that lies between the body of the sphenoid bone anteriorly and the basilar part of the occipital bone posteriorly.

The petro-occipital suture extends from medial to lateral as far as the jugular foramen. It separates the jugular fossa on the petrous portion of the temporal bone from the jugular process on the basilar part of the occipital bone.

The petrosphenoidal suture is located between the petrous portion of the temporal bone and the infratemporal surface of the greater wing of the sphenoid bone. The groove for the pharyngotympanic tube is also located between these two areas. The apex of the petrous process does not extend entirely as far as the spheno-occipital suture, resulting in an opening called the foramen lacerum medially.

Posterior

The occipitomastoid suture, as previously discussed, is located on the posterior part of the base of the skull.

There are two different synovial joints present in the skull. One of them is the atlanto-occipital joint. This is where the condyles on the inferior surface of the occipital bone articulate directly with the C1 vertebra (the atlas). Flexion and extension of the skull occurs here, allowing the nodding motion of the head as in when we are saying yes.

As with all synovial joints, a number of ligaments stabilize the atlanto-occipital joint. These are the atlanto-occipital membranes. The posterior atlanto-occipital membrane extends from the posterior margin of the foramen magnum of the occipital bone to the posterior arch of the atlas. The anterior atlanto-occipital membrane extends from the anterior margin of the foramen magnum to the upper border of the anterior arch of the atlas.

The second of the synovial joints is a pair of joints located on the lateral sides of the skull. These are the temporomandibular joints. They are the points at which the head of the mandible, also called the condyle, articulates with the mandibular fossa of the temporal bone on either side of the skull.

Between the condyles of the mandible and the mandibular fossa is the articular disk, a small piece of cartilage. This disk effectively divides the joint into two separate joints. The upper joint is between the mandibular fossa of the temporal bone and the articular disk where side to side movement of the jaw (excursion) occurs. The lower joint is between the articular disk and the condyle of the mandible; this is the joint at which there is the hinge-like motion in opening and closing the mouth.

Reinforcing the temporomandibular joint are 3 ligaments. The temporomandibular ligament is a thickening of the lateral aspect of the joint capsule, extending from the zygomatic process and articular ligament of the temporal bone to the neck of the mandible. The stylomandibular ligament attaches to the styloid process of the temporal bone to the angle of the mandible, while the sphenomandibular ligament extends from the spine of the sphenoid bone to the lingula on the inner surface of the mandible.

The bones of the neurocranium develop as two different portions: the membranous part forming the flat bones and the cartilaginous part forming the bones of the base of the skull. At birth, the flat bones are separated from each other by sutures. At sites where more than two bones meet, these sutures are wide and incomplete. These areas are called fontanelles, more commonly known as ‘soft spots’. The anterior fontanelle is the most prominent of these structures. It is located where the parietal bones meet the frontal bone.

These fontanelles are present to allow the bones of the cranial vault to overlap during birth, and allow the skull to expand with brain growth after birth. Some remain open for a considerable time after birth, despite the cranium being fully structurally developed to full capacity between 5 and 7 years old; some of the sutures are not entirely complete until adulthood. The anterior fontanelle can be used clinically to determine if ossification of the sutures is progressing sufficiently. Anterior fontanelle ossification typically occurs around 18 to 24 months after birth, usually being the last fontanelle to close.

APPROACH TO BONE AND JOINT X-RAYS

IMAGE ACQUISITION:

Optimal image exposure should allow you to see the cortex of the bone distinctly and differentiate between cortex and medulla without difficulty.

The standard views are AP (anterior-posterior) and lateral. These two views are taken at right angles (orthogonal) to each other. If these images are not helpful, ancillary views such as oblique views, or special views such as, an axillary or carpal tunnel view, may be required based upon the clinical scenario.

Stress views i.e. a force is applied to a bone or joint to determine if an undetected injury is present, such as, a subtle avulsion or a suspected tendon or ligament tear. These are acquired as special requests and should be performed in a manner that minimizes patient pain and discomfort.

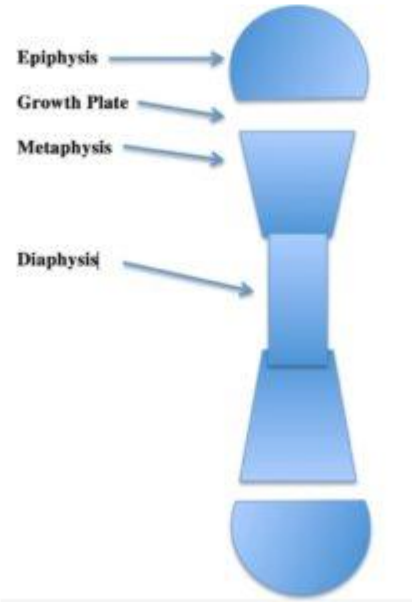
At least one joint space should be visible in relation to the suspected bone injury. If the entire fracture is not visualized, additional views and views of another adjacent joint space may be required.

Comparison views to the contralateral, normal bone, or joint, may be required, this is especially true if a subtle growth plate injury is suspected in a child. Comparison views should not be ordered routinely, but should be used if clinically necessary.

It is important to remember that some bone and ligament injuries occur as a common pattern of multiple injuries i.e. the Colle fracture of the distal radius is often associated with an avulsion fracture of the ulnar styloid. Ankle ligament injuries and fractures often occur in a sequence i.e. medial malleolar avulsion fracture, interosseous ligament between the tibia and fibula is torn, and there is an oblique fracture of the proximal fibula (Maisonneuve fracture complex). Keep this in mind as you encounter various patients and you will develop knowledge and experience of these associated bone and soft tissue injuries.

There are some fractures that may be associated with bone ischemia and avascular necrosis i.e. capital femoral fractures and scaphoid fractures. Be aware of this and learn the importance of aggressive and pre-emptive management for these patients.

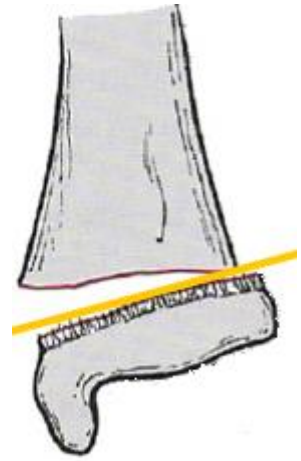
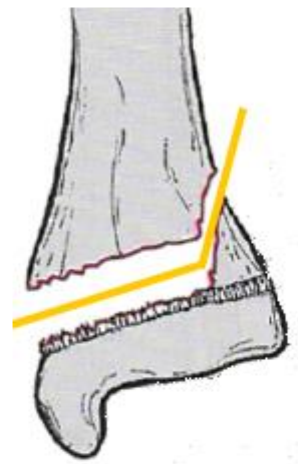
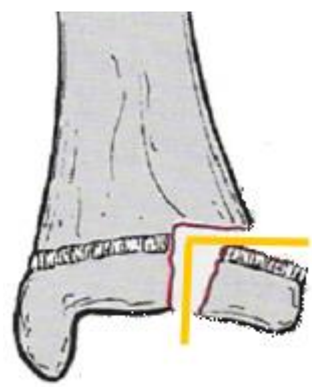
Anatomic Locations in Bone

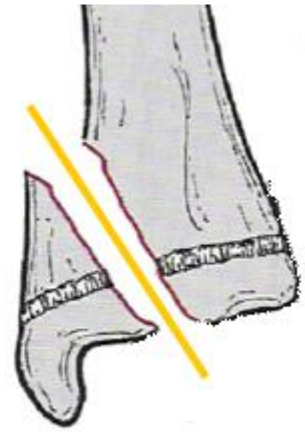
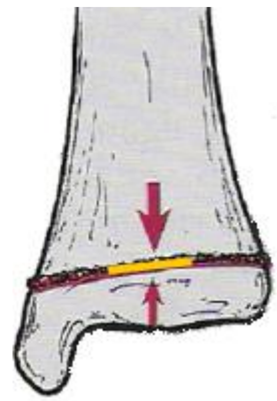


iaphysis	Middle of the bone
letaphysis	Flared region of the bone, between the epiphysis and the diaphysis
piphysis	The end of the bone, usually this area is associated with actively growing bone at the epiphyseal plate in children
tra- ticular	The joint space

COMPLETE FRACTURE:

Transverse	Across the long axis of the bone i.e. 90 degrees to the long axis of the bone
Oblique	Passes across the bone with an angle of less than 90 degrees
Spiral	Passes around the bone in a cork screw path
Longitudinal	Fracture is oriented parallel to the long axis of the bone
T-Shaped	There are two fractures, a longitudinal portion and a transverse or oblique portion

Type	Description	Image
I	The fracture plane extends completely through the growth plate. This type of fracture can be minimally displaced, making detection challenging. Repeated x-rays in 7 days will demonstrate periosteal new bone if a subtle fracture is suspected. 5 – 7% frequency. Good prognosis.	
II	The fracture plane leaves a small, triangular or quadrangular portion of the metaphysis in contact with the growth plate. This is the most common type of Salter-Harris injury. 75% frequency. Good prognosis.	
III	A quadrangular fragment of the epiphysis is isolated from the adjacent bone. 7 – 10% frequency. Poorer prognosis.	

IV	A triangular fragment of epiphysis, growth plate, and metaphysis is separated from the adjacent bone. 10% frequency. Poorer prognosis.	
V	This injury is focal and results in delayed abnormal bone growth in a focal region of the bone due crushing type of damage to the growing bone. 1% frequency. Worst prognosis	

Fracture line completely traverses the bone effecting the cortex and medulla.

Table 5.2 Types of complete bone fractures

INCOMPLETE FRACTURE:

The fracture does not complete traverse the bone.

Bowing	The bone is bent but not fractured
Buckle	One cortex is bucked outward, the buckle is like a fold The opposite cortex may be fractured or may be intact
Greenstick	One cortex is compressed into denser bone while the contralateral cortex is fractured
Salter-Harris	This classification describes the various epiphyseal and metaphyseal findings to describe the degree of damage to the actively developing growth plate

Table 5.3 Types of Incomplete Bone Fractures

SALTER-HARRIS

Some fractures in children involve the growth plate and the adjacent metaphysis of the bone. These fractures have been categorized using the Salter-Harris classification.

Table 5.4 Classification of Salter-Harris Fractures

DISPLACEMENT

Describe based upon the location and orientation of the distal bone fragment.

Distracted	The bone ends are quite displaced away from each other
Impacted	The bone ends are collapsed into each other
Angulated	There is an angle that can be described. The angle can be measured and describe based upon the apex of the angle seen. Some also describe the angle based upon the normal angulation of the bone in the region and whether this has been altered i.e. the bone is varus or valgus in comparison to the normal
Translational	The distal fragment is shifted away from normal
Rotational	The distal fragment is spun out of normal alignment
Pathologic	The bone at the fracture site is abnormal due to infection, congenital bone abnormality, a metabolic bone abnormality, or malignancy. Fractures that are the result of these conditions are pathologic
Avulsion	A small fragment of bone (triangular, quadrangular) is pulled off of the parent bone by a ligament or tendon. The ligament is usually intact as the bone was the greatest point of weakness that gave way
Stress Fractures	Repetitive, low-grade injury to a bone can lead to stress fracture. Frequent sites are the ventral tibial cortex and the metatarsals but they can occur elsewhere. These are most often seen in young active patients who complain of chronic, focal, bone pain

Table 5.5 Types of bone displacements

DESCRIPTORS OF DISPLACEMENT

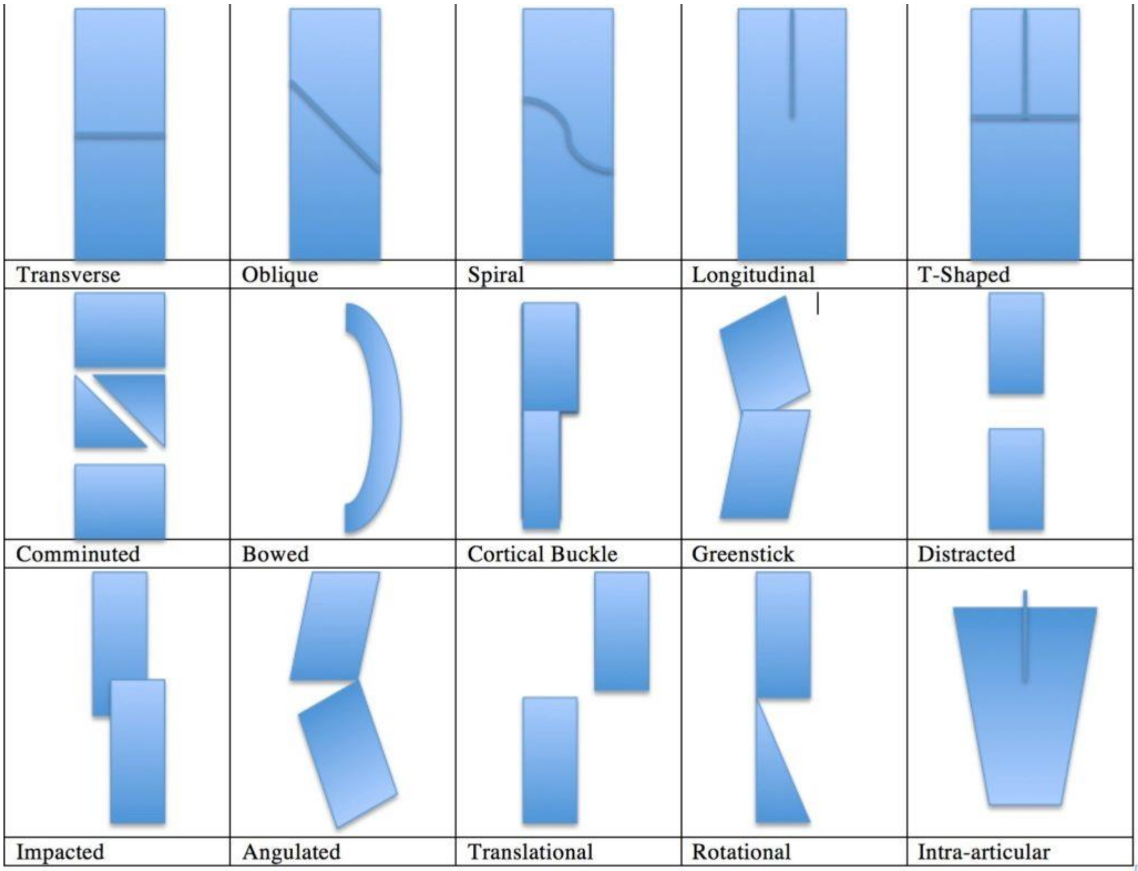


Figure 5.16 Illustrations of Displacement.

ADDITIONAL DESCRIPTORS

Subluxation	Joint alignment is disrupted but the cartilaginous ends of the bones at the joint space are still in contact with each other
Dislocation	The bones have been displaced and the cartilaginous ends of the bones no longer are in proximity to each other
Open Fracture	There is a discontinuity of the skin and underlying soft tissues that allows air to be in contact with the bone and/or the joint space. This type of injury increases the risk for infections such as, septic arthritis and osteomyelitis. There may be an underlying fracture or dislocation, but this is not always the case

Intra-articular, Salter-Harris, and open fractures require enhanced treatment and close clinical follow-up to minimize the possibility of undetected abnormal healing, or infection, that can lead to heightened morbidity or mortality.

JOINT, ARTHRITIC CONDITIONS

The two most common arthritic conditions encountered are degenerative (osteoarthritis) and inflammatory (rheumatoid) arthritis. The radiographic appearance of these arthridites will vary based upon severity and distribution. The longer the condition has been present the worse the imaging changes will usually be unless treatment has been instituted. There are a variety of arthritic conditions that can be encountered. Using laboratory assessment, clinical parameters, and imaging features often one can shorten the differential diagnostic possibilities. Osteoarthritis is usually quite distinct from erosive arthritides, i.e. rheumatoid, gout, calcium pyrophosphate, psoriatic, etc. It is beyond the scope of this work to discuss the imaging features of all of the various possible arthritides. The two most common arthritides encountered will be compared using the ABCDS method detailed below.

ABCDS METHOD IS ONE WAY TO APPROACH BONE AND JOINT ARTHRITIS.

A- Alignment of bones

B- Bones – bone mineralization, new bone formation, erosions, osteophytes, fractures

C- Cartilage – joint space alignment and narrowing, joint calcifications, effusions

D- Distribution of disease – Some distribution of bone involvement is characteristic for certain diseases i.e. hip and knee osteoarthritis, first metatarsal-phalangeal gout, interphalangeal joint rheumatoid arthritis, etc.

S- Soft tissues – swelling and calcifications

Masticatory muscles

- The **masticatory muscles** (or **muscles of mastication**) are responsible for the chewing movements of the mandible or lower jaw. The **masticatory muscles** originate on the skull and insert onto the mandible, thus acting upon the mastication and other movements of the lower jaw at the temporomandibular joint.

There are four **masticatory muscles** on each side of the head:

- masseter,
- temporalis,
- lateral pterygoid,
- medial pterygoid.

Unlike the muscles of facial expression that are innervated by the facial nerve (CN VII), the **muscles of mastication** are innervated by motor branches of the mandibular division of the trigeminal nerve (CN V3).

Temporalis

- The **temporalis** (also **temporalis muscle**, **temporal muscle**, latin: ***musculus temporalis***) is one of the main muscles of mastication, which is involved in the elevation and retraction of the lower jaw. The **temporal muscle** is a wide, fan-shaped muscle on each side of the head that covers most of the temporal bone and fills the temporal fossa. The **temporalis** is covered by the temporal fascia.

Origin

The **temporalis** originates from the temporal plane on the side of the cranium.

Insertion

The **temporalis** muscle passes the zygomatic muscle medially and forms a tendon that inserts onto the coronoid process of the mandible.

Action

Upon activation the **temporalis** muscle elevates the mandible. The **temporalis** also retracts the mandible, pulling it backwards with the posterior fibers of the muscle.

Innervation

The **temporalis** is innervated by the deep temporal nerve, a branch of the mandibular division of the trigeminal nerve (CN V3).

Masseter

- The **masseter** (also **masseter muscle**, latin: ***musculus masseter***) is a masticatory muscle that elevates the lower jaw and originates from zygomatic arch and inserts into the masseteric tuberosity of the mandible. The **masseter muscle** is thick and quadrangular in shape.

Origin

The **masseter** originates from the zygomatic arch.

Insertion

The **masseter muscle** inserts onto the masseteric tuberosity of the mandible.

Action

Contractions of the **masseter muscles** elevate the mandible.

Innervation

The **masseter** is innervated by the masseteric nerve, a branch of the mandibular division of the trigeminal nerve (CN V3).

Lateral pterygoid

- The **lateral pterygoid** (also **lateral pterygoid muscle**, latin: ***musculus pterygoideus lateralis***) is one of the masticatory muscles, a thick short muscle located in the infratemporal fossa.

Origin

The **lateral pterygoid** originates from the the infratemporal surface of the greater wing of the sphenoid bone and partly from the lateral plate of the pterygoid process.

Insertion

The **lateral pterygoid** inserts on the pterygoid fossa of the mandible.

Action

Upon bilateral contraction the **lateral pterygoid muscles** push the mandible forward, while by contraction on one side the activated **lateral pterygoid muscle** pushes the mandible to the opposite side.

Innervation

The **lateral pterygoid** is innervated by the lateral pterygoid nerve, a branch of the mandibular division of the trigeminal nerve (CN V3).

Medial pterygoid

- The **medial pterygoid** (also **medial pterygoid muscle**, latin: ***musculus pterygoideus medialis***) is one of the masticatory muscles. The **medial pterygoid** is located in the infratemporal fossa and is involved in several movements of the mandible.

Origin

The **medial pterygoid** originates from the pterygoid fossa of the sphenoid bone

Insertion

The **medial pterygoid** inserts on the pterygoid tuberosity of the mandible.

Action

Upon bilateral contractions the **medial pterygoid muscles** push the mandible forward. By contraction on one side the **medial pterygoid muscle** pushes the mandible to the opposite side.

The **medial pterygoid** also contributes to the elevation of the mandible acting as a synergist to the temporalis and masseter muscles.

Innervation

The **medial pterygoid** is innervated by the medial pterygoid nerve, branch of mandibular division of the trigeminal nerve (CN V3).

The Muscles and Fasciæ of the Shoulder

In this group are included:

Deltoideus.	Infraspinatus.
Subscapularis.	Teres minor.
Supraspinatus.	Teres major.

Deep Fascia.—The deep fascia covering the Deltoideus invests the muscle, and sends numerous septa between its fasciculi. In front it is continuous with the fascia covering the Pectoralis major; behind, where it is thick and strong, with that covering the Infraspinatus; above, it is attached to the clavicle, the acromion, and the spine of the scapula; below, it is continuous with the deep fascia of the arm.

The **Deltoideus** (*Deltoid muscle*) (Fig. 410) is a large, thick, triangular muscle, which covers the shoulder-joint in front, behind, and laterally. It *arises* from the anterior border and upper surface of the lateral third of the clavicle; from the lateral margin and upper surface of the acromion, and from the lower lip of the posterior border of the spine of the scapula, as far back as the triangular surface at its medial end. From this extensive origin the fibers converge toward their insertion, the middle passing vertically, the anterior obliquely backward and lateralward, the posterior obliquely forward and lateralward; they unite in a thick tendon, which is inserted into the deltoid prominence on the middle of the lateral side of the body of the humerus. At its *insertion* the muscle gives off an expansion to the deep fascia of the arm. This muscle is remarkably coarse in texture, and the arrangement of its fibers is somewhat peculiar; the central portion of the muscle—that is to say, the part arising from the acromion—consists of oblique fibers; these arise in a bipenniform manner from the sides of the tendinous intersections, generally four in number, which are attached above to the acromion and pass downward parallel to one another in the substance of the muscle. The oblique fibers thus formed are inserted into similar tendinous intersections, generally three in number, which pass upward from the insertion of the muscle and alternate with the descending septa. The portions of the muscle arising from the clavicle and spine of the scapula are not arranged in this manner, but are inserted into the margins of the inferior tendon.

Variations.—Large variations uncommon. More or less splitting common. Continuation into the Trapezius; fusion with the Pectoralis major; additional slips from the vertebral border of the scapula, infraspinous fascia and axillary border of scapula not uncommon. Insertion varies in extent or rarely is prolonged to origin of Brachioradialis.

Nerves.—The Deltoideus is supplied by the fifth and sixth cervical through the axillary nerve.

Actions.—The Deltoideus raises the arm from the side, so as to bring it at right angles with the trunk. Its anterior fibers, assisted by the Pectoralis major, draw the arm forward; and its posterior fibers, aided by the Teres major and Latissimus dorsi, draw it backward.

Subscapular Fascia (*fascia subscapularis*).—The subscapular fascia is a thin membrane attached to the entire circumference of the subscapular fossa, and affording attachment by its deep surface to some of the fibers of the Subscapularis.

The **Subscapularis** (Fig. 411) is a large triangular muscle which fills the subscapular fossa, and *arises* from its medial two-thirds and from the lower two-thirds of the groove on the axillary border of the bone. Some fibers *arise* from tendinous laminæ which intersect the muscle and are attached to ridges on the bone; others from an aponeurosis, which separates the muscle from the Teres major and the long head of the Triceps brachii. The fibers pass lateralward, and, gradually converging, end in a tendon which is *inserted* into the lesser tubercle of the humerus and the front of the capsule of the shoulder-joint. The tendon of the muscle is separated from the neck of the scapula by a large bursa, which communicates with the cavity of the shoulder-joint through an aperture in the capsule.

Nerves.—The Subscapularis is supplied by the fifth and sixth cervical nerves through the upper and lower subscapular nerves.

Actions.—The Subscapularis rotates the head of the humerus inward; when the arm is raised, it draws the humerus forward and downward. It is a powerful defence to the front of the shoulder-joint, preventing displacement of the head of the humerus.

Supraspinatous Fascia (*fascia supraspinata*).—The supraspinatous fascia completes the osseofibrous case in which the Supraspinatus muscle is contained; it affords attachment, by its deep surface, to some of the fibers of the muscle. It is thick medially, but thinner laterally under the coracoacromial ligament.

The **Supraspinatus** (Fig. 412) occupies the whole of the supraspinatous fossa, *arising* from its medial two-thirds, and from the strong supraspinatous fascia. The muscular fibers converge to a tendon, which crosses the upper part of the shoulder-joint, and is *inserted* into the highest of the three impressions on the greater tubercle of the humerus; the tendon is intimately adherent to the capsule of the shoulder-joint.

Infraspinatous Fascia (*fascia infraspinata*).—The infraspinatous fascia is a dense fibrous membrane, covering the Infraspinatous muscle and fixed to the circum ference of the infraspinatous fossa; it affords attachment, by its deep surface, to some fibers of that muscle. It is intimately attached to the deltoid fascia along the over-lapping border of the Deltoideus.

The **Infraspinatus** (Fig. 412) is a thick triangular muscle, which occupies the chief part of the infraspinatous fossa; it *arises* by fleshy fibers from its medial two-thirds, and by tendinous fibers from the ridges on its surface; it also arises from the infraspinatous fascia which covers it, and separates it from the Teretes major and minor. The fibers converge to a tendon, which glides over the lateral border of the spine of the scapula, and, passing across the posterior part of the capsule of the shoulder-joint, is *inserted* into the middle impression on the greater tubercle of the humerus. The tendon of this muscle is sometimes separated from the capsule of the shoulder-joint by a bursa, which may communicate with the joint cavity.

The **Teres minor** (Fig. 412) is a narrow, elongated muscle, which *arises* from the dorsal surface of the axillary border of the scapula for the upper two-thirds of its extent, and from two aponeurotic laminæ, one of which separates it from the Infraspinatus, the other from the Teres major. Its fibers run obliquely upward and lateralward; the upper ones end in a tendon which is *inserted* into the lowest of the three impressions on the greater tubercle of the humerus; the lowest fibers are *inserted* directly into the humerus immediately below this impression. The tendon of this muscle passes across, and is united with, the posterior part of the capsule of the shoulder-joint.

Variations.—It is sometimes inseparable from the Infraspinatus.

The **Teres major** (Fig. 412) is a thick but somewhat flattened muscle, which *arises* from the oval area on the dorsal surface of the inferior angle of the scapula, and from the fibrous septa interposed between the muscle and the Teres minor and Infraspinatus; the fibers are directed upward and lateralward, and end in a flat tendon, about 5 cm. long, which is *inserted* into the crest of the lesser tubercle of the humerus. The tendon, at its insertion, lies behind that of the Latissimus dorsi, from which it is separated by a bursa, the two tendons being, however, united along their lower borders for a short distance.

Nerves.—The Supraspinatus and Infraspinatus are supplied by the fifth and sixth cervical nerves through the suprascapular nerve; the Teres minor, by the fifth cervical, through the axillary; and the Teres major, by the fifth and sixth cervical, through the lowest subscapular.

Actions.—The Supraspinatus assists the Deltoideus in raising the arm from the side of the trunk and fixes the head of the humerus in the glenoid cavity. The Infraspinatus and Teres minor rotate the head of the humerus outward; they also assist in carrying the arm backward. One of the most important uses of these three muscles is to protect the shoulder-joint, the Supraspinatus supporting it above, and the Infraspinatus and Teres minor behind. The Teres major assists the Latissimus dorsi in drawing the previously raised humerus downward and backward, and in rotating it inward; when the arm is fixed it may assist the Pectorales and the Latissimus dorsi in drawing the trunk forward.

he muscles of the arm are:

Coracobrachialis.	Brachialis.
Biceps brachii.	Triceps brachii.

Brachial Fascia (*fascia brachii; deep fascia of the arm*).—The brachial fascia is continuous with that covering the Deltoideus and the Pectoralis major, by means of which it is attached, above, to the clavicle, acromion, and spine of the scapula; it forms a thin, loose, membranous sheath for the muscles of the arm, and sends septa between them; it is composed of fibers disposed in a circular or spiral direction, and connected together by vertical and oblique fibers. It differs in thickness at different parts, being thin over the Biceps brachii, but thicker where it covers the Triceps brachii, and over the epicondyles of the humerus: it is strengthened by fibrous aponeuroses, derived from the Pectoralis major and Latissimus dorsi medially, and from the Deltoideus laterally. On either side it gives off a strong intermuscular septum, which is attached to the corresponding supracondylar ridge and epicondyle of the humerus. The **lateral intermuscular septum** extends from the lower part of the crest of the greater tubercle, along the lateral supracondylar ridge, to the lateral epicondyle; it is blended with the tendon of the Deltoideus, gives attachment to the Triceps brachii behind, to the Brachialis, Brachioradialis, and Extensor carpi radialis longus in front, and is perforated by the radial nerve and profunda branch of the branchial artery. The **medial intermuscular septum,** thicker than the preceding, extends from the lower part of the crest of the lesser tubercle of the humerus below the Teres major, along the medial supracondylar ridge to the medial epicondyle; it is blended with the tendon of the Coracobrachialis, and affords attachment to the Triceps brachii behind and the Brachialis in front. It is perforated by the ulnar nerve, the superior ulnar collateral artery, and the posterior branch of the inferior ulnar collateral artery. At the elbow, the deep fascia is attached to the epicondyles of the humerus and the olecranon of the ulna, and is continuous with the deep fascia of the forearm. Just below the middle of the arm, on its medial side, is an oval opening in the deep fascia, which transmits the basilic vein and some lymphatic vessels.

Muscles of the upper arm

Deltoid: is a large and the strongest muscle of the shoulder, connecting to the shoulder blade, the clavicle and the humerus. It is used to lift the arm sideways and rotate it laterally and medially.

Triceps brachii: is the three-headed muscle on the posterior side of the upper arm. It is used to straighten the forearm. It is particularly evident in athletic individuals.

Brachialis: is a strong elbow flexor and helps the biceps brachii to bend the elbow.

Brachioradialis: extends from distal humerus to the lower radius. It is used to flex the elbow and aid pronation and supination of the forearm.

Anconeus: is a small muscle of the elbow with a triangular shape joining the ulna to the lateral humerus. It assists in elbow extension and rotation.

Extensor carpi radialis longus: is a long muscle arising partially at the lateral supracondylar ridge and partially at the lateral epicondyle of the humerus. It runs on the thumb side of the forearm and inserts at the base of the 2nd metacarpal bone (corresponding to the index finger). It is a major muscle used for wrist abduction and extension.

Biceps or Biceps brachii: is the muscle likely used more often when moving the arm. It is connected to the bones of the shoulder, the glenoid and coracoid process, via two tendons, and to the proximal region (tuberosity of the radius) with one tendon. The biceps is essential to bend the arm and turn the hand outward (supination).

Muscles of the forearm

The muscles of the forearm are located on the dorsal and ventral side of the forearm.

Many of them originate from the epicondyles of the upper arm (humerus) and are involved in the movement of the elbow, hand and fingers. Muscles on the dorsal side of the forearm:

Muscles on the dorsal side of the forearm:

Extensor carpi ulnaris: lies on the ulnar side of the forearm. It originates from the lateral epicondyle at the inner elbow and crosses the forearm downward to insert at the base of the 5th metacarpal of the hand. It is used for the extension and adduction of the wrist.

Extensor carpi radialis longus: is a long muscle on the radial side of the forearm used to extend the hand and flex the forearm. It inserts at the lateral humerus to attach distally at the second metacarpal bone of the index finger.

Extensor digitorum: is located on the forearm back side. It arises at lateral epicondyle of the humerus and divides into four tendons to reach the distal and middle phalanges of the fingers. It controls the extension of the medial fingers.

Extensor carpi radialis brevis: originates above the lateral epicondyle of the humerus and inserts into the 3rd metacarpal bone. It functions in synergy with the extensor carpi longus and is used to abduct and extend the hand and wrist.

Extensor digiti minimi: arises at the lateral epicondyle of the humerus and joins with the hand muscle, the extensor digitorium communis. It controls the movements of the little finger (flexion, extension).

Flexor carpi ulnaris: arises at the medial epicondyle of the humerus and the ulnar head. It extends to the wrist where it inserts at the pisiform bone prior to the 5th metacarpal bone. It works together with the extensor carpi radialis to flex or adduct the wrist.

Abductor pollicis longus: together with extensor pollicis muscles, it controls the thumb movement. It begins at the proximal radius and ulna and attaches at the base of 1st metacarpal bone. It assists in thumb abduction and extension and contributes to wrist flexion.

Extensor pollicis brevis: is located on the dorsal forearm. It originates at the distal radius and inserts at the base of the proximal phalanx of the thumb (latin: pollux-pollicis) where it forms the known snuff box at the radial wrist. It works with extensor pollicis longus in the extension and abduction of the thumb.

Muscles of the deep forearm back:

Supinator: is a short muscle arranged in two layers. Its fibres run from the ulna and the lateral end of the humerus to the radius. It supports the biceps brachii in rotating the forearm (supination).

Extensor pollicis longus: originates at the ulna bone and interosseous membrane and inserts at the distal phalange of the thumb. It is used for thumb extension.

Extensor indicis: originates at the interosseous membrane and ulna and travels to the index finger parallel to the extensor digitorum tendon. It assists in the index extension of all phalanges and also of the wrist mid-carpal joints.

Muscles on the ventral side of the forearm:

Pronator teres: inserts proximally with two heads at medial epicondyle of the humerus and ulnar coronoid process and runs diagonally across the forearm to connect to the outer radius. It is used with the pronator quadratus during forearm pronation (palm down)

Flexor carpi radialis: inserts at the humerus epicondyle and runs through the anterior forearm to the base of the 2nd metacarpal bone. It is used during wrist flexion and hand abduction.

Flexor carpi ulnaris: originates with two ends, one at the medial epicondyle of the humerus and the other at the olecranon. It inserts at the wrist carpal bones, the pisiform, hamamate and to the basis of the 5th metacarpal bone. It is used to flex and adduct the hand and wrist.

Palmaris longus: is a thin muscle arising at the medial epicondyle that runs in the middle of the forearm, where it inserts on the palmar aponeurosis on the hand palm. Its function is to flex the hand at the wrist. It can be absent in over 10% of the population or consist of a tendon rather then muscle tissue.

Flexor digitorum superficialis: has two heads one inserting at the medial epicondyle and the other at the radius head. It separates into two tendons that insert at the middle phalanges of the fingers. They are used during flexion of the interphalangeal joints of middle phalanges (2nd to 5th fingers).

Deep muscles of the front forearm:

Flexor digitorum profundus: inserts at the ulna and interosseous membrane and runs to the phalanges of the 2nd to the 5th finger. It controls the flexion of the distal phalanges.

Flexor pollicis longus: originates from the distal radius and runs through the medial forearm to reach the tip of the thumb as a tendon enclosed into the carpal tunnel. It is used for thumb flexion.

Pronator quadratus: is a squared (latin: quadratus) muscle located at the forearm near the wrist. It runs horizontally to connect the ulna with the radius. It assists the pronator teres muscle in forearm pronation (palm facing).

Tendons of the Upper Arm

The tendons of the upper arm connect the muscles to the bones of the forearms. At the proximal side (shoulder) there are two tendons of the biceps: the tendon of the long head inserts to the glenoid, whereas the short head connects with the coracoid process of the shoulder.

The distal tendon of the biceps is connected to the proximal radius and flexes the forearm at the elbow and supinates the forearm. The distal tendon of the triceps is connected to the olecranon and extends the forearm in the elbow joint.

Tendons of the forearm

The forearm tendons (extensors) connect the muscles of the forearm to the lateral epicondyle of the humerus. The extensor carpi radialis brevis is the muscle mostly known for being involved in a pathology named tennis elbow.

Anteriorly - the biceps tendon connects the biceps muscle to the radius. It is used to bend the elbow with strength (see image on previous page).

Posteriorly - the triceps tendon attaches the triceps muscle to the ulna. It is used to straighten the arm with a push-up (see image on previous page).

Elbow capsule

Synovial membrane

The synovial membrane forms a fibrous capsule around the elbow joint. It produces the synovial fluid, which reduces the friction of the bones and tendons by absorbing the pressure during the movement of the joint. It extends from the surface of the humerus, along the ulna and the radius.

Other structures assist in stabilising and protecting the integrity of the elbow joint capsule. The cartilage is a thin layer of connective tissue covering the extremity of all articulating bones (humerus, radius and ulna), which prevents the friction of the bones during the movements of the elbow. In addition, a multitude of ligaments connect the bones with one another to stabilise further the elbow joint (see ligaments).

Blood vessels

Blood vessels are an intricate network of flexible ducts that circulate blood through the body's tissues. They are divided into arteries and veins. The arteries supply the body with oxygenated blood originating from the heart, while the veins transport carbon dioxide-rich blood from peripheral tissues back to the heart. Together they form the vascular system.

Arteries

The subclavian artery is the largest artery providing blood to the upper limbs. It differs on each body side: the right subclavian artery arises from the brachiocephalic trunk whereas the left subclavian artery branches directly from the aorta. After crossing the lateral side of the first rib, the subclavian artery enters the axilla to become the axillary artery and further down it divides again to form the brachial artery.

The largest artery of the arm is the *brachial artery*, which is a direct extension of the subclavian artery. Downstream, the brachial artery forms the *profunda brachii* or, deep artery of the arm, that travels along the posterior surface of the humerus. It supplies the muscles in the posterior part of the arm (e.g triceps brachii), and ends up into a network of vessels at the elbow. As it descends immediately posterior to the median nerve it divides into smaller arteries as it continues towards the arm, wrist and hand. Then it crosses the *cubital fossa* (or elbow pit, the triangular area on the anterior side of the elbow), it bifurcates into the radial and ulnar arteries. Doctors use this pulsating artery to measure blood pressure. Injury to the brachial artery can seriously affect the hand as it is the only blood supply. At the elbow, the brachial artery divides into:

Ulnar artery with its branches, the superior and inferior ulnar collateral arteries, is located at the medial and anterior side of the forearm to reach the wrist

Radial artery descends in the anterior and lateral side of the forearm. Downstream, it divides into different branches to supply the hand

Interosseous recurrent artery supplies the interosseous membrane between the radius and ulna.

Veins

The main veins of the upper arm, elbow and forearm are the *cephalic vein*, the *basilic vein* and the *median cubital vein* situated on the superficial upper extremities. Their description follows the flow of venous blood, ascending from the lower forearm to the upper arm.

Cephalic vein runs from the forearm through the elbow and arm, up to the shoulder where it merges with the axillary vein in the upper chest

The basilic vein runs at the forearm, it passes the elbow and takes the name *axillary vein* at the shoulder. It also merges with the *subclavian vein.* The basilic vein joins with the brachial vein to form the axillary vein

Median cubital vein is a large superficial vein running parallel to the brachial artery. It connects the basilic and cephalic veins. This vein is usually clearly visible through the skin

Median antebrachial vein runs in the anterior aspect of the forearm between the radial and ulnar veins and drains into the basilic vein

Cubital vein is used to draw blood with a needle, or venipuncture, to deliver intravenous infusion of various solutions and medications.

Brachial, radial and ulnar veins are located in the deeper forearm. They take the same names of their corresponding arteries and flow parallel to them. At the elbow, the ulnar and radial veins join to form the brachial vein.

Nerves

The upper limbs are innervated by five nerves: the median, ulnar, radial, axillar and musculocutaneous nerves, each one mediating distinct motor and sensory functions.

Brachial Plexus

The nerves of the arm originate from the cervical spine vertebrae (C5-C8 and T1) and descend along the body to form the brachial plexus from where they interchange and extend along the shoulder, the upper arm and forearm up to the hand and fingers.

Axillary nerve

The axillary nerve or the circumflex nerve is located in the axilla and originates from the brachial plexus. It innervates the upper arm and shoulder region. Differently from other nerves it does not descend along the arm. After leaving the plexus it divides into the anterior and posterior branch.

The anterior branch innervates the deltoid muscle in the upper arm while the posterior branch extends to the upper shoulder, supplying the teres minor (a muscle located in the lateral side of the scapula attaching to the rotator cuff in the shoulder joint) and the posterior area of the deltoid. The axillary nerve provides sensory function to the skin of the shoulder joint and deltoid muscle.

Nerves of the upper extremities

Three main nerves of the arm are:

Median nerve

Radial nerve

Ulnar nerve

Pathological symptoms of the elbow and forearm can be induced by problems of the nerves. The nerves are enclosed by tunnels and due to the complex arm movements; they are subject to bending and straightening. Alterations of the nerves and tunnels can lead to pain, numbness and weakness in the arm and hand. These nerves can also be injured during trauma and improper surgery.

Median nerve

The median nerve controls the following motor functions: forearm pronation, thumb palmar abduction and thumb/index/long finger flexion. The motor branches of the median nerve and the respective muscles they innervate are listed below:

Proximal extrinsic motor branches (median nerve):

1. Pronator teres

2. Flexor carpi radialis

3. Palmaris longus

4. Flexor digitorum superficialis

Proximal extrinsic motor branches **(*anterior interosseous nerve*)**

5. Flexor digitorum profundus (to index and, usually long finger)

6. Flexor pollicis longus

7. Pronator quadratus

Distal intrinsic motor branches (thenar branch)

1. Abductor pollicis brevis

2. Flexor pollicis brevis (superficial head)

3. Opponens pollicis

***Distal intrinsic motor branches* (common digital branches of the median nerve)**

4. First lumbrical (to index and long fingers)

5. Second lumbrical (to index and long fingers)

Palmar branch (to radial base of palm)

Articular branches to the wrist joint (via distal anterior interosseous nerve).

Sensory Branches of the median nerve

These branches control sensation to the illustrated areas of the hand and fingers: volar thumb, index, long, and radial half of ring finger. They also provide sensation to specific areas of the hand - the pinch surfaces of the thumb, index and third fingers. Compression of the median nerve at the wrist is known for causing the carpal tunnel syndrome.

Radial nerve

Motor branches of the radial nerve contribute to the function of the elbow, wrist, finger and thumb.

The muscles Innervated by the radial nerve are:

Triceps brachii / anconeus

Brachioradialis

Extensor carpi radialis longus

Extensor carpi radialis brevis

Supinator

Extensor carpi ulnaris

Extensor digitorum communis

Extensor digiti minimi

Abductor pollicis longus

Extensor pollicis brevis

Extensor indicis proprius

Extensor pollicis longus

Brachialis (contribution; though main supply to brachialis is the musculocutaneous nerve)

Sensory branches

The sensory component of the radial nerve, the superficial radial sensory nerve (or radial sensory branch), is the frequent cause of neuropathic pain following injury.

These are the sensory branches:

Posterior brachial cutaneous nerve/ inferior lateral brachial cutaneous nerve

Posterior antebrachial cutaneous nerve

Radial sensory nerve (sensory branch of the radial nerve)

Ulnar nerve

Motor branches: ulnar nerve contributes to the following motor functions: fine hand movements, coordination of finger motion and pinch strength, flexion of the small and ring fingers.

Proximal extrinsic motor branches (ulnar nerve)

Flexor carpi ulnaris

Flexor digitorum profundus (ulnar half to small, ring +/- long finger)

Distal intrinsic motor branch (superficial ulnar nerve branch)

Palmaris brevis

Distal intrinsic motor branches (deep ulnar nerve branch)

Abductor digiti minimi

Flexor digiti minimi

Opponens digiti minimi

3rd and 4th lumbricals (to small & ring fingers)

Palmar and dorsal interosseous muscles

Adductor pollicis

Flexor pollicis brevis

First dorsal interosseous

First palmar interosseous

Sensory branches

The ulnar nerve mediates parts of the sensation of the palm and of the small finger including the ulnar border of the fourth finger. The ulnar nerve is enclosed in the Guyon canal, where a pathologic nerve entrapment can occur.

These are the main branches of the ulnar nerve:

Dorsal branch

Common and proper digital nerves (superficial branch) to volar small and ulnar half of ring finger

Palmar branch

Articular branches to the elbow joint and carpal and metacarpo-phalangeal joints.

Image shows the areas of sensation of the median radial and ulnar nerves.

The **Coracobrachialis** (Fig. 411), the smallest of the three muscles in this region, is situated at the upper and medial part of the arm. It *arises* from the apex of the coracoid process, in common with the short head of the Biceps brachii, and from the intermuscular septum between the two muscles; it is *inserted* by means of a flat tendon into an impression at the middle of the medial surface and border of the body of the humerus between the origins of the Triceps brachii and Brachialis. It is perforated by the musculocutaneous nerve.

Brachial Fascia (fascia brachii; deep fascia of the arm).—The brachial fascia is continuous with that covering the Deltoideus and the Pectoralis major, by means of which it is attached, above, to the clavicle, acromion, and spine of the scapula; it forms a thin, loose, membranous sheath for the muscles of the arm, and sends septa between them; it is composed of fibers disposed in a circular or spiral direction, and connected together by vertical and oblique fibers. It differs in thickness at different parts, being thin over the Biceps brachii, but thicker where it covers the Triceps brachii, and over the epicondyles of the humerus: it is strengthened by fibrous aponeuroses, derived from the Pectoralis major and Latissimus dorsi medially, and from the Deltoideus laterally. On either side it gives off a strong intermuscular septum, which is attached to the corresponding supracondylar ridge and epicondyle of the humerus. The lateral intermuscular septum extends from the lower part of the crest of the greater tubercle, along the lateral supracondylar ridge, to the lateral epicondyle; it is blended with the tendon of the Deltoideus, gives attachment to the Triceps brachii behind, to the Brachialis, Brachioradialis, and Extensor carpi radialis longus in front, and is perforated by the radial nerve and profunda branch of the branchial artery. The medial intermuscular septum, thicker than the preceding, extends from the lower part of the crest of the lesser tubercle of the humerus below the Teres major, along the medial supracondylar ridge to the medial epicondyle; it is blended with the tendon of the Coracobrachialis, and affords attachment to the Triceps brachii behind and the Brachialis in front. It is perforated by the ulnar nerve, the superior ulnar collateral artery, and the posterior branch of the inferior ulnar collateral artery. At the elbow, the deep fascia is attached to the epicondyles of the humerus and the olecranon of the ulna, and is continuous with the deep fascia of the forearm. Just below the middle of the arm, on its medial side, is an oval opening in the deep fascia, which transmits the basilic vein and some lymphatic vessels.

The Coracobrachialis (Fig. 411), the smallest of the three muscles in this region, is situated at the upper and medial part of the arm. It arises from the apex of the coracoid process, in common with the short head of the Biceps brachii, and from the intermuscular septum between the two muscles; it is inserted by means of a flat tendon into an impression at the middle of the medial surface and border of the body of the humerus between the origins of the Triceps brachii and Brachialis. It is perforated by the musculocutaneous nerve.

Antibrachial Fascia (fascia antibrachii; deep fascia of the forearm).—The antibrachial fascia continuous above with the brachial fascia, is a dense, membranous investment, which forms a general sheath for the muscles in this region; it is attached, behind, to the olecranon and dorsal border of the ulna, and gives off from its deep surface numerous intermuscular septa, which enclose each muscle separately. Over the Flexor tendons as they approach the wrist it is especially thickened, and forms the volar carpal ligament. This is continuous with the transverse carpal ligament, and forms a sheath for the tendon of the Palmaris longus which passes over the transverse carpal ligament to be inserted into the palmar aponeurosis. Behind, near the wrist-joint, it is thickened by the addition of many transverse fibers, and forms the dorsal carpal ligament. It is much thicker on the dorsal than on the volar surface, and at the lower than at the upper part of the forearm, and is strengthened above by tendinous fibers derived from the Biceps brachii in front, and from the Triceps brachii behind. It gives origin to muscular fibers, especially at the upper part of the medial and lateral sides of the forearm, and forms the boundaries of a series of cone-shaped cavities, in which the muscles are contained. Besides the vertical septa separating the individual muscles, transverse septa are given off both on the volar and dorsal surfaces of the forearm, separating the deep from the superficial layers of muscles. Apertures exist in the fascia for the passage of vessels and nerves; one of these apertures of large size, situated at the front of the elbow, serves for the passage of a communicating branch between the superficial and deep veins.

The antibrachial or forearm muscles may be divided into a volar and a dorsal group.

1. The Volar Antibrachial Muscles—These muscles are divided for convenience of description into two groups, superficial and deep.

The muscles of this group take origin from the medial epicondyle of the humerus by a common tendon; they receive additional fibers from the deep fascia of the forearm near the elbow, and from the septa which pass from this fascia between the individual muscles.

The Pronator teres has two heads of origin—humeral and ulnar. The humeral head, the larger and more superficial, arises immediately above the medial epicondyle, and from the tendon common to the origin of the other muscles; also from the intermuscular septum between it and the Flexor carpi radialis and from the antibrachial fascia. The ulnar head is a thin fasciculus, which arises from the medial side of the coronoid process of the ulna, and joins the preceding at an acute angle. The median nerve enters the forearm between the two heads of the muscle, and is separated from the ulnar artery by the ulnar head. The muscle passes obliquely across the forearm, and ends in a flat tendon, which is inserted into a rough impression at the middle of the lateral surface of the body of the radius. The lateral border of the muscle forms the medial boundary of a triangular hollow situated in front of the elbow-joint and containing the brachial artery, median nerve, and tendon of the Biceps brachii.

Variations.—Absence of ulnar head; additional slips from the medial intermuscular septum, from the Biceps and from the Brachialis anticus occasionally occur.

The Flexor carpi radialis lies on the medial side of the preceding muscle. It arises from the medial epicondyle by the common tendon; from the fascia of the forearm; and from the intermuscular septa between it and the Pronator teres laterally, the Palmaris longus medially, and the Flexor digitorum sublimis beneath. Slender and aponeurotic in structure at its commencement, it increases in size, and ends in a tendon which forms rather more than the lower half of its length. This tendon passes through a canal in the lateral part of the transverse carpal ligament and runs through a groove on the greater multangular bone; the groove is converted into a canal by fibrous tissue, and lined by a mucous sheath. The tendon is inserted into the base of the second metacarpal bone, and sends a slip to the base of the third metacarpal bone. The radial artery, in the lower part of the forearm, lies between the tendon of this muscle and the Brachioradialis.

Variations.—Slips from the tendon of the Biceps, the lacertus fibrosus, the coronoid, and the radius have been found. Its insertion often varies and may be mostly into the annular ligament, the trapezium, or the fourth metacarpal as well as the second or third. The muscle may be absent.

The Palmaris longus is a slender, fusiform muscle, lying on the medial side of the preceding. It arises from the medial epicondyle of the humerus by the common tendon, from the intermuscular septa between it and the adjacent muscles, and from the antibrachial fascia. It ends in a slender, flattened tendon, which passes over the upper part of the transverse carpal ligament, and is inserted into the central part of the transverse carpal ligament and lower part of the palmar aponeurosis, frequently sending a tendinous slip to the short muscles of the thumb.

Variations.—One of the most variable muscles in the body. This muscle is often absent about (10 per cent.), and is subject to many variations; it may be tendinous above and muscular below; or it may be muscular in the center with a tendon above and below; or it may present two muscular bundles with a central tendon; or finally it may consist solely of a tendinous band. The muscle may be double. Slips of origin from the coronoid process or from the radius have been seen.Partial or complete insertion into the fascia of the forearm, into the tendon of the Flexor carpi ulnaris and pisiform bone, into the navicular, and into the muscles of the little finger have been observed.

The Flexor carpi ulnaris lies along the ulnar side of the forearm. It arises by two heads, humeral and ulnar, connected by a tendinous arch, beneath which the ulnar nerve and posterior ulnar recurrent artery pass. The humeral head arises from the medial epicondyle of the humerus by the common tendon; the ulnar head arises from the medial margin of the olecranon and from the upper two-thirds of the dorsal border of the ulna by an aponeurosis, common to it and the Extensor carpi ulnaris and Flexor digitorum profundus; and from the intermuscular septum between it and the Flexor digitorum sublimis. The fibers end in a tendon, which occupies the anterior part of the lower half of the muscle and is inserted into the pisiform bone, and is prolonged from this to the hamate and fifth metacarpal bones by the pisohamate and pisometacarpal ligaments; it is also attached by a few fibers to the transverse carpal ligament. The ulnar vessels and nerve lie on the lateral side of the tendon of this muscle, in the lower two-thirds of the forearm.

Variations.—Slips of origin from the coronoid. The Epitrochleo-anconæus, a small muscle often present runs from the back of the inner condyle to the olecranon, over the ulnar nerve.

The Flexor digitorum sublimis is placed beneath the previous muscle; it is the largest of the muscles of the superficial group, and arises by three heads—humeral, ulnar, and radial. The humeral head arises from the medial epicondyle of the humerus by the common tendon, from the ulnar collateral ligament of the elbow-joint, and from the intermuscular septa between it and the preceding muscles. The ulnar head arises from the medial side of the coronoid process, above the ulnar origin of the Pronator teres (see Fig. 213, page 216). The radial head arises from the oblique line of the radius, extending from the radial tuberosity to the insertion of the Pronator teres. The muscle speedily separates into two planes of muscular fibers, superficial and deep: the superficial plane divides into two parts which end in tendons for the middle and ring fingers; the deep plane gives off a muscular slip to join the portion of the superficial plane which is associated with the tendon of the ring finger, and then divides into two parts, which end in tendons for the index and little fingers. As the four tendons thus formed pass beneath the transverse carpal ligament into the palm of the hand, they are arranged in pairs, the superficial pair going to the middle and ring fingers, the deep pair to the index and little fingers. The tendons diverge from one another in the palm and form dorsal relations to the superficial volar arch and digital branches of the median and ulnar nerves. Opposite the bases of the first phalanges each tendon divides into two slips to allow of the passage of the corresponding tendon of the Flexor digitorum profundus; the two slips then reunite and form a grooved channel for the reception of the accompanying tendon of the Flexor digitorum profundus. Finally the tendon divides and is inserted into the sides of the second phalanx about its middle.

Variations.—Absence of radial head, of little finger portion; accessory slips from ulnar tuberosity to the index and middle finger portions; from the inner head to the Flexor profundus; from the ulnar or annular ligament to the little finger.

The **Flexor digitorum profundus** is situated on the ulnar side of the forearm, immediately beneath the superficial Flexors. It *arises* from the upper three-fourths of the volar and medial surfaces of the body of the ulna, embracing the insertion of the Brachialis above, and extending below to within a short distance of the Pronator quadratus. It also arises from a depression on the medial side of the coronoid process; by an aponeurosis from the upper three-fourths of the dorsal border of the ulna, in common with the Flexor and Extensor carpi ulnaris; and from the ulnar half of the interosseous membrane. The muscle ends in four tendons which run under the transverse carpal ligament dorsal to the tendons of the Flexor digitorum sublimis. Opposite the first phalanges the tendons pass through the openings in the tendons of the Flexor digitorum sublimis, and are finally *inserted* into the bases of the last phalanges. The portion of the muscle for the index finger is usually distinct throughout, but the tendons for the middle, ring, and little fingers are connected together by areolar tissue and tendinous slips, as far as the palm of the hand.

Fibrous Sheaths of the Flexor Tendons.—After leaving the palm, the tendons of the Flexores digitorum sublimis and profundus lie in osseo-aponeurotic canals (Fig. 427), formed behind by the phalanges and in front by strong fibrous bands, which arch across the tendons, and are attached on either side to the margins of the phalanges. Opposite the middle of the proximal and second phalanges the bands (digital vaginal ligaments) are very strong, and the fibers are transverse; but opposite the joints they are much thinner, and consist of *annular* and *cruciate* ligamentous fibers. Each canal contains a mucous sheath, which is reflected on the contained tendons.

Within each canal the tendons of the Flexores digitorum sublimis and profundus are connected to each other, and to the phalanges, by slender, tendinous bands, called **vincula tendina** (Fig. 416). There are two sets of these; (*a*) the **vincula brevia,** which are two in number in each finger, and consist of triangular bands of fibers, one connecting the tendon of the Flexor digitorum sublimis to the front of the first interphalangeal joint and head of the first phalanx, and the other the tendon of the Flexor digitorum profundus to the front of the second interphalangeal joint and head of the second phalanx; (*b*) the **vincula longa,** which connect the under surfaces of the tendons of the Flexor digitorum profundus to those of the subjacent Flexor sublimis after the tendons of the former have passed through the latter.

Variations.—The index finger portion may arise partly from the upper part of the radius. Slips from the inner head of the Flexor sublimis, medial epicondyle, or the coronoid are found. Connection with the Flexor pollicis longus.

Four small muscles, the Lumbricales, are connected with the tendons of the Flexor profundus in the palm. They will be described with the muscles of the hand (page 464).

The **Flexor pollicis longus** is situated on the radial side of the forearm, lying in the same plane as the preceding. It *arises* from the grooved volar surface of the body of the radius, extending from immediately below the tuberosity and oblique line to within a short distance of the Pronator quadratus. It *arises* also from the adjacent part of the interosseous membrane, and generally by a fleshy slip from the medial border of the coronoid process, or from the medial epicondyle of the humerus. The fibers end in a flattened tendon, which passes beneath the transverse carpal ligament, is then lodged between the lateral head of the Flexor pollicis brevis and the oblique part of the Adductor pollicis, and, entering an osseoaponeurotic canal similar to those for the Flexor tendons of the fingers, is *inserted* into the base of the distal phalanx of the thumb. The volar interosseous nerve and vessels pass downward on the front of the interosseous membrane between the Flexor pollicis longus and Flexor digitorum profundus.

Variations.—Slips may connect with Flexor sublimis, or Profundus, or Pronator teres. An additional tendon to the index finger is sometimes found.

The **Pronator quadratus** is a small, flat, quadrilateral muscle, extending across the front of the lower parts of the radius and ulna. It *arises* from the pronator ridge on the lower part of the volar surface of the body of the ulna; from the medial part of the volar surface of the lower fourth of the ulna; and from a strong aponeurosis which covers the medial third of the muscle. The fibers pass lateralward and slightly downward, to be inserted into the lower fourth of the lateral border and the volar surface of the body of the radius. The deeper fibers of the muscle are inserted into the triangular area above the ulnar notch of the radius—an attachment comparable with the origin of the Supinator from the triangular area below the radial notch of the ulna.

Variations.—Rarely absent; split into two or three layers; increased attachment upward or downward.

Nerves.—All the muscles of the superficial layer are supplied by the median nerve, excepting the Flexor carpi ulnaris, which is supplied by the ulnar. The Pronator teres, the Flexor carpi radialis, and the Palmaris longus derive their supply primarily from the sixth cervical nerve; the Flexor digitorum sublimis from the seventh and eighth cervical and first thoracic nerves, and the Flexor carpi ulnaris from the eighth cervical and first thoracic. Of the deep layer, the Flexor digitorum profundus is supplied by the eighth cervical and first thoracic through the ulnar, and the volar interosseous branch of the median. The Flexor pollicis longus and Pronator quadratus are supplied by the eighth cervical and first thoracic through the volar interosseous branch of the median.

Actions.—These muscles act upon the forearm, the wrist, and hand. The Pronator teres rotates the radius upon the ulna, rendering the hand prone; when the radius is fixed, it assists in flexing the forearm. The Flexor carpi radialis is a flexor and abductor of the wrist; it also assists in pronating the hand, and in bending the elbow. The Flexor carpi ulnaris is a flexor and adductor of the wrist; it also assists in bending the elbow. The Palmaris longus is a flexor of the wrist-joint; it also assists in flexing the elbow. The Flexor digitorum sublimis flexes first the middle and then the proximal phalanges; it also assists in flexing the wrist and elbow. The Flexor digitorum profundus is one of the flexors of the phalanges. After the Flexor sublimis has bent the second phalanx, the Flexor profundus flexes the terminal one; but it cannot do so until after the contraction of the superficial muscle. It also assists in flexing the wrist. The Flexor pollicis longus is a flexor of the phalanges of the thumb; when the thumb is fixed, it assists in flexing the wrist. The Pronator quadratus rotates the radius upon the ulna, rendering the hand prone.

The Dorsal Antibrachial Muscles—These muscles are divided for convenience of description into two groups, superficial and deep.

The Superficial Group (Fig. 418).

Brachioradialis.	Extensor digitorum communis.
Extensor carpi radialis longus.	Extensor digiti quinti proprius.
Extensor carpi radialis brevis.	Extensor carpi ulnaris.
Anconæus.	

The **Brachioradialis** (*Supinator longus*) is the most superficial muscle on the radial side of the forearm. It *arises* from the upper two-thirds of the lateral supracondylar ridge of the humerus, and from the lateral intermuscular septum, being limited above by the groove for the radial nerve. Interposed between it and the Brachialis are the radial nerve and the anastomosis between the anterior branch of the profunda artery and the radial recurrent. The fibers end above the middle of the forearm in a flat tendon, which is *inserted* into the lateral side of the base of the styloid process of the radius. The tendon is crossed near its insertion by the tendons of the Abductor pollicis longus and Extensor pollicis brevis; on its ulnar side is the radial artery.

Variations.—Fusion with the Brachialis; tendon of insertion may be divided into two or three slips; insertion partial or complete into the middle of the radius, fasciculi to the tendon of the Biceps, the tuberosity or oblique line of the radius; slips to the Extensor carpi radialis longus or Abductor pollicis longus; absence; rarely doubled.

The **Extensor carpi radialis longus** (*Extensor carpi radialis longior*) is placed partly beneath the Brachioradialis. It *arises* from the lower third of the lateral supracondylar ridge of the humerus, from the lateral intermuscular septum, and by a few fibers from the common tendon of origin of the Extensor muscles of the forearm. The fibers end at the upper third of the forearm in a flat tendon, which runs along the lateral border of the radius, beneath the Abductor pollicis longus and Extensor pollicis brevis; it then passes beneath the dorsal carpal ligament, where it lies in a groove on the back of the radius common to it and the Extensor carpi radialis brevis, immediately behind the styloid process. It is *inserted* into the dorsal surface of the base of the second metacarpal bone, on its radial side.

The **Extensor carpi radialis brevis** (*Extensor carpi radialis brevior*) is shorter and thicker than the preceding muscle, beneath which it is placed. It *arises* from the lateral epicondyle of the humerus, by a tendon common to it and the three following muscles; from the radial collateral ligament of the elbow-joint; from a strong aponeurosis which covers its surface; and from the intermuscular septa between it and the adjacent muscles. The fibers end about the middle of the forearm in a flat tendon, which is closely connected with that of the preceding muscle, and accompanies it to the wrist; it passes beneath the Abductor pollicis longus and Extensor pollicis brevis, then beneath the dorsal carpal ligament, and is *inserted* into the dorsal surface of the base of the third metacarpal bone on its radial side. Under the dorsal carpal ligament the tendon lies on the back of the radius in a shallow groove, to the ulnar side of that which lodges the tendon of the Extensor carpi radialis, longus, and separated from it by a faint ridge.

The tendons of the two preceding muscles pass through the same compartment of the dorsal carpal ligament in a single mucous sheath.

Variations.—Either muscle may split into two or three tendons of insertion to the second and third or even the fourth metacarpal. The two muscles may unite into a single belly with two tendons. Cross slips between the two muscles may occur. The *Extensor carpi radialis intermedius* rarely arises as a distinct muscle from the humerus, but is not uncommon as an accessory slip from one or both muscles to the second or third or both metacarpals. The *Extensor carpi radialis accessorius* is occasionally found arising from the humerus with or below the Extensor carpi radialis longus and inserted into the first metacarpal, the Abductor pollicis brevis, the First dorsal interosseous, or elsewhere.

The **Extensor digitorum communis** *arises* from the lateral epicondyle of the humerus, by the common tendon; from the intermuscular septa between it and the adjacent muscles, and from the antibrachial fascia. It divides below into four tendons, which pass, together with that of the Extensor indicis proprius, through a separate compartment of the dorsal carpal ligament, within a mucous sheath. The tendons then diverge on the back of the hand, and are *inserted* into the second and third phalanges of the fingers in the following manner. Opposite the metacarpophalangeal articulation each tendon is bound by fasciculi to the collateral ligaments and serves as the dorsal ligament of this joint; after having crossed the joint, it spreads out into a broad aponeurosis, which covers the dorsal surface of the first phalanx and is reinforced, in this situation, by the tendons of the Interossei and Lumbricalis. Opposite the first interphalangeal joint this aponeurosis divides into three slips; an intermediate and two collateral: the former is inserted into the base of the second phalanx; and the two collateral, which are continued onward along the sides of the second phalanx, unite by their contiguous margins, and are *inserted* into the dorsal surface of the last phalanx. As the tendons cross the interphalangeal joints, they furnish them with dorsal ligaments. The tendon to the index finger is accompanied by the Extensor indicis proprius, which lies on its ulnar side. On the back of the hand, the tendons to the middle, ring, and little fingers are connected by two obliquely placed bands, one from the third tendon passing downward and lateralward to the second tendon, and the other passing from the same tendon downward and medialward to the fourth. Occasionally the first tendon is connected to the second by a thin transverse band.

Variations.—An increase or decrease in the number of tendons is common; an additional slip to the thumb is sometimes present.

The **Extensor digiti quinti proprius** (*Extensor minimi digiti*) is a slender muscle placed on the medial side of the Extensor digitorum communis, with which it is generally connected. It *arises* from the common Extensor tendon by a thin tendinous slip, from the intermuscular septa between it and the adjacent muscles. Its tendon runs through a compartment of the dorsal carpal ligament behind the distal radio-ulnar joint, then divides into two as it crosses the hand, and finally joins the expansion of the Extensor digitorum communis tendon on the dorsum of the first phalanx of the little finger.

Variations.—An additional fibrous slip from the lateral epicondyle; the tendon of insertion may not divide or may send a slip to the ring finger. Absence of muscle rare; fusion of the belly with the Extensor digitorum communis not uncommon.

The **Extensor carpi ulnaris** lies on the ulnar side of the forearm. It *arises* from the lateral epicondyle of the humerus, by the common tendon; by an aponeurosis from the dorsal border of the ulna in common with the Flexor carpi ulnaris and the Flexor digitorum profundus; and from the deep fascia of the forearm. It ends in a tendon, which runs in a groove between the head and the styloid process of the ulna, passing through a separate compartment of the dorsal carpal ligament, and is *inserted* into the prominent tubercle on the ulnar side of the base of the fifth metacarpal bone.

Variations.—Doubling; reduction to tendinous band; insertion partially into fourth metacarpal. In many cases (52 per cent.) a slip is continued from the insertion of the tendon anteriorly over the Opponens digiti quinti, to the fascia covering that muscle, the metacarpal bone, the capsule of the metacarpophalangeal articulation, or the first phalanx of the little finger. This slip may be replaced by a muscular fasciculus arising from or near the pisiform.

The **Anconæus** is a small triangular muscle which is placed on the back of the elbow-joint, and appears to be a continuation of the Triceps brachii. It *arises* by a separate tendon from the back part of the lateral epicondyle of the humerus; its fibers diverge and are *inserted* into the side of the olecranon, and upper fourth of the dorsal surface of the body of the ulna.

The **Supinator** (*Supinator brevis*) (Fig. 420) is a broad muscle, curved around the upper third of the radius. It consists of two planes of fibers, between which the deep branch of the radial nerve lies. The two planes *arise* in common—the superficial one by tendinous and the deeper by muscular fibers—from the lateral epicondyle of the humerus; from the radial collateral ligament of the elbow-joint, and the annular ligament; from the ridge on the ulna, which runs obliquely downward from the dorsal end of the radial notch; from the triangular depression below the notch; and from a tendinous expansion which covers the surface of the muscle. The superficial fibers surround the upper part of the radius, and are inserted into the lateral edge of the radial tuberosity and the oblique line of the radius, as low down as the insertion of the Pronator teres. The upper fibers of the deeper plane form a sling-like fasciculus, which encircles the neck of the radius above the tuberosity and is attached to the back part of its medial surface; the greater part of this portion of the muscle is inserted into the dorsal and lateral surfaces of the body of the radius, midway between the oblique line and the head of the bone.

The **Abductor pollicis longus** (*Extensor oss. metacarpi pollicis*) lies immediately below the Supinator and is sometimes united with it.

It *arises* from the lateral part of the dorsal surface of the body of the ulna below the insertion of the Anconæus, from the interosseous membrane, and from the middle third of the dorsal surface of the body of the radius. Passing obliquely downward and lateralward, it ends in a tendon, which runs through a groove on the lateral side of the lower end of the radius, accompanied by the tendon of the Extensor pollicis brevis, and is *inserted* into the radial side of the base of the first metacarpal bone. It occasionally gives off two slips near its insertion: one to the greater multangular bone and the other to blend with the origin of the Abductor pollicis brevis.

Variations.—More or less doubling of muscle and tendon with insertion of the extra tendon into the first metacarpal, the greater multangular, or into the Abductor pollicis brevis or Opponens pollicis.

The **Extensor pollicis brevis** (*Extensor primi internodii pollicis*) lies on the medial side of, and is closely connected with, the Abductor pollicis longus. It *arises* from the dorsal surface of the body of the radius below that muscle, and from the interosseous membrane. Its direction is similar to that of the Abductor pollicis longus, its tendon passing the same groove on the lateral side of the lower end of the radius, to be *inserted* into the base of the first phalanx of the thumb.

Variations.—Absence; fusion of tendon with that of the Extensor pollicis longus.

The **Extensor pollicis longus** (*Extensor secundi internodii pollicis*) is much larger than the preceding muscle, the origin of which it partly covers. It *arises* from the lateral part of the middle third of the dorsal surface of the body of the ulna below the origin of the Abductor pollicis longus, and from the interosseous membrane. It ends in a tendon, which passes through a separate compartment in the dorsal carpal ligament, lying in a narrow, oblique groove on the back of the lower end of the radius. It then crosses obliquely the tendons of the Extensores carpi radialis longus and brevis, and is separated from the Extensor brevis pollicis by a triangular interval, in which the radial artery is found; and is finally *inserted* into the base of the last phalanx of the thumb. The radial artery is crossed by the tendons of the Abductor pollicis longus and of the Extensores pollicis longus and brevis.

The **Extensor indicis proprius** (*Extensor indicis*) is a narrow, elongated muscle, placed medial to, and parallel with, the preceding. It *arises*, from the dorsal surface of the body of the ulna below the origin of the Extensor pollicis longus, and from the interosseous membrane. Its tendon passes under the dorsal carpal ligament in the same compartment as that which transmits the tendons of the Extensor digitorum communis, and opposite the head of the second metacarpal bone, joins the ulnar side of the tendon of the Extensor digitorum communis which belongs to the index finger.

Variations.—Doubling; the ulnar part may pass beneath the dorsal carpal ligament with the Extensor digitorum communis; a slip from the tendon may pass to the index finger.

Nerves.—The Brachioradialis is supplied by the fifth and sixth, the Extensores carpi radialis longus and brevis by the sixth and seventh, and the Anconæus by the seventh and eighth cervical nerves, through the radial nerve; the remaining muscles are innervated through the deep radial nerve, the Supinator being supplied by the sixth, and all the other muscles by the seventh cervical.

Actions.—The muscles of the lateral and dorsal aspects of the forearm, which comprise all the Extensor muscles and the Supinator, act upon the forearm, wrist, and hand; they are the direct antagonists of the Pronator and Flexor muscles. The Anconæus assists the Triceps in extending the forearm. The Brachioradialis is a flexor of the elbow-joint, but only acts as such when the movement of flexion has been initiated by the Biceps brachii and Brachialis. The action of the Supinator is suggested by its name; it assists the Biceps in bringing the hand into the supine position. The Extensor carpi radialis longus extends the wrist and abducts the hand. It may also assist in bending the elbow-joint; at all events it serves to fix or steady this articulation. The Extensor carpi radialis brevis extends the wrist, and may also act slightly as an abductor of the hand. The Extensor carpi ulnaris extends the wrist, but when acting alone inclines the hand toward the ulnar side; by its continued action it extends the elbow-joint. The Extensor digitorum communis extends the phalanges, then the wrist, and finally the elbow. It acts principally on the proximal phalanges, the middle and terminal phalanges being extended mainly by the Interossei and Lumbricales. It tends to separate the fingers as it extends them. The Extensor digiti quinti proprius extends the little finger, and by its continued action assists in extending the wrist. It is owing to this muscle that the little finger can be extended or pointed while the others are flexed. The chief action of the Abductor pollicis longus is to carry the thumb laterally from the palm of the hand. By its continued action it helps to extend and abduct the wrist. The Extensor pollicis brevis extends the proximal phalanx, and the Extensor pollicis longus the terminal phalanx of the thumb; by their continued action they help to extend and abduct the wrist. The Extensor indicis proprius extends the index finger, and by its continued action assists in extending the wrist

The Muscles and Fasciæ of the Hand

The muscles of the hand are subdivided into three groups: (1) those of the thumb, which occupy the radial side and produce the **thenar eminence;** (2) those of the little finger, which occupy the ulnar side and give rise to the **hypothenar eminence;** (3) those in the middle of the palm and between the metacarpal bones.

Volar Carpal Ligament (*ligamentum carpi volare*).—The volar carpal ligament is the thickened band of antibrachial fascia which extends from the radius to the ulna over the Flexor tendons as they enter the wrist.

Transverse Carpal Ligament (*ligamentum carpi transversum; anterior annular ligament*) (Figs. 421, 422).—**The transverse carpal ligament is a strong, fibrous band, which arches over the carpus, converting the deep groove on the front of the carpal bones into a tunnel, through which the Flexor tendons of the digits and the median nerve pass. It is attached, medially, to the pisiform and the hamulus of the hamate bone; laterally, to the tuberosity of the navicular, and to the medial part of the volar surface and the ridge of the greater multangular. It is continuous, above, with the volar carpal ligament; and below, with the palmar aponeurosis. It is crossed by the ulnar vessels and nerve, and the cutaneous branches of the median and ulnar nerves. At its lateral end is the tendon of theFlexor carpi radialis, which lies in the groove on the greater multangular between the attachments of the ligament to the bone. On its volar surface the tendons of the Palmaris longus and Flexor carpi ulnaris are partly *inserted;* below, it gives origin to the short muscles of the thumb and little finger**

The Mucous Sheaths of the Tendons on the Front of the Wrist.—**Two sheaths envelop the tendons as they pass beneath the transverse carpal ligament, one for the Flexores digitorum sublimis and profundus, the other for the Flexor pollicis longus (Fig. 423). They extend into the forearm for about 2.5 cm. above the transverse carpal ligament, and occasionally communicate with each other under the ligament. The sheath which surrounds the Flexores digitorum extends downward about half-way along the metacarpal bones, where it ends in blind diverticula around the tendons to the index, middle, and ring fingers. It is prolonged on the tendons to the little finger and usually communicates with the mucous sheath of these tendons. The sheath of the tendon of the Flexor pollicis longus is continued along the thumb as far as the insertion of the tendon. The mucous sheaths enveloping the terminal parts of the tendons of the Flexores digitorum have been described on page 449.**

Dorsal Carpal Ligament (*ligamentum carpi dorsale; posterior annular ligament*) (Figs. 421, 422).—**The dorsal carpal ligament is a strong, fibrous band, extending obliquely downward and medialward across the back of the wrist, and consisting of part of the deep fascia of the back of the forearm, strengthened by the addition of some transverse fibers. It is attached, *medially*, to the styloid process of the ulna and to the triangular and pisiform bones; *laterally*, to the lateral margin of the radius; and, in its passage across the wrist, to the ridges on the dorsal surface of the radius.**

The Mucous Sheaths of the Tendons on the Back of the Wrist.—**Between the dorsal carpal ligament and the bones six compartments are formed for the passage of tendons, each compartment having a separate mucous sheath. One is found in each of the following positions (Fig. 424): (1) on the lateral side of the styloid process, for the tendons of the Abductor pollicis longus and Extensor pollicis brevis; (2) behind the styloid process, for the tendons of the Extensores carpi radialis longus and brevis; (3) about the middle of the dorsal surface of the radius, for the tendon of the Extensor pollicis longus; (4) to the medial side of the latter, for the tendons of the Extensor digitorum communis and Extensor indicis proprius; (5) opposite the interval between the radius and ulna, for the Extensor digiti quinti proprius; (6) between the head and styloid process of the ulna, for the tendon of the Extensor carpi ulnaris. The sheaths lining these compartments extends from above the dorsal carpal ligament; those for the tendons of Abductor pollicis longus, Extensor brevis pollicis, Extensores carpi radialis, and Extensor carpi ulnaris stop immediately proximal to the bases of the metacarpal bones, while the sheaths for Extensor communis digitorum, Extensor indicis proprius, and Extensor digiti quinti proprius are prolonged to the junction**

of the proximal and intermediate thirds of the metacarpus

Palmar Aponeurosis (*aponeurosis palmaris; palmar fascia*) (Fig. 425).—The palmar aponeurosis invests the muscles of the palm, and consists of central, lateral, and medial portions.

The **central portion** occupies the middle of the palm, is triangular in shape, and of great strength and thickness. Its apex is continuous with the lower margin of the transverse carpal ligament, and receives the expanded tendon of the Palmaris longus. Its base divides below into four slips, one for each finger. Each slip gives off superficial fibers to the skin of the palm and finger, those to the palm joining the skin at the furrow corresponding to the metacarpophalangeal articulations, and those to the fingers passing into the skin at the transverse fold at the bases of the fingers. The deeper part of each slip subdivides into two processes, which are inserted into the fibrous sheaths of the Flexor tendons. From the sides of these processes offsets are attached to the transverse metacarpal ligament. By this arrangement short channels are formed on the front of the heads of the metacarpal bones; through these the Flexor tendons pass. The intervals between the four slips transmit the digital vessels and nerves, and the tendons of the Lumbricales. At the points of division into the slips mentioned, numerous strong, transverse fasciculi bind the separate processes together. The central part of the palmar aponeurosis is intimately bound to the integument by dense fibroareolar tissue forming the superficial palmar fascia, and gives origin by its medial margin to the Palmaris brevis. It covers the superficial volar arch, the tendons of the Flexor muscles, and the branches of the median and ulnar nerves; and on either side it gives off a septum, which is continuous with the interosseous aponeurosis, and separates the intermediate from the collateral groups of muscles.

The **lateral** and **medial portions** of the palmar aponeurosis are thin, fibrous layers, which cover, on the radial side, the muscles of the ball of the thumb, and, on the ulnar side, the muscles of the little finger; they are continuous with the central portion and with the fascia on the dorsum of the hand.

The **Superficial Transverse Ligament of the Fingers** is a thin band of transverse fasciculi (Fig. 425); it stretches across the roots of the four fingers, and is closely attached to the skin of the clefts, and medially to the fifth metacarpal bone, forming a sort of rudimentary web. Beneath it the digital vessels and nerves pass to their destinations.

The **Abductor pollicis brevis** (*Abductor pollicis*) is a thin, flat muscle, placed immediately beneath the integument. It *arises* from the transverse carpal ligament, the tuberosity of the navicular, and the ridge of the greater multangular, frequently by two distinct slips. Running lateralward and downward, it is *inserted* by a thin, flat tendon into the radial side of the base of the first phalanx of the thumb and the capsule of the metacarpophalangeal articulation.

The **Opponens pollicis** is a small, triangular muscle, placed beneath the preceding. It *arises* from the ridge on the greater multangular and from the transverse carpal ligament, passes downward and lateralward, and is *inserted* into the whole length of the metacarpal bone of the thumb on its radial side.

The **Flexor pollicis brevis** consists of two portions, lateral and medial. The **lateral** and more **superficial portion** *arises* from the lower border of the transverse carpal ligament and the lower part of the ridge on the greater multangular bone; it passes along the radial side of the tendon of the Flexor pollicis longus, and, becoming tendinous, is *inserted* into the radial side of the base of the first phalanx of the thumb; in its tendon of insertion there is a sesamoid bone. The **medial** and **deeper portion** of the muscle is very small, and *arises* from the ulnar side of the first metacarpal bone between the Adductor pollicis (obliquus) and the lateral head of the first Interosseous dorsalis, and is *inserted* into the ulnar side of the base of the first phalanx with the Adductor pollicis (obliquus). The medial part of the Flexor brevis pollicis is sometimes described as the **first Interosseous volaris.**

The **Adductor pollicis** (**obliquus**) (*Adductor obliquus pollicis*) *arises* by several slips from the capitate bone, the bases of the second and third metacarpals, the intercarpal ligaments, and the sheath of the tendon of the Flexor carpi radialis. From this origin the greater number of fibers pass obliquely downward and converge to a tendon, which, uniting with the tendons of the medial portion of the Flexor pollicis brevis and the transverse part of the Adductor, is *inserted* into the ulnar side of the base of the first phalanx of the thumb, a sesamoid bone being present in the tendon. A considerable fasciculus, however, passes more obliquely beneath the tendon of the Flexor pollicis longus to join the lateral portion of the Flexor brevis and the Abductor pollicis brevis.

The **Adductor pollicis** (**transversus**) (*Adductor transversus pollicis*) (Fig. 426) is the most deeply seated of this group of muscles. It is of a triangular form arising by a broad base from the lower two-thirds of the volar surface of the third metacarpal bone; the fibers converge, to be *inserted* with the medial part of the Flexor pollicis brevis and the Adductor pollicis (obliquus) into the ulnar side of the base of the first phalanx of the thumb.

Variations.—The Abductor pollicis brevis is often divided into an outer and an inner part; accessory slips from the tendon of the Abductor pollicis longus or Palmaris longus, more rarely from the Extensor carpi radialis longus, from the styloid process or Opponens pollicis or from the skin over the thenar eminence. The deep head of the Flexor pollicis brevis may be absent or enlarged. The two adductors vary in their relative extent and in the closeness of their connection. The Adductor obliquus may receive a slip from the transverse metacarpal ligament.

Nerves.—The Abductor brevis, Opponens, and lateral head of the Flexor pollicis brevis are supplied by the sixth and seventh cervical nerves through the median nerve; the medial head of the Flexor brevis, and the Adductor, by the eighth cervical through the ulnar nerve.

Actions.—The Abductor pollicis brevis draws the thumb forward in a plane at right angles to that of the palm of the hand. The Adductor pollicis is the opponent of this muscle, and approximates the thumb to the palm. The

Opponens pollicis flexes the metacarpal bone, *i. e.*, draws it medialward over the palm; the Flexor pollicis brevis flexes and adducts the proximal phalanx.

The Medial Volar Muscles (Figs. 426, 427)

Palmaris brevis.	Flexor digiti quinti brevis.
Abductor digiti quinti.	Opponens digiti quinti.

The **Palmaris brevis** is a thin, quadrilateral muscle, placed beneath the integument of the ulnar side of the hand. It *arises* by tendinous fasciculi from the transverse carpal ligament and palmar aponeurosis; the fleshy fibers are inserted into the skin on the ulnar border of the palm of the hand.

The **Abductor digiti quinti** (*Abductor minimi digiti*) is situated on the ulnar border of the palm of the hand. It *arises* from the pisiform bone and from the tendon of the Flexor carpi ulnaris, and ends in a flat tendon, which divides into two slips; one is *inserted* into the ulnar side of the base of the first phalanx of the little finger; the other into the ulnar border of the aponeurosis of the Extensor digiti quinti proprius.

The **Flexor digiti quinti brevis** (*Flexor brevis minimi digiti*) lies on the same plane as the preceding muscle, on its radial side. It *arises* from the convex surface of the hamulus of the hamate bone, and the volar surface of the transverse carpal ligament, and is *inserted* into the ulnar side of the base of the first phalanx of the little finger. It is separated from the Abductor, at its origin, by the deep branches of the ulnar artery and nerve. This muscle is sometimes wanting; the Abductor is then, usually, of large size.

The **Opponens digiti quinti** (*Opponens minimi digiti*) (Fig. 426) is of a triangular form, and placed immediately beneath the preceding muscles. It *arises* from the convexity of the hamulus of the hamate bone, and contiguous portion of the transverse carpal ligament; it is inserted into the whole length of the metacarpal bone of the little finger, along its ulnar margin.

Variations.—The Palmaris brevis varies greatly in size. The Abductor digiti quinti may be divided into two or three slips or united with the Flexor digiti quinti brevis. Accessory head from the tendon of the Flexor carpi ulnaris, the transverse carpal ligament, the fascia of the forearm or the tendon of the Palmaris longus. A portion of the muscle may insert into the metacarpal, or separate slips the *Pisimetacarpus, Pisiuncinatus* or the *Pisiannularis* muscle may exist.

Nerves.—All the muscles of this group are supplied by the eighth cervical nerve through the ulnar nerve.

Actions.—The Abductor and Flexor digiti quinti brevis abduct the little finger from the ring finger and assist in flexing the proximal phalanx. The Opponens digiti quinti draws forward the fifth metacarpal bone, so as to deepen the hollow of the palm. The Palmaris brevis corrugates the skin on the ulnar side of the palm.

3. The Intermediate Muscles

Lumbricales. Interossei.

The **Lumbricales** (Fig. 427) are four small fleshy fasciculi, associated with the tendons of the Flexor digitorum profundus. The first and second *arise* from the radial sides and volar surfaces of the tendons of the index and middle fingers respectively; the third, from the contiguous sides of the tendons of the middle and ring fingers; and the fourth, from the contiguous sides of the tendons of the ring and little fingers. Each passes to the radial side of the corresponding finger, and opposite the metacarpophalangeal articulation is *inserted* into the tendinous expansion of the Extensor digitorum communis covering the dorsal aspect of the finger.

Variations.—The Lumbricales vary in number from two to five or six and there is considerable variation in insertions.

The **Interossei** (Figs. 428, 429) are so named from occupying the intervals between the metacarpal bones, and are divided into two sets, a dorsal and a volar.

The **Interossei dorsales** (*Dorsal interossei*) are *four* in number, and occupy the intervals between the metacarpal bones. They are bipenniform muscles, each *arising* by two heads from the adjacent sides of the metacarpal bones, but more extensively from the metacarpal bone of the finger into which the muscle is inserted. They are inserted into the bases of the first phalanges and into the aponeuroses of the tendons of the Extensor digitorum communis. Between the double origin of each of these muscles is a narrow triangular interval; through the first of these the radial artery passes; through each of the other three a perforating branch from the deep volar arch is transmitted.

The **first** or **Abductor indicis** is larger than the others. It is flat, triangular in form, and *arises* by two heads, separated by a fibrous arch for the passage of the radial artery from the dorsum to the palm of the hand. The lateral head *arises* from the proximal half of the ulnar border of the first metacarpal bone; the medial head, from almost the entire length of the radial border of the second metacarpal bone; the tendon is inserted into the radial side of the index finger. The **second** and **third** are inserted into the middle finger, the former into its radial, the latter into its ulnar side. The **fourth** is inserted into the ulnar side of the ring finger.

The **Interossei volares** (*Palmar interossei*), three in number, are smaller than the Interossei dorsales, and placed upon the volar surfaces of the metacarpal bones, rather than between them. Each *arises* from the entire length of the metacarpal bone of one finger, and is *inserted* into the side of the base of the first phalanx and aponeurotic expansion of the Extensor communis tendon to the same finger.

The **first** *arises* from the ulnar side of the second metacarpal bone, and is *inserted* into the same side of the first phalanx of the index finger. The **second** *arises* from the radial side of the fourth metacarpal bone, and is *inserted* into the same side of the ring finger. The **third** *arises* from the radial side of the fifth metacarpal bone, and is *inserted* into the same side of the little finger. From this account it may be seen that each finger is provided with two Interossei, with the exception of the little finger, in which the Abductor takes the place of one of the pair.

As already mentioned (p. 461), the medial head of the Flexor pollicis brevis is sometimes described as the **Interosseus volaris primus.**

Nerves.—The two lateral Lumbricales are supplied by the sixth and seventh cervical nerves, through the third and fourth digital branches of the median nerve; the two medial Lumbricales and all the Interossei are supplied by the eighth cervical nerve, through the deep palmar branch of the ulnar nerve. The third Lumbricalis frequently receives a twig from the median.

Actions.—The Interossei volares adduct the fingers to an imaginary line drawn longitudinally through the center of the middle finger; and the Interossei dorsales abduct the fingers from that line. In addition to this the Interossei, in conjunction with the Lumbricales, flex the first phalanges at the metacarpophalangeal joints, and extend the second and third phalanges in consequence of their insertions into the expansions of the Extensor tendons. The Extensor digitorum communis is believed to act almost entirely on the first phalanges.

The muscles of the lower extremity are subdivided into groups corresponding with the different regions of the limb.

I. Muscles of the Iliac Region. III. Muscles of the Leg.

II. Muscles of the Thigh. IV. Muscles of the Foot.

The Muscles and Fasciae of the Iliac Region.

Psoas major. Psoas minor. Iliacus.

The Fascia Covering the Psoas and Iliacus is thin above, and becomes gradually thicker below as it approaches the inguinal ligament.

The portion covering the Psoas is thickened above to form the medial lumbocostal arch, which stretches from the transverse process of the first lumbar vertebra to the body of the second. Medially, it is attached by a series of arched processes to the intervertebral fibrocartilages, and prominent margins of the bodies of the vertebræ, and to the upper part of the sacrum; the intervals left, opposite the constricted portions of the bodies, transmit the lumbar arteries and veins and filaments of the sympathetic trunk. Laterally, above the crest of the ilium, it is continuous with the fascia covering the front of the Quadratus lumborum, while below the crest of the ilium it is continuous with the fascia covering the Iliacus.

The portions investing the Iliacus (fascia iliaca; iliac fascia) is connected, laterally to the whole length of the inner lip of the iliac crest; and medially, to the linea terminalis of the lesser pelvis, where it is continuous with the periosteum. At the iliopectineal eminence it receives the tendon of insertion of the Psoas minor, when that muscle exists. Lateral to the femoral vessels it is intimately connected to the posterior margin of the inguinal ligament, and is continuous with the transversalis fascia. Immediately lateral to the femoral vessels the iliac fascia is prolonged backward and medialward from the inguinal ligament as a band, the iliopectineal fascia, which is attached to the iliopectineal eminence. This fascia divides the space between the inguinal ligament and the hip bone into two lacunæ or compartments, the medial of which transmits the femoral vessels, the lateral the Psoas major and Iliacus and the femoral nerve. Medial to the vessels the iliac fascia is attached to the pectineal line behind the inguinal aponeurotic falx, where it is again continuous with the transversalis fascia. On the thigh the fasciæ of the Iliacus and Psoas form a single sheet termed the iliopectineal fascia. Where the external iliac vessels pass into the thigh, the fascia descends behind them, forming the posterior wall of the femoral sheath. The portion of the iliopectineal fascia which passes behind the femoral vessels is also attached to the pectineal line beyond the limits of the attachment of the inguinal aponeurotic falx; at this part it is continuous with the pectineal fascia. The external iliac vessels lie in front of the iliac fascia, but all the branches of the lumbar plexus are behind it; it is separated from the peritoneum by a quantity of loose areolar tissue.

The Psoas major (Psoas magnus) is a long fusiform muscle placed on the side of the lumbar region of the vertebral column and brim of the lesser pelvis. It arises from the anterior surfaces of the bases and lower borders of the transverse processes of all the lumbar vertebræ from the sides of the bodies and the corresponding intervertebral fibrocartilages of the last thoracic and all the lumbar vertebræ by five slips, each of which is attached to the adjacent upper and lower margins of two vertebræ, and to the intervertebral fibrocartilage; from a series of tendinous arches which extend across the constricted parts of the bodies of the lumbar vertebræ between the previous slips; the lumbar arteries and veins, and filaments from the sympathetic trunk pass beneath these tendinous arches. The muscle proceeds downward across the brim of the lesser pelvis, and diminishing gradually in size, passes beneath the inguinal ligament and in front of the capsule of the hip-joint and ends in a tendon; the tendon receives nearly the whole of the fibers of the Iliacus and is inserted into the lesser trochanter of the femur. A large bursa which may communicate with the cavity of the hip-joint, separates the tendon from the pubis and the capsule of the joint.

The Psoas minor (Psoas parvus) is a long slender muscle, placed in front of the Psoas major. It arises from the sides of the bodies of the twelfth thoracic and first lumbar vertebræ and from the fibrocartilage between them. It ends in a long flat tendon which is inserted into the pectineal line and iliopectineal eminence, and, by its lateral border, into the iliac fascia. This muscle is often absent.

The Iliacus is a flat, triangular muscle, which fills the iliac fossa. It arises from the upper two-thirds of this fossa, and from the inner lip of the iliac crest; behind, from the anterior sacroiliac and the iliolumbar ligaments, and base of the sacrum; in front, it reaches as far as the anterior superior and anterior inferior iliac spines, and the notch between them. The fibers converge to be inserted into the lateral side of the tendon of the Psoas major, some of them being prolonged on to the body of the femur for about 2.5 cm. below and in front of the lesser trochanter.

Variations. —The Iliacus minor or Iliocapsularis, a small detached part of the Iliacus is frequently present. It arises from the anterior inferior spine of the ilium and is inserted into the lower part of the intertrochanteric line of the femur or into the iliofemoral ligament.

Nerves. —The Psoas major is supplied by branches of the second and third lumbar nerve; the Psoas minor by a branch of the first lumbar nerve; and the Iliacus by branches of the second and third lumbar nerves through the femoral nerve.

Actions. —The Psoas major, acting from above, flexes the thigh upon the pelvis, being assisted by the Iliacus; acting from below, with the femur fixed, it bends the lumbar portion of the vertebral column forward and to its own side, and then, in conjunction with the Iliacus, tilts the pelvis forward. When the muscles of both sides are acting from below, they serve to maintain the erect posture by supporting the vertebral column and pelvis upon the femora, or in continued action bend the trunk and pelvis forward, as in raising the trunk from the recumbent posture.

Superficial Fascia. —The superficial fascia forms a continuous layer over the whole of the thigh; it consists of areolar tissue containing in its meshes much fat, and may be separated into two or more layers, between which are found the superficial vessels and nerves. It varies in thickness in different parts of the limb; in the groin it is thick, and the two layers are separated from one another by the superficial inguinal lymph glands, the great saphenous vein, and several smaller vessels. The superficial layer is continuous above with the superficial fascia of the abdomen. The deep layer of the superficial fascia is a very thin, fibrous stratum, best marked on the medial side of the great saphenous vein and below the inguinal ligament. It is placed beneath the subcutaneous vessels and nerves and upon the surface of the fascia lata. It is intimately adherent to the fascia lata a little below the inguinal ligament. It covers the fossa ovalis (saphenous opening), being closely united to its circumference, and is connected to the sheath of the femoral vessels. The portion of fascia covering this fossa is perforated by the great saphenous vein and by numerous blood and lymphatic vessels, hence it has been termed the fascia cribrosa, the openings for these vessels having been likened to the holes in a sieve. A large subcutaneous bursa is found in the superficial fascia over the patella.

Deep Fascia. —The deep fascia of the thigh is named, from its great extent, the fascia lata; it constitutes an investment for the whole of this region of the limb, but varies in thickness in different parts. Thus, it is thicker in the upper and lateral part of the thigh, where it receives a fibrous expansion from the Glutæus maximus, and where the Tensor fasciæ latæ is inserted between its layers; it is very thin behind and at the upper and medial part, where it covers the Adductor muscles, and again becomes stronger around the knee, receiving fibrous expansions from the tendon of the Biceps femoris laterally, from the Sartorius medially, and from the Quadriceps femoris in front. The fascia lata is attached, above and behind, to the back of the sacrum and coccyx; laterally, to the iliac crest; in front, to the inguinal ligament, and to the superior ramus of the pubis; and medially, to the inferior ramus of the pubis, to the inferior ramus and tuberosity of the ischium, and to the lower border of the sacrotuberous ligament. From its attachment to the iliac crest it passes down over the Glutæus medius to the upper border of the Glutæus maximus, where it splits into two layers, one passing superficial to and the other beneath this muscle; at the lower border of the muscle the two layers reunite. Laterally, the fascia lata receives the greater part of the tendon of insertion of the Glutæus maximus, and becomes proportionately thickened. The portion of the fascia lata attached to the front part of the iliac crest, and corresponding to the origin of the Tensor fasciæ latæ, extends down the lateral side of the thigh as two layers, one superficial to and the other beneath this muscle; at the lower end of the muscle these two layers unite and form a strong band, having first received the insertion of the muscle. This band is continued downward, under the name of the iliotibial band (tractus iliotibialis) and is attached to the lateral condyle of the tibia. The part of the iliotibial band which lies beneath the Tensor fasciæ latæ is prolonged upward to join the lateral part of the capsule of the hip-joint. Below, the fasciæ lata is attached to all the prominent points around the knee-joint, viz., the condyles of the femur and tibia, and the head of the fibula. On either side of the patella it is strengthened by transverse fibers from the lower parts of the Vasti, which are attached to and support this bone. Of these the lateral are the stronger, and are continuous with the iliotibial band. The deep surface of the fascia lata gives off two strong intermuscular septa, which are attached to the whole length of the linea aspera and its prolongations above and below; the lateral and stronger one, which extends from the insertion of the Glutæus maximus to the lateral condyle, separates the Vastus lateralis in front from the short head of the Biceps femoris behind, and gives partial origin to these muscles; the medial and thinner one separates the

Vastus medialis from the Adductores and Pectineus. Besides these there are numerous smaller septa, separating the individual muscles, and enclosing each in a distinct sheath.

The Fossa Ovalis (saphenous opening) — At the upper and medial part of the thigh, a little below the medial end of the inguinal ligament, is a large oval-shaped aperture in the fascia lata; it transmits the great saphenous vein, and other, smaller vessels, and is termed the fossa ovalis. The fascia cribrosa, which is pierced by the structures passing through the opening, closes the aperture and must be removed to expose it. The fascia lata in this part of the thigh is described as consisting of a superficial and a deep portion.

The superficial portion of the fascia lata is the part on the lateral side of the fossa ovalis. It is attached, laterally, to the crest and anterior superior spine of the ilium, to the whole length of the inguinal ligament, and to the pectineal line in conjunction with the lacunar ligament. From the tubercle of the pubis it is reflected downward and lateralward, as an arched margin, the falciform margin, forming the lateral boundary of the fossa ovalis; this margin overlies and is adherent to the anterior layer of the sheath of the femoral vessels: to its edge is attached the fascia cribrosa. The upward and medial prolongation of the falciform margin is named the superior cornu; its downward and medial prolongation, the inferior cornu. The latter is well-defined, and is continuous behind the great saphenous vein with the pectineal fascia.

The deep portion is situated on the medial side of the fossa ovalis, and at the lower margin of the fossa is continuous with the superficial portion; traced upward, it covers the Pectineus, Adductor longus, and Gracilis, and, passing behind the sheath of the femoral vessels, to which it is closely united, is continuous with the iliopectineal fascia, and is attached to the pectineal line.

From this description it may be observed that the superficial portion of the fascia lata lies in front of the femoral vessels, and the deep portion behind them, so that an apparent aperture exists between the two, through which the great saphenous passes to join the femoral vein.

The Sartorius, the longest muscle in the body, is narrow and ribbon-like; it arises by tendinous fibers from the anterior superior iliac spine and the upper half of the notch below it. It passes obliquely across the upper and anterior part of the thigh, from the lateral to the medial side of the limb, then descends vertically, as far as the medial side of the knee, passing behind the medial condyle of the femur to end in a tendon. This curves obliquely forward and expands into a broad aponeurosis, which is inserted, in front of the Gracilis and Semitendinous, into the upper part of the medial surface of the body of the tibia, nearly as far forward as the anterior crest. The upper part of the aponeurosis is curved backward over the upper edge of the tendon of the Gracilis so as to be inserted behind it. An offset, from its upper margin, blends with the capsule of the knee-joint, and another from its lower border, with the fascia on the medial side of the leg.

Variations. —Slips of origin from the outer end of the inguinal ligament, the notch of the ilium, the ilio-pectineal line or the pubis occur. The muscle may be split into two parts, and one part may be inserted into the fascia lata, the femur, the ligament of the patella or the tendon of the Semitendinosus. The tendon of insertion may end in the fascia lata, the capsule of the knee-joint, or the fascia of the leg. The muscle may be absent.

The Quadriceps femoris (Quadriceps extensor) includes the four remaining muscles on the front of the thigh. It is the great extensor muscle of the leg, forming a large fleshy mass which covers the front and sides of the femur. It is subdivided into separate portions, which have received distinctive names. One occupying the middle of the thigh, and connected above with the ilium, is called from its straight course the Rectus femoris. The other three lie in immediate connection with the body of the femur, which they cover from the trochanters to the condyles. The portion on the lateral side of the femur is termed the Vastus lateralis; that covering the medial side, the Vastus medialis; and that in front, the Vastus intermedius.

The Rectus femoris is situated in the middle of the front of the thigh; it is fusiform in shape, and its superficial fibers are arranged in a bipenniform manner, the deep fibers running straight down to the deep aponeurosis. It arises by two tendons: one, the anterior or straight, from the anterior inferior iliac spine; the other, the posterior or reflected, from a groove above the brim of the acetabulum. The two unite at an acute angle, and spread into an aponeurosis which is prolonged downward on the anterior surface of the muscle, and from this the muscular fibers arise. The muscle ends in a broad and thick aponeurosis which occupies the lower two-thirds of its posterior surface, and, gradually becoming narrowed into a flattened tendon, is inserted into the base of the patella.

The Vastus lateralis (Vastus externus) is the largest part of the Quadriceps femoris. It arises by a broad aponeurosis, which is attached to the upper part of the intertrochanteric line, to the anterior and inferior borders of the greater trochanter, to the lateral lip of the gluteal tuberosity, and to the upper half of the lateral lip of the linea aspera; this aponeurosis covers the upper three-fourths of the muscle, and from its deep surface many fibers take origin. A few additional fibers arise from the tendon of the Glutæus maximus, and from the lateral intermuscular septum between the Vastus lateralis and short head of the Biceps femoris. The fibers form a large fleshy mass, which is attached to a strong aponeurosis, placed on the deep surface of the lower part of the muscle: this aponeurosis becomes contracted and thickened into a flat tendon inserted into the lateral border of the patella, blending with the Quadriceps femoris tendon, and giving an expansion to the capsule of the knee-joint.

The Vastus medialis and Vastus intermedius appear to be inseparably united, but when the Rectus femoris has been reflected a narrow interval will be observed extending upward from the medial border of the patella between the two muscles, and the separation may be continued as far as the lower part of the intertrochanteric line, where, however, the two muscles are frequently continuous.

The Vastus medialis (Vastus internus) arises from the lower half of the intertrochanteric line, the medial lip of the linea aspera, the upper part of the medial supracondylar line, the tendons of the Adductor longus and the Adductor magnus and the medial intermuscular septum. Its fibers are directed downward and forward, and are chiefly attached to an aponeurosis which lies on the deep surface of the muscle and is inserted into the medial border of the patella and the Quadriceps femoris tendon, an expansion being sent to the capsule of the knee-joint.

The Vastus intermedius (Crureus) arises from the front and lateral surfaces of the body of the femur in its upper two-thirds and from the lower part of the lateral intermuscular septum. Its fibers end in a superficial aponeurosis, which forms the deep part of the Quadriceps femoris tendon.

The tendons of the different portions of the Quadriceps unite at the lower part of the thigh, so as to form a single strong tendon, which is inserted into the base of the patella, some few fibers passing over it to blend with the ligamentum patellæ. More properly, the patella may be regarded as a sesamoid bone, developed in the tendon of the Quadriceps; and the ligamentum patellæ, which is continued from the apex of the patella to the tuberosity of the tibia, as the proper tendon of insertion of the muscle, the medial and lateral patellar retinacula being expansions from its borders. A bursa, which usually communicates with the cavity of the knee-joint, is situated between the femur and the portion of the Quadriceps tendon above the patella; another is interposed between the tendon and the upper part of the front of the tibia; and a third, the prepatellar bursa, is placed over the patella itself.

The Articularis genu (Subcrureus) is a small muscle, usually distinct from the Vastus intermedius, but occasionally blended with it; it arises from the anterior surface of the lower part of the body of the femur, and is inserted into the upper part of the synovial membrane of the knee-joint. It sometimes consists of several separate muscular bundles.

Nerves. —The muscles of this region are supplied by the second, third, and fourth lumbar nerves, through the femoral nerve.

Actions. —The Sartorius flexes the leg upon the thigh, and, continuing to act, flexes the thigh upon the pelvis; it next abducts and rotates the thigh outward. When the knee is bent, the Sartorius assists the Semitendinosus, Semimembranosus, and Popliteus in rotating the tibia inward. Taking its fixed point from the leg, it flexes the pelvis upon the thigh, and, if one muscle acts, assists in rotating the pelvis. The Quadriceps femoris extends the leg upon the thigh. The Rectus femoris assists the Psoas major and Iliacus in supporting the pelvis and trunk upon the femur. It also assists in flexing the thigh on the pelvis, or if the thigh be fixed it will flex the pelvis. The Vastus medialis draws the patella medialward as well as upward.

2. The Medial Femoral Muscles

The Gracilis is the most superficial muscle on the medial side of the thigh. It is thin and flattened, broad above, narrow and tapering below. It arises by a thin aponeurosis from the anterior margins of the lower half of the symphysis pubis and the upper half of the pubic arch. The fibers run vertically downward, and end in a rounded tendon, which passes behind the medial condyle of the femur, curves around the medial condyle of the tibia, where it becomes flattened, and is inserted into the upper part of the medial surface of the body of the tibia, below the condyle. A few of the fibers of the lower part of the tendon are prolonged into the deep fascia of the leg. At its insertion the tendon is situated immediately above that of the Semitendinosus, and its upper edge is overlapped by the tendon of the Sartorius, with which it is in part blended. It is separated from the tibial collateral ligament of the knee-joint, by a bursa common to it and the tendon of the Semitendinosus.

The Pectineus is a flat, quadrangular muscle, situated at the anterior part of the upper and medial aspect of the thigh. It arises from the pectineal line, and to a slight extent from the surface of bone in front of it, between the iliopectineal eminence and tubercle of the pubis, and from the fascia covering the anterior surface of the muscle; the fibers pass downward, backward, and lateralward, to be inserted into a rough line leading from the lesser trochanter to the linea aspera.

The Adductor longus, the most superficial of the three Adductores, is a triangular muscle, lying in the same plane as the Pectineus. It arises by a flat, narrow tendon, from the front of the pubis, at the angle of junction of the crest with the symphysis; and soon expands into a broad fleshy belly. This passes downward, backward, and lateralward, and is inserted, by an aponeurosis, into the linea aspera, between the Vastus medialis and the Adductor magnus, with both of which it is usually blended.

The Adductor brevis is situated immediately behind the two preceding muscles. It is somewhat triangular in form, and arises by a narrow origin from the outer surfaces of the superior and inferior rami of the pubis, between the Gracilis and Obturator externus. Its fibers, passing backward, lateralward, and downward, are inserted, by an aponeurosis, into the line leading from the lesser trochanter to the linea aspera and into the upper part of the linea aspera, immediately behind the Pectineus and upper part of the Adductor longus.

The Adductor magnus is a large triangular muscle, situated on the medial side of the thigh. It arises from a small part of the inferior ramus of the pubis, from the inferior ramus of the ischium, and from the outer margin of the inferior part of the tuberosity of the ischium. Those fibers which arise from the ramus of the pubis are short, horizontal in direction, and are inserted into the rough line leading from the greater trochanter to the linea aspera, medial to the Glutæus maximus; those from the ramus of the ischium are directed downward and lateralward with different degrees of obliquity, to be inserted, by means of a broad aponeurosis, into the linea aspera and the upper part of its medial prolongation below. The medial portion of the muscle, composed principally of the fibers arising from the tuberosity of the ischium, forms a thick fleshy mass consisting of coarse bundles which descend almost vertically, and end about the lower third of the thigh in a rounded tendon which is inserted into the adductor tubercle on the medial condyle of the femur, and is connected by a fibrous expansion to the line leading upward from the tubercle to the linea aspera. At the insertion of the muscle, there is a series of osseoaponeurotic openings, formed by tendinous arches attached to the bone. The upper four openings are small, and give passage to the perforating branches of the profunda femoris artery. The lowest is of large size, and transmits the femoral vessels to the popliteal fossa.

Variations. —The Pectineus is sometimes divided into an outer part supplied by the femoral nerve and an inner part supplied by the obturator nerve. The muscle may be attached to or inserted into the capsule of the hip-joint. The Adductor longus may be double, may extend to the knee, or be more or less united with the Pectineus. The Adductor brevis may be divided into two or three parts, or it may be united to the Adductor magnus. The Adductor magnus may be more or less segmented, the anterior and superior portion is often described as a separate muscle, the Adductor minimus. The muscle may be fused with the Quadratus femoris.

Nerves. —The three Adductores and the Gracilis are supplied by the third and fourth lumbar nerves through the obturator nerve; the Adductor magnus receiving an additional branch from the sacral plexus through the sciatic. The Pectineus is supplied by the second, third, and fourth lumbar nerves through the femoral nerve, and by the third lumbar through the accessory obturator when this latter exists. Occasionally it receives a branch from the obturator nerve. (*86

Actions. —The Pectineus and three Adductores adduct the thigh powerfully; they are especially used in horse exercise, the sides of the saddle being grasped between the knees by the contraction of these muscles. In consequence of the obliquity of their insertions into the linea aspera, they rotate the thigh outward, assisting the external Rotators, and when the limb has been abducted, they draw it medialward, carrying the thigh across that of the opposite side. The Pectineus and Adductores brevis and longus assist the Psoas major and Iliacus in flexing the thigh upon the pelvis. In progression, all these muscles assist in drawing forward the lower limb. The Gracilis assists the Sartorius in flexing the leg and rotating it inward; it is also an adductor of the thigh. If the lower extremities be fixed, these muscles, taking their fixed points below, may act upon the pelvis, serving to maintain the body in an erect posture; or, if their action be continued, flex the pelvis forward upon the femur.

3. The Muscles of the Gluteal Region

The Glutæus maximus, the most superficial muscle in the gluteal region, is a broad and thick fleshy mass of a quadrilateral shape, and forms the prominence of the nates. Its large size is one of the most characteristic features of the muscular system in man, connected as it is with the power he has of maintaining the trunk in the erect posture. The muscle is remarkably coarse in structure, being made up of fasciculi lying parallel with one another and collected together into large bundles separated by fibrous septa. It arises from the posterior gluteal line of the ilium, and the rough portion of bone including the crest, immediately above and behind it; from the posterior surface of the lower part of the sacrum and the side of the coccyx; from the aponeurosis of the Sacrospinalis, the sacrotuberous ligament, and the fascia (gluteal aponeurosis) covering the Glutæus medius. The fibers are directed obliquely downward and lateralward; those forming the upper and larger portion of the muscle, together with the superficial fibers of the lower portion, end in a thick tendinous lamina, which passes across the greater trochanter, and is inserted into the iliotibial band of the fascia lata; the deeper fibers of the lower portion of the muscle are inserted into the gluteal tuberosity between the Vastus lateralis and Adductor magnus.

Bursæ—Three bursæ are usually found in relation with the deep surface of this muscle. One of these, of large size, and generally multilocular, separates it from the greater trochanter; a second, often wanting, is situated on the tuberosity of the ischium; a third is found between the tendon of the muscle and that of the Vastus lateralis.

The Glutæus medius is a broad, thick, radiating muscle, situated on the outer surface of the pelvis. Its posterior third is covered by the Glutæus maximus, its anterior two-thirds by the gluteal aponeurosis, which separates it from the superficial fascia and integument. It arises from the outer surface of the ilium between the iliac crest and posterior gluteal line above, and the anterior gluteal line below; it also arises from the gluteal aponeurosis covering its outer surface. The fibers converge to a strong flattened tendon, which is inserted into the oblique ridge which runs downward and forward on the lateral surface of the greater trochanter. A bursa separates the tendon of the muscle from the surface of the trochanter over which it glides.

Variations.—The posterior border may be more or less closely united to the Piriformis, or some of the fibers end on its tendon.

The Glutæus minimus, the smallest of the three Glutæi, is placed immediately beneath the preceding. It is fan-shaped, arising from the outer surface of the ilium, between the anterior and inferior gluteal lines, and behind, from the margin of the greater sciatic notch. The fibers converge to the deep surface of a radiated aponeurosis, and this ends in a tendon which is inserted into an impression on the anterior border of the greater trochanter, and gives an expansion to the capsule of the hip-joint. A bursa is interposed between the tendon and the greater trochanter. Between the Glutæus medius and Glutæus minimus are the deep branches of the superior gluteal vessels and the superior gluteal nerve. The deep surface of the Glutæus minimus is in relation with the reflected tendon of the Rectus femoris and the capsule of the hip-joint.

Variations. —The muscle may be divided into an anterior and a posterior part, or it may send slips to the Piriformis, the Gemellus superior or the outer part of the origin of the Vastus lateralis.

The Tensor fasciæ latæ (Tensor fasciæ femoris) arises from the anterior part of the outer lip of the iliac crest; from the outer surface of the anterior superior iliac spine, and part of the outer border of the notch below it, between the Glutæus medius and Sartorius; and from the deep surface of the fascia lata. It is inserted between the two layers of the iliotibial band of the fascia lata about the junction of the middle and upper thirds of the thigh.

The Piriformis is a flat muscle, pyramidal in shape, lying almost parallel with the posterior margin of the Glutæus medius. It is situated partly within the pelvis against its posterior wall, and partly at the back of the hip-joint. It arises from the front of the sacrum by three fleshy digitations, attached to the portions of bone between the first, second, third, and fourth anterior sacral foramina, and to the grooves leading from the foramina: a few fibers also arise from the margin of the greater sciatic foramen, and from the anterior surface of the sacrotuberous ligament. The muscle passes out of the pelvis through the greater sciatic foramen, the upper part of which it fills, and is inserted by a rounded tendon into the upper border of the greater trochanter behind, but often partly blended with, the common tendon of the Obturator internus and Gemelli.

Variations. —It is frequently pierced by the common peroneal nerve and thus divided more or less into two parts. It may be united with the Glutæus medius, or send fibers to the Glutæus minimus or receive fibers from the Gemellus superior. It may have only one or two sacral attachments or be inserted in to the capsule of the hip-joint. It may be absent.

Obturator Membrane —The obturator membrane is a thin fibrous sheet, which almost completely closes the obturator foramen. Its fibers are arranged in interlacing bundles mainly transverse in direction; the uppermost bundle is attached to the obturator tubercles and completes the obturator canal for the passage of the obturator vessels and nerve. The membrane is attached to the sharp margin of the obturator foramen except at its lower lateral angle, where it is fixed to the pelvic surface of the inferior ramus of the ischium, i. e., within the margin. Both obturator muscles are connected with this membrane.

The Obturator internus is situated partly within the lesser pelvis, and partly at the back of the hip-joint. It arises from the inner surface of the antero-lateral wall of the pelvis, where it surrounds the greater part of the obturator foramen, being attached to the inferior rami of the pubis and ischium, and at the side to the inner surface of the hip bone below and behind the pelvic brim, reaching from the upper part of the greater sciatic foramen above and behind to the obturator foramen below and in front. It also arises from the pelvic surface of the obturator membrane except in the posterior part, from the tendinous arch which completes the canal for the passage of the obturator vessels and nerve, and to a slight extent from the obturator fascia, which covers the muscle. The fibers converge rapidly toward the lesser sciatic foramen, and end in four or five tendinous bands, which are found on the deep surface of the muscle; these bands are reflected at a right angle over the grooved surface of the ischium between its spine and tuberosity. This bony surface is covered by smooth cartilage, which is separated from the tendon by a bursa, and presents one or more ridges corresponding with the furrows between the tendinous bands. These bands leave the pelvis through the lesser sciatic foramen and unite into a single flattened tendon, which passes horizontally across the capsule of the hip-joint, and, after receiving the attachments of the Gemelli, is inserted into the forepart of the medial surface of the greater trochanter above the trochanteric fossa. A bursa, narrow and elongated in form, is usually found between the tendon and the capsule of the hip-joint; it occasionally communicates with the bursa between the tendon and the ischium.

The Gemelli are two small muscular fasciculi, accessories to the tendon of the Obturator internus which is received into a groove between them.

The Gemellus superior, the smaller of the two, arises from the outer surface of the spine of the ischium, blends with the upper part of the tendon of the Obturator internus, and is inserted with it into the medial surface of the greater trochanter. It is sometimes wanting.

The Gemellus inferior arises from the upper part of the tuberosity of the ischium, immediately below the groove for the Obturator internus tendon. It blends with the lower part of the tendon of the

Obturator internus, and is inserted with it it into the medial surface of the greater trochanter. Rarely absent.

The Quadratus femoris is a flat, quadrilateral muscle, between the Gemellus inferior and the upper margin of the Adductor magnus; it is separated from the latter by the terminal branches of the medial femoral circumflex vessels. It arises from the upper part of the external border of the tuberosity of the ischium, and is inserted into the upper part of the linea quadrata—that is, the line which extends vertically downward from the intertrochanteric crest. A bursa is often found between the front of this muscle and the lesser trochanter. Sometimes absent.

The Obturator externus is a flat, triangular muscle, which covers the outer surface of the anterior wall of the pelvis. It arises from the margin of bone immediately around the medial side of the obturator foramen, viz., from the rami of the pubis, and the inferior ramus of the ischium; it also arises from the medial two-thirds of the outer surface of the obturator membrane, and from the tendinous arch which completes the canal for the passage of the obturator vessels and nerves. The fibers springing from the pubic arch extend on to the inner surface of the bone, where they obtain a narrow origin between the margin of the foramen and the attachment of the obturator membrane. The fibers converge and pass backward, lateralward, and upward, and end in a tendon which runs across the back of the neck of the femur and lower part of the capsule of the hipjoint and is inserted into the trochanteric fossa of the femur. The obturator vessels lie between the muscle and the obturator membrane; the anterior branch of the obturator nerve reaches the thigh by passing in front of the muscle, and the posterior branch by piercing it.

Nerves.—The Glutæus maximus is supplied by the fifth lumbar and first and second sacra nerves through the inferior gluteal nerve; the Glutæi medius and minimus and the Tensor fasciæ latæ by the fourth and fifth lumbar and first sacral nerves through the superior gluteal; the Piriformis is supplied by the first and second sacral nerves; the Gemellus inferior and Quadratus femoris by the last lumbar and first sacral nerves; the Gemellus superior and Obturator internus by the first, second, and third sacral nerves, and the Obturator externus by the third and fourth lumbar nerves through the obturator.

Actions. —When the Glutæus maximus takes its fixed point from the pelvis, it extends the femur and brings the bent thigh into a line with the body. Taking its fixed point from below, it acts upon the pelvis, supporting it and the trunk upon the head of the femur; this is especially obvious in standing on one leg. Its most powerful action is to cause the body to regain the erect position after stooping, by drawing the pelvis backward, being assisted in this action by the Biceps femoris, Semitendinosus, and Semimembranosus. The **Glutæus maximus** is a tensor of the fascia lata, and by its connection with the iliotibial band steadies the femur on the articular surfaces of the tibia during standing, when the Extensor muscles are relaxed. The lower part of the muscle also acts as an adductor and external rotator of the limb. The Glutæi medius and minimus abduct the thigh, when the limb is extended, and are principally called into action in supporting the body on one limb, in conjunction with the Tensor fasciæ latæ. Their anterior fibers, by drawing the greater trochanter forward, rotate the thigh inward, in which action they are also assisted by the Tensor fasciæ latæ. The Tensor fasciæ latæ is a tensor of the fascia lata; continuing its action, the oblique direction of its fibers enables it to abduct the thigh and to rotate it inward. In the erect posture, acting from below, it will serve to steady the pelvis upon the head of the femur; and by means of the iliotibial band it steadies the condyles of the femur on the articular surfaces of the tibia, and assists the Glutæus maximus in supporting the knee in the extended position. The remaining muscles are powerful external rotators of the thigh. In the sitting posture, when the thigh is flexed upon the pelvis, their action as rotators ceases, and they become abductors, with the exception of the Obturator externus, which still rotates the femur outward.

4. The Posterior Femoral Muscles (Hamstring Muscles) (Fig. 434).

The Biceps femoris (Biceps) is situated on the posterior and lateral aspect of the thigh. It has two heads of origin; one, the long head, arises from the lower and inner impression on the back part of the tuberosity of the ischium, by a tendon common to it and the Semitendinosus, and from the lower part of the sacrotuberous ligament; the other, the short head, arises from the lateral lip of the linea aspera, between the Adductor magnus and Vastus lateralis, extending up almost as high as the insertion of the Glutæus maximus; from the lateral prolongation of the linea aspera to within 5 cm. of the lateral condyle; and from the lateral intermuscular septum. The fibers of the long head form a fusiform belly, which passes obliquely downward and lateralward across the sciatic nerve to end in an aponeurosis which covers the posterior surface of the muscle, and receives the fibers of the short head; this aponeurosis becomes gradually contracted into a tendon, which is inserted into the lateral side of the head of the fibula, and by a small slip into the lateral condyle of the tibia. At its insertion the tendon divides into two portions, which embrace the fibular collateral ligament of the knee-joint. From the posterior border of the tendon a thin expansion is given off to the fascia of the leg. The tendon of insertion of this muscle forms the lateral hamstring; the common personeal nerve descends along its medial border.

Variations. —The short head may be absent; additional heads may arise from the ischial tuberosity, the linea aspera, the medial supracondylar ridge of the femur or from various other parts. A slip may pass to the Gastrocnemius.

The Semitendinosus, remarkable for the great length of its tendon of insertion, is situated at the posterior and medial aspect of the thigh. It arises from the lower and medial impression on the tuberosity of the ischium, by a tendon common to it and the long head of the Biceps femoris; it also arises from an aponeurosis which connects the adjacent surfaces of the two muscles to the extent of about 7.5 cm. from their origin. The muscle is fusiform and ends a little below the middle of the thigh in a long round tendon which lies along the medial side of the popliteal fossa; it then curves around the medial condyle of the tibia and passes over the tibial collateral ligament of the knee-joint, from which it is separated by a bursa, and is inserted into the upper part of the medial surface of the body of the tibia, nearly as far forward as its anterior crest. At its insertion it gives off from its lower border a prolongation to the deep fascia of the leg and lies behind the tendon of the Sartorius, and below that of the Gracilis, to which it is united. A tendinous intersection is usually observed about the middle of the muscle.

The Semimembranosus, so called from its membranous tendon of origin, is situated at the back and medial side of the thigh. It arises by a thick tendon from the upper and outer impression on the tuberosity of the ischium, above and lateral to the Biceps femoris and Semitendinosus. The tendon of origin expands into an aponeurosis, which covers the upper part of the anterior surface of the muscle; from this aponeurosis muscular fibers arise, and converge to another aponeurosis which covers the lower part of the posterior surface of the muscle and contracts into the tendon of insertion. It is inserted mainly into the horizontal groove on the posterior medial aspect of the medial condyle of the tibia. The tendon of insertion gives off certain fibrous expansions: one, of considerable size, passes upward and lateralward to be inserted into the back part of the lateral condyle of the femur, forming part of the oblique popliteal ligament of the knee-joint; a second is continued downward to the fascia which covers the Popliteus muscle; while a few fibers join the tibial collateral ligament of the joint and the fascia of the leg. The muscle overlaps the upper part of the popliteal vessels.

Variations. —It may be reduced or absent, or double, arising mainly from the sacrotuberous ligament and giving a slip to the femur or Adductor magnus.

Nerves. —The muscles of this region are supplied by the fourth and fifth lumbar and the first, second, and third sacral nerves; the nerve to the short head of the Biceps femoris is derived from the common peroneal, the other muscles are supplied through the tibial nerve.

Actions. —The hamstring muscles flex the leg upon the thigh. When the knee is semiflexed, the Biceps femoris in consequence of its oblique direction rotates the leg slightly outward; and the Semitendinosus, and to a slight extent the Semimembranosus, rotate the leg inward, assisting the Popliteus. Taking their fixed point from below, these muscles serve to support the pelvis upon the head of the femur, and to draw the trunk directly backward, as in raising it from the stooping position or in feats of strength, when the body is thrown backward in the form of an arch. As already indicated on page 285, complete flexion of the hip cannot be effected unless the knee-joint is also flexed, on account of the shortness of the hamstring muscles.

The muscles of the leg may be divided into three groups: anterior, posterior, and lateral.

The Anterior Crural Muscles.

Deep Fascia (fascia cruris). —The deep fascia of the leg forms a complete investment to the muscles, and is fused with the periosteum over the subcutaneous surfaces of the bones. It is continuous above with the fascia lata, and is attached around the knee to the patella, the ligamentum patellæ, the tuberosity and condyles of the tibia, and the head of the tibula. Behind, it forms the popliteal fascia, covering in the popliteal fossa; here it is strengthened by transverse fibers, and perforated by the small saphenous vein. It receives an expansion from the tendon of the Biceps femoris laterally, and from the tendons of the Sartorius, Gracilis, Semitendinosus, and Semimembranosus medially; in front, it blends with the periosteum covering the subcutaneous surface of the tibia, and with that covering the head and malleolus of the fibula; below, it is continuous with the transverse crural and laciniate ligaments. It is thick and dense in the upper and anterior part of the leg, and gives attachment, by its deep surface, to the Tibialis anterior and Extensor digitorum longus; but thinner behind, where it covers the Gastrocnemius and Soleus. It gives off from its deep surface, on the lateral side of the leg, two strong intermuscular septa, the anterior and posterior peroneal septa, which enclose the Peronæi longus and brevis, and separate them from the muscles of the anterior and posterior crural regions, and several more slender processes which enclose the individual muscles in each region. A broad transverse intermuscular septum, called the deep transverse fascia of the leg, intervenes between the superficial and deep posterior crural muscles.

The Tibialis anterior (Tibialis anticus) is situated on the lateral side of the tibia; it is thick and fleshy above, tendinous below. It arises from the lateral condyle and upper half or two-thirds of the lateral surface of the body of the tibia; from the adjoining part of the interosseous membrane; from the deep surface of the fascia; and from the intermuscular septum between it and the Extensor digitorum longus. The fibers run vertically downward, and end in a tendon, which is apparent on the anterior surface of the muscle at the lower third of the leg. After passing through the most medial compartments of the transverse and cruciate crural ligaments, it is inserted into the medial and under surface of the first cuneiform bone, and the base of the first metatarsal bone. This muscle overlaps the anterior tibial vessels and deep peroneal nerve in the upper part of the leg.

Variations. —A deep portion of the muscle is rarely inserted into the talus, or a tendinous slip may pass to the head of the first metatarsal bone or the base of the first phalanx of the great toe. The Tibiofascialis anterior, a small muscle from the lower part of the tibia to the transverse or cruciate crural ligaments or deep fascia.

The Extensor hallucis longus (Extensor proprius hallucis) is a thin muscle, situated between the Tibialis anterior and the Extensor digitorum longus. It arises from the anterior surface of the fibula for about the middle two-fourths of its extent, medial to the origin of the Extensor digitorum longus; it also arises from the interosseous membrane to a similar extent. The anterior tibial vessels and deep peroneal nerve lie between it and the Tibialis anterior. The fibers pass downward, and end in a tendon, which occupies the anterior border of the muscle, passes through a distinct compartment in the cruciate crural ligament, crosses from the lateral to the medial side of the anterior tibial vessels near the bend of the ankle, and is inserted into the base of the distal phalanx of the great toe. Opposite the metatarsophalangeal articulation, the tendon gives off a thin prolongation on either side, to cover the surface of the joint. An expansion from the medial side of the tendon is usually inserted into the base of the proximal phalanx.

Variations. —Occasionally united at its origin with the Extensor digitorum longus. Extensor ossis metatarsi hallucis, a small muscle, sometimes found as a slip from the Extensor hallucis longus, or from the Tibialis anterior, or from the Extensor digitorum longus, or as a distinct muscle; it traverses the same compartment of the transverse ligament with the Extensor hallucis longus.

The Extensor digitorum longus is a penniform muscle, situated at the lateral part of the front of the leg. It arises from the lateral condyle of the tibia; from the upper three-fourths of the anterior surface of the body of the fibula; from the upper part of the interosseous membrane; from the deep surface of the fascia; and from the intermuscular septa between it and the Tibialis anterior on the medial, and the Peronæi on the lateral side. Between it and the Tibialis anterior are the upper portions of the anterior tibial vessels and deep peroneal nerve. The tendon passes under the transverse and cruciate crural ligaments in company with the Peronæus tertius, and divides into four slips, which run forward on the dorsum of the foot, and are inserted into the second and third phalanges of the four lesser toes. The tendons to the second, third, and fourth toes are each joined, opposite the metatarsophalangeal articulation, on the lateral side by a tendon of the Extensor digitorum brevis. The tendons are inserted in the following manner: each receives a fibrous expansion from the Interossei and Lumbricalis, and then spreads out into a broad aponeurosis, which covers the dorsal surface of the first phalanx: this aponeurosis, at the articulation of the first with the second phalanx, divides into three slips—an intermediate, which is inserted into the base of the second phalanx; and two collateral slips, which, after uniting on the dorsal surface of the second phalanx, are continued onward, to be inserted into the base of the third phalanx.

Variations. —This muscle varies considerably in the modes of origin and the arrangement of its various tendons. The tendons to the second and fifth toes may be found doubled, or extra slips are given off from one or more tendons to their corresponding metatarsal bones, or to the short extensor, or to one of the interosseous muscles. A slip to the great toe from the innermost tendon has been found.

The Peronæus tertius is a part of the Extensor digitorum longus, and might be described as its fifth tendon. The fibers belonging to this tendon arise from the lower third or more of the anterior surface of the fibula; from the lower part of the interosseous membrane; and from an intermuscular septum between it and the Peronæus brevis. The tendon, after passing under the transverse and cruciate crural ligaments in the same canal as the Extensor digitorum longus, is inserted into the dorsal surface of the base of the metatarsal bone of the little toe. This muscle is sometimes wanting

Nerves. —These muscles are supplied by the fourth and fifth lumbar and first sacral nerves through the deep peroneal nerve.

Actions. —The Tibialis anterior and Peronæus tertius are the direct flexors of the foot at the ankle-joint; the former muscle, when acting in conjunction with the Tibialis posterior, raises the medial border of the foot, i. e., inverts the foot; and the latter, acting with the Peronæi brevis and longus, raises the lateral border of the foot, i. e., everts the foot. The Extensor digitorum longus and Extensor hallucis longus extend the phalanges of the toes, and, continuing their action, flex the foot upon the leg. Taking their fixed points from below, in the erect posture, all these muscles serve to fix the bones of the leg in the perpendicular position, and give increased strength to the ankle-joint.

2.The Posterior Crural Muscles—The muscles of the back of the leg are subdivided into two groups—superficial and deep. Those of the superficial group constitute a powerful muscular mass, forming the calf of the leg. Their large size is one of the most characteristic features of the muscular apparatus in man, and bears a direct relation to his erect attitude and his mode of progression.

The Gastrocnemius is the most superficial muscle, and forms the greater part of the calf. It arises by two heads, which are connected to the condyles of the femur by strong, flat tendons. The medial and larger head takes its origin from a depression at the upper and back part of the medial condyle and from the adjacent part of the femur. The lateral head arises from an impression on the side of the lateral condyle and from the posterior surface of the femur immediately above the lateral part of the condyle. Both heads, also, arise from the subjacent part of the capsule of the knee. Each tendon spreads out into an aponeurosis, which covers the posterior surface of that portion of the muscle to which it belongs. From the anterior surfaces of these tendinous expansions, muscular fibers are given off; those of the medial head being thicker and extending lower than those of the lateral. The fibers unite at an angle in the middle line of the muscle in a tendinous raphé, which expands into a broad aponeurosis on the anterior surface of the muscle, and into this the remaining fibers are inserted. The aponeurosis, gradually contracting, unites with the tendon of the Soleus, and forms with it the tendo calcaneus.

Variations. —Absence of the outer head or of the entire muscle. Extra slips from the popliteal surface of the femur.

The Soleus is a broad flat muscle situated immediately in front of the Gastrocnemius. It arises by tendinous fibers from the back of the head of the fibula, and from the upper third of the posterior surface of the body of the bone; from the popliteal line, and the middle third of the medial border of the tibia; some fibers also arise from a tendinous arch placed between the tibial and fibular origins of the muscle, in front of which the popliteal vessels and tibial nerve run. The fibers end in an aponeurosis which covers the posterior surface of the muscle, and, gradually becoming thicker and narrower, joins with the tendon of the Gastrocnemius, and forms with it the tendo calcaneus.

Variations. —Accessory head to its lower and inner part usually ending in the tendocalcaneus, or the calcaneus, or the laciniate ligament.

The Gastrocnemius and Soleus together form a muscular mass which is occasionally described as the Triceps suræ; its tendon of insertion is the tendo calcaneus.

Tendo Calcaneus (tendo Achillis). —The tendo calcaneus, the common tendon of the Gastrocnemius and Soleus, is the thickest and strongest in the body. It is about 15 cm. long, and begins near the middle of the leg, but receives fleshy fibers on its anterior surface, almost to its lower end. Gradually becoming contracted below, it is inserted into the middle part of the posterior surface of the calcaneus, a bursa being interposed between the tendon and the upper part of this surface. The tendon spreads out somewhat at its lower end, so that its narrowest part is about 4 cm. above its insertion. It is covered by the fascia and the integument, and is separated from the deep muscles and vessels by a considerable interval filled up with areolar and adipose tissue. Along its lateral side, but superficial to it, is the small saphenous vein.

The Plantaris is placed between the Gastrocnemius and Soleus. It arises from the lower part of the lateral prolongation of the linea aspera, and from the oblique popliteal ligament of the knee-joint. It forms a small fusiform belly, from 7 to 10 cm. long, ending in a long slender tendon which crosses obliquely between the two muscles of the calf, and runs along the medial border of the tendo calcaneus, to be inserted with it into the posterior part of the calcaneus. This muscle is sometimes double, and at other times wanting. Occasionally, its tendon is lost in the laciniate ligament, or in the fascia of the leg.

Nerves. —The Gastrocnemius and Soleus are supplied by the first and second sacral nerves, and the Plantaris by the fourth and fifth lumbar and first sacral nerves, through the tibial nerve.

Actions. —The muscles of the calf are the chief extensors of the foot at the ankle-joint. They possess considerable power, and are constantly called into use in standing, walking, dancing, and leaping; hence the large size they usually present. In walking, these muscles raise the heel from the ground; the body being thus supported on the raised foot, the opposite limb can be carried forward. In standing, the Soleus, taking its fixed point from below, steadies the leg upon the foot and prevents the body from falling forward. The Gastrocnemius, acting from below, serves to flex the femur upon the tibia, assisted by the Popliteus. The Plantaris is the rudiment of a large muscle which in some of the lower animals is continued over the calcaneus to be inserted into the plantar aponeurosis. In man it is an accessory to the Gastrocnemius, extending the ankle if the foot be free, or bending the knee if the foot be fixed.

The Deep Group.

Deep Transverse Fascia.—The deep transverse fascia of the leg is a transversely placed, intermuscular septum, between the superficial and deep muscles of the back of the leg. At the sides it is connected to the margins of the tibia and fibula. Above, where it covers the Popliteus, it is thick and dense, and receives an expansion from the tendon of the Semimembranosus; it is thinner in the middle of the leg; but below, where it covers the tendons passing behind the malleoli, it is thickened and continuous with the laciniate ligament.

The Popliteus is a thin, flat, triangular muscle, which forms the lower part of the floor of the popliteal fossa. It arises by a strong tendon about 2.5 cm. long, from a depression at the anterior part of the groove on the lateral condyle of the femur, and to a small extent from the oblique popliteal ligament of the knee-joint; and is inserted into the medial two-thirds of the triangular surface above the popliteal line on the posterior surface of the body of the tibia, and into the tendinous expansion covering the surface of the muscle.

Variations. —Additional head from the sesamoid bone in the outer head of the Gastrocnemius. Popliteus minor, rare, origin from femur on the inner side of the Plantaris, insertion into the posterior ligament of the knee-joint. Peroneotibialis, 14 per cent., origin inner side of the head of the fibula, insertion into the upper end of the oblique line of the tibia, it lies beneath the Popliteus.

The Flexor hallucis longus is situated on the fibular side of the leg. It arises from the inferior two-thirds of the posterior surface of the body of the fibula, with the exception of 2.5 cm. at its lowest part; from the lower part of the interosseous membrane; from an intermuscular septum between it and the Peronæi, laterally, and from the fascia covering the Tibialis posterior, medially. The fibers pass obliquely downward and backward, and end in a tendon which occupies nearly the whole length of the posterior surface of the muscle. This tendon lies in a groove which crosses the posterior surface of the lower end of the tibia, the posterior surface of the talus, and the under surface of the sustentaculum tali of the calcaneus; in the sole of the foot it runs forward between the two heads of the Flexor hallucis brevis, and is inserted into the base of the last phalanx of the great toe. The grooves on the talus and calcaneus, which contain the tendon of the muscle, are converted by tendinous fibers into distinct canals, lined by a mucous sheath. As the tendon passes forward in the sole of the foot, it is situated above, and crosses from the lateral to the medial side of the tendon of the Flexor digitorum longus, to which it is connected by a fibrous slip.

Variations. —Usually a slip runs to the Flexor digitorum and frequently an additional slip runs from the Flexor digitorum to the Flexor hallucis. Peroneocalcaneus internus, rare, origin below or outside the Flexor hallucis from the back of the fibula, passes over the sustentaculum tali with the Flexor hallucis and is inserted into the calcaneum.

The Flexor digitorum longus is situated on the tibial side of the leg. At its origin it is thin and pointed, but it gradually increases in size as it descends. It arises from the posterior surface of the body of the tibia, from immediately below the popliteal line to within 7 or 8 cm. of its lower extremity, medial to the tibial origin of the Tibialis posterior; it also arises from the fascia covering the Tibialis posterior. The fibers end in a tendon, which runs nearly the whole length of the posterior surface of the muscle. This tendon passes behind the medial malleolus, in a groove, common to it and the Tibialis posterior, but separated from the latter by a fibrous septum, each tendon being contained in a special compartment lined by a separate mucous sheath. It passes obliquely forward and lateralward, superficial to the deltoid ligament of the ankle-joint, into the sole of the foot (Fig. 444), where it crosses below the tendon of the Flexor hallucis longus, and receives from it a strong tendinous slip. It then expands and is joined by the Quadratus plantæ, and finally divides into four tendons, which are inserted into the bases of the last phalanges of the second, third, fourth, and fifth toes, each tendon passing through an opening in the corresponding tendon of the Flexor digitorum brevis opposite the base of the first phalanx.

Variations. —Flexor accessorius longus digitorum, not infrequent, origin from fibula, or tibia, or the deep fascia and ending in a tendon which, after passing beneath the laciniate ligament, joins the tendon of the long flexor or the Quadratus plantæ.

The Tibialis posterior (Tibialis posticus) lies between the two preceding muscles, and is the most deeply seated of the muscles on the back of the leg. It begins above by two pointed processes, separated by an angular interval through which the anterior tibial vessels pass forward to the front of the leg. It arises from the whole of the posterior surface of the interosseous membrane, excepting its lowest part; from the lateral portion of the posterior surface of the body of the tibia, between the commencement of the popliteal line above and the junction of the middle and lower thirds of the body below; and from the upper two-thirds of the medial surface of the fibula; some fibers also arise from the deep transverse fascia, and from the intermuscular septa separating it from the adjacent muscles. In the lower fourth of the leg its tendon passes in front of that of the Flexor digitorum longus and lies with it in a groove behind the medial malleolus, but enclosed in a separate sheath; it next passes under the laciniate and over the deltoid ligament into the foot, and then beneath the plantar calcaneonavicular ligament. The tendon contains a sesamoid fibrocartilage, as it runs under the plantar calcaneonavicular ligament. It is inserted into the tuberosity of the navicular bone, and gives off fibrous expansions, one of which passes backward to the sustentaculum tali of the calcaneus, others forward and lateralward to the three cuneiforms, the cuboid, and the bases of the second, third, and fourth metatarsal bones.

Nerves. —The Popliteus is supplied by the fourth and fifth lumbar and first sacral nerves, the Flexor digitorum longus and Tibialis posterior by the fifth lumbar and first sacral, and the Flexor hallucis longus by the fifth lumbar and the first and second sacral nerves, through the tibial nerve.

Actions. —The Popliteus assists in flexing the leg upon the thigh; when the leg is flexed, it will rotate the tibia inward. It is especially called into action at the beginning of the act of bending the knee, inasmuch as it produces the slight inward rotation of the tibia which is essential in the early stage of this movement. The Tibialis posterior is a direct extensor of the foot at the ankle-joint; acting in conjunction with the Tibialis anterior, it turns the sole of the foot upward and medialward, i.e., inverts the foot, antagonizing the Peronæi, which turn it upward and lateralward (evert it). In the sole of the foot the tendon of the Tibialis posterior lies directly below the plantar calcaneonavicular ligament, and is therefore an important factor in maintaining the arch of the foot. The Flexor digitorum longus and Flexor hallucis longus are the direct flexors of the phalanges, and, continuing their action, extend the foot upon the leg; they assist the Gastrocnemius and Soleus in extending the foot, as in the act of walking, or in standing on tiptoe. In consequence of the oblique direction of its tendons the Flexor digitorum longus would draw the toes medialward, were it not for the Quadratus plantæ, which is inserted into the lateral side of the tendon, and draws it to the middle line of the foot. Taking their fixed point from the foot, these muscles serve to maintain the upright posture by steadying the tibia and fibula perpendicularly upon the talus.

3. The Lateral Crural Muscles

The Peronæus longus is situated at the upper part of the lateral side of the leg, and is the more superficial of the two muscles. It arises from the head and upper two-thirds of the lateral surface of the body of the fibula, from the deep surface of the fascia, and from the intermuscular septa between it and the muscles on the front and back of the leg; occasionally also by a few fibers from the lateral condyle of the tibia. Between its attachments to the head and to the body of the fibula there is a gap through which the common peroneal nerve passes to the front of the leg. It ends in a long tendon, which runs behind the lateral malleolus, in a groove common to it and the tendon of the Peronæus brevis, behind which it lies; the groove is converted into a canal by the superior peroneal retinaculum, and the tendons in it are contained in a common mucous sheath. The tendon then extends obliquely forward across the lateral side of the calcaneus, below the trochlear process, and the tendon of the Peronæus brevis, and under cover of the inferior peroneal retinaculum. It crosses the lateral side of the cuboid, and then runs on the under surface of that bone in a groove which is converted into a canal by the long plantar ligament; the tendon then crosses the sole of the foot obliquely, and is inserted into the lateral side of the base of the first metatarsal bone and the lateral side of the first cuneiform. Occasionally it sends a slip to the base of the second metatarsal bone. The tendon changes its direction at two points: first, behind the lateral malleolus; secondly, on the cuboid bone; in both of these situations the tendon is thickened, and, in the latter, a sesamoid fibrocartilage (sometimes a bone), is usually developed in its substance.

The Peronæus brevis lies under cover of the Peronæus longus, and is a shorter and smaller muscle. It arises from the lower two-thirds of the lateral surface of the body of the fibula; medial to the Peronæus longus; and from the intermuscular septa separating it from the adjacent muscles on the front and back of the leg. The fibers pass vertically downward, and end in a tendon which runs behind the lateral malleolus along with but in front of that of the preceding muscle, the two tendons being enclosed in the same compartment, and lubricated by a common mucous sheath. It then runs forward on the lateral side of the calcaneus, above the trochlear process and the tendon of the Peronæus longus, and is inserted into the tuberosity at the base of the fifth metatarsal bone, on its lateral side.

On the lateral surface of the calcaneus the tendons of the Peronæi longus and brevis occupy separate osseoaponeurotic canals formed by the calcaneus and the perineal retinacula; each tendon is enveloped by a forward prolongation of the common mucous sheath.

Variations. —Fusion of the two peronæi is rare. A slip from the Peronæus longus to the base of the third, fourth or fifth metatarsal bone, or to the Adductor hallucis is occasionally seen.

Peronæus accessorius, origin from the fibula between the longus and brevis, joins the tendon of the longus in the sole of the foot.

Peronæus quinti digiti, rare, origin lower fourth of the fibula under the brevis, insertion into the Extensor aponeurosis of the little toe. More common as a slip of the tendon of the Peronæus brevis.

Peronæus quartus, 13 per cent. (Gruber), origin back of fibula between the brevis and the Flexor hallucis, insertion into the peroneal spine of the calcaneum, (peroneocalcaneus externum), or less frequently into the tuberosity of the cuboid (peroneocuboideus).

Nerves. —The Peronæi longus and brevis are supplied by the fourth and fifth lumbar and first sacral nerves through the superficial peroneal nerve.

Actions. —The Peronæi longus and brevis extend the foot upon the leg, in conjunction with the Tibialis posterior, antagonizing the Tibialis anterior and Peronæus tertius, which are flexors of the foot. The Peronæus longus also everts the sole of the foot, and from the oblique direction of the tendon across the sole of the foot is an important agent in the maintenance of the transverse arch. Taking their fixed points below, the Peronæi serve to steady the leg upon the foot. This is especially the case in standing upon one leg, when the tendency of the superincumbent weight is to throw the leg medialward; the Peronæus longus overcomes this tendency by drawing on the lateral side of the leg.

Fibrous bands, or thickened portions of the fascia, bind down the tendons in front of and behind the ankle in their passage to the foot. They comprise three ligaments, viz., the transverse crural, the cruciate crural and the laciniate; and the superior and inferior peroneal retinacula.

Transverse Crural Ligament (ligamentum transversum cruris; upper part of anterior annular ligament) —The transverse crural ligament binds down the tendons of Extensor digitorum longus, Extensor hallucis longus, Peronæus tertius, and Tibialis anterior as they descend on the front of the tibia and fibula; under it are found also the anterior tibial vessels and deep peroneal nerve. It is attached laterally to the lower end of the fibula, and medially to the tibia; above it is continuous with the fascia of the leg.

Cruciate Crural Ligament (ligamentum cruciatum cruris; lower part of anterior annular ligament)—The cruciate crural ligament is a Y-shaped band placed in front of the ankle-joint, the stem of the Y being attached laterally to the upper surface of the calcaneus, in front of the depression for the interosseous talocalcanean ligament; it is directed medialward as a double layer, one lamina passing in front of, and the other behind, the tendons of the Peronæus tertius and Extensor digitorum longus. At the medial border of the latter tendon these two layers join together, forming a compartment in which the tendons are enclosed. From the medial extremity of this sheath the two limbs of the Y diverge: one is directed upward and medialward, to be attached to the tibial malleolus, passing over the Extensor hallucis longus and the vessels and nerves, but enclosing the Tibialis anterior by a splitting of its fibers. The other limb extends downward and medialward, to be attached to the border of the plantar aponeurosis, and passes over the tendons of the Extensor hallucis longus and Tibialis anterior and also the vessels and nerves.

Laciniate Ligament (ligamentum laciniatum; internal annular ligament). —The laciniate ligament is a strong fibrous band, extending from the tibial malleolus above to the margin of the calcaneus below, converting a series of bony grooves in this situation into canals for the passage of the tendons of the Flexor muscles and the posterior tibial vessels and tibial nerve into the sole of the foot. It is continuous by its upper border with the deep fascia of the leg, and by its lower border with the plantar aponeurosis and the fibers of origin of the Abductor hallucis muscle. Enumerated from the medial side, the four canals which it forms transmit the tendon of the Tibialis posterior; the tendon of the Flexor digitorum longus; the posterior tibial vessels and tibial nerve, which run through a broad space beneath the ligament; and lastly, in a canal formed partly by the talus, the tendon of the Flexor hallucis longus

Peroneal Retinacula. —The peroneal retinacula are fibrous bands which bind down the tendons of the Peronæi longus and brevis as they run across the lateral side of the ankle. The fibers of the superior retinaculum (external annular ligament) are attached above to the lateral malleolus and below to the lateral surface of the calcaneus. The fibers of the inferior retinaculum are continuous in front with those of the cruciate crural ligament; behind they are attached to the lateral surface of the calcaneus; some of the fibers are fixed to the peroneal trochlea, forming a septum between the tendons of the Peronæi longus and brevis.

The Mucous Sheaths of the Tendons Around the Ankle. —All the tendons crossing the ankle-joint are enclosed for part of their length in mucous sheaths which have an almost uniform length of about 8 cm. each. On the front of the ankle. the sheath for the Tibialis anterior extends from the upper margin of the transverse crural ligament to the interval between the diverging limbs of the cruciate ligament; those for the Extensor digitorum longus and Extensor hallucis longus reach upward to just above the level of the tips of the malleoli, the former being the higher. The sheath of the Extensor hallucis longus is prolonged on to the base of the first metatarsal bone, while that of the Extensor digitorum longus reaches only to the level of the base of the fifth metatarsal. On the medial side of the ankle the sheath for the Tibialis posterior extends highest up—to about 4 cm. above the tip of the malleolus—while below it stops just short of the tuberosity of the navicular. The sheath for Flexor hallucis longus reaches up to the level of the tip of the malleolus, while that for the Flexor digitorum longus is slightly higher; the former is continued to the base of the first metatarsal, but the latter stops opposite the first cuneiform bone.

On the lateral side of the ankle a sheath which is single for the greater part of its extent encloses the Peronæi longus and brevis. It extends upward for about 4 cm. above the tip of the malleolus and downward and forward for about the same distance

The Muscles and Fasciæ of the Foot

The Dorsal Muscle of the Foot

Extensor digitorum brevis—The fascia on the dorsum of the foot is a thin membranous layer, continuous above with the transverse and cruciate crural ligaments; on either side it blends with the plantar aponeurosis; anteriorly it forms a sheath for the tendons on the dorsum of the foot.

The Extensor digitorum brevis is a broad, thin muscle, which arises from the forepart of the upper and lateral surfaces of the calcaneus, in front of the groove for the Peronæus brevis; from the lateral talocalcanean ligament; and from the common limb of the cruciate crural ligament. It passes obliquely across the dorsum of the foot, and ends in four tendons. The most medial, which is the largest, is inserted into the dorsal surface of the base of the first phalanx of the great toe, crossing the dorsalis pedis artery; it is frequently described as a separate muscle—the Extensor hallucis brevis. The other three are inserted into the lateral sides of the tendons of the Extensor digitorum longus of the second, third, and fourth toes.

Variations. —Accessory slips of origin from the talus and navicular, or from the external cunei-form and third metatarsal bones to the second slip of the muscle, and one from the cuboid to the third slip have been observed. The tendons vary in number and position; they may be reduced to two, or one of them may be doubled, or an additional slip may pass to the little toe. A supernumerary slip ending on one of the metatarsophalangeal articulations, or joining a dorsal interosseous muscle is not uncommon. Deep slips between this muscle and the Dorsal interossei occur.

Nerves. —It is supplied by the deep peroneal nerve.

Actions. —The Extensor digitorum brevis extends the phalanges of the four toes into which it is inserted, but in the great toe acts only on the first phalanx. The obliquity of its direction counteracts the oblique movement given to the toes by the long Extensor, so that when both muscles act, the toes are evenly extended.

2. The Plantar Muscles of the Foot

Plantar Aponeurosis (aponeurosis plantaris; plantar fascia). —The plantar aponeurosis is of great strength, and consists of pearly white glistening fibers, disposed, for the most part, longitudinally: it is divided into central, lateral, and medial portions.

The central portion, the thickest, is narrow behind and attached to the medial process of the tuberosity of the calcaneus, posterior to the origin of the Flexor digitorum brevis; and becoming broader and thinner in front, divides near the heads of the metatarsal bones into five processes, one for each of the toes. Each of these processes divides opposite the metatarsophalangeal articulation into two strata, superficial and deep. The superficial stratum is inserted into the skin of the transverse sulcus which separates the toes from the sole. The deeper stratum divides into two slips which embrace the side of the Flexor tendons of the toes, and blend with the sheaths of the tendons, and with the transverse metatarsal ligament, thus forming a series of arches through which the tendons of the short and long Flexors pass to the toes. The intervals left between the five processes allow the digital vessels and nerves and the tendons of the Lumbricales to become superficial. At the point of division of the aponeurosis, numerous transverse fasciculi are superadded; these serve to increase the strength of the aponeurosis at this part by binding the processes together, and connecting them with the integument. The central portion of the plantar aponeurosis is continuous with the lateral and medial portions and sends upward into the foot, at the lines of junction, two strong vertical intermuscular septa, broader in front than behind, which separate the intermediate from the lateral and medial plantar groups of muscles; from these again are derived thinner transverse septa which separate the various layers of muscles in this region. The upper surface of this aponeurosis gives origin behind to the Flexor digitorum brevis.

The lateral and medial portions of the plantar aponeurosis are thinner than the central piece, and cover the sides of the sole of the foot.

The lateral portion covers the under surface of the Abductor digiti quinti; it is thin in front and thick behind, where it forms a strong band between the lateral process of the tuberosity of the calcaneus and the base of the fifth metatarsal bone; it is continuous medially with the central portion of the plantar aponeurosis, and laterally with the dorsal fascia.

The medial portion is thin, and covers the under surface of the Abductor hallucis; it is attached behind to the laciniate ligament, and is continuous around the side of the foot with the dorsal fascia, and laterally with the central portion of the plantar aponeurosis.

The muscles in the plantar region of the foot may be divided into three groups, in a similar manner to those in the hand. Those of the medial plantar region are connected with the great toe, and corrrespond with those of the thumb; those of the lateral plantar region are connected with the little toe, and correspond with those of the little finger; and those of the intermediate plantar region are connected with the tendons intervening between the two former groups. But in order to facilitate the description of these muscles, it is more convenient to divide them into four layers, in the order in which they are successively exposed.

The First Layer.

The Abductor hallucis lies along the medial border of the foot and covers the origins of the plantar vessels and nerves. It arises from the medial process of the tuberosity of the calcaneus, from the laciniate ligament, from the plantar aponeurosis, and from the intermuscular septum between it and the Flexor digitorum brevis. The fibers end in a tendon, which is inserted, together with the medial tendon of the Flexor hallucis brevis, into the tibial side of the base of the first phalanx of the great toe.

Variations. —Slip to the base of the first phalanx of the second toe.

The Flexor digitorum brevis lies in the middle of the sole of the foot, immediately above the central part of the plantar aponeurosis, with which it is firmly united. Its deep surface is separated from the lateral plantar vessels and nerves by a thin layer of fascia. It arises by a narrow tendon, from the medial process of the tuberosity of the calcaneus, from the central part of the plantar aponeurosis, and from the intermuscular septa between it and the adjacent muscles. It passes forward, and divides into four tendons, one for each of the four lesser toes. Opposite the bases of the first phalanges, each tendon divides into two slips, to allow of the passage of the corresponding tendon of the Flexor digitorum longus; the two portions of the tendon then unite and form a grooved channel for the reception of the accompanying long Flexor tendon. Finally, it divides a second time, and is inserted into the sides of the second phalanx about its middle. The mode of division of the tendons of the Flexor digitorum brevis, and of their insertion into the phalanges, is analogous to that of the tendons of the Flexor digitorum sublimis in the hand.

Variations. —Slip to the little toe frequently wanting, 23 per cent.; or it may be replaced by a small fusiform muscle arising from the long flexor tendon or from the Quadratus plantæ.

Fibrous Sheaths of the Flexor Tendons. —The terminal portions of the tendons of the long and short Flexor muscles are contained in osseoaponeurotic canals similar in their arrangement to those in the fingers. These canals are formed above by the phalanges and below by fibrous bands, which arch across the tendons, and are attached on either side to the margins of the phalanges. Opposite the bodies of the proximal and second phalanges the fibrous bands are strong, and the fibers are transverse; but opposite the joints they are much thinner, and the fibers are directed obliquely. Each canal contains a mucous sheath, which is reflected on the contained tendons.

The Abductor digiti quinti (Abductor minimi digiti) lies along the lateral border of the foot, and is in relation by its medial margin with the lateral plantar vessels and nerves. It arises, by a broad origin, from the lateral process of the tuberosity of the calcaneus, from the under surface of the calcaneus between the two processes of the tuberosity, from the forepart of the medial process, from the plantar aponeurosis, and from the intermuscular septum between it and the Flexor digitorum brevis. Its tendon, after gliding over a smooth facet on the under surface of the base of the fifth metatarsal bone, is inserted, with the Flexor digiti quinti brevis, into the fibular side of the base of the first phalanx of the fifth toe.

Variations. —Slips of origin from the tuberosity at the base of the fifth metatarsal. Abductor ossis metatarsi quinti, origin external tubercle of the calcaneus, insertion into tuberosity of the fifth metatarsal bone in common with or beneath the outer margin of the plantar fascia.

The Second Layer.

The Quadratus plantæ (Flexor accessorius) is separated from the muscles of the first layer by the lateral plantar vessels and nerve. It arises by two heads, which are separated from each other by the long plantar ligament: the medial or larger head is muscular, and is attached to the medial concave surface of the calcaneus, below the groove which lodges the tendon of the Flexor hallucis longus; the lateral head, flat and tendinous, arises from the lateral border of the inferior surface of the calcaneus, in front of the lateral process of its tuberosity, and from the long plantar ligament. The two portions join at an acute angle, and end in a flattened band which is inserted into the lateral margin and upper and under surfaces of the tendon of the Flexor digitorum longus, forming a kind of groove, in which the tendon is lodged. It usually sends slips to those tendons of the Flexor digitorum longus which pass to the second, third, and fourth toes.

Variations. —Lateral head often wanting; entire muscle absents. Variation in the number of digital tendons to which fibers can be traced. Most frequent offsets are sent to the second, third and fourth toes; in many cases to the fifth as well; occasionally to two toes only.

The Lumbricales are four small muscles, accessory to the tendons of the Flexor digitorum longus and numbered from the medial side of the foot; they arise from these tendons, as far back as their angles of division, each springing from two tendons, except the first. The muscles end in tendons, which pass forward on the medial sides of the four lesser toes, and are inserted into the expansions of the tendons of the Extensor digitorum longus on the dorsal surfaces of the first phalanges.

Variations. —Absence of one or more; doubling of the third or fourth. Insertion partly or wholly into the first phalanges.

The Third Layer.

The Flexor hallucis brevis arises, by a pointed tendinous process, from the medial part of the under surface of the cuboid bone, from the contiguous portion of the third cuneiform, and from the prolongation of the tendon of the Tibialis posterior which is attached to that bone. It divides in front into two portions, which are inserted into the medial and lateral sides of the base of the first phalanx of the great toe, a sesamoid bone being present in each tendon at its insertion. The medial portion is blended with the Abductor hallucis previous to its insertion; the lateral portion with the Adductor hallucis; the tendon of the Flexor hallucis longus lies in a groove between them; the lateral portion is sometimes described as the first Interosseous plantaris.

Variations. —Origin subject to considerable variation; it often receives fibers from the calcaneus or long plantar ligament. Attachment to the cuboid sometimes wanting. Slip to first phalanx of the second toe.

The Adductor hallucis (Adductor obliquus hallucis) arises by two heads—oblique and transverse. The oblique head is a large, thick, fleshy mass, crossing the foot obliquely and occupying the hollow space under the first second, third, and fourth metatarsal bones. It arises from the bases of the second, third, and fourth metatarsal bones, and from the sheath of the tendon of the Peronæus longus, and is inserted, together with the lateral portion of the Flexor hallucis brevis, into the lateral side of the base of the first phalanx of the great toe. The transverse head (Transversus pedis) is a narrow, flat fasciculus which arises from the plantar metatarsophalangeal ligaments of the third, fourth, and fifth toes (sometimes only from the third and fourth), and from the transverse ligament of the metatarsus. It is inserted into the lateral side of the base of the first phalanx of the great toe, its fibers blending with the tendon of insertion of the oblique head.

Variations. —Slips to the base of the first phalanx of the second toe. Opponens hallucis, occasional slips from the adductor to the metatarsal bone of the great toe.

The Abductor, Flexor brevis, and Adductor of the great toe, like the similar muscles of the thumb, give off, at their insertions, fibrous expansions to blend with the tendons of the Extensor digitorum longus.

The Flexor digiti quinti brevis (Flexor brevis minimi digiti) lies under the metatarsal bone of the little toe, and resembles one of the Interossei. It arises from the base of the fifth metatarsal bone, and from the sheath of the Peronæus longus; its tendon is inserted into the lateral side of the base of the first phalanx of the fifth toe. Occasionally a few of the deeper fibers are inserted into the lateral part of the distal half of the fifth metatarsal bone; these are described by some as a distinct muscle, the Opponens digiti quinti.

The Fourth Layer

Interossei—The Interossei in the foot are similar to those in the hand, with this exception, that they are grouped around the middle line of the second digit, instead of that of the third. They are seven in number, and consist of two groups, dorsal and plantar.

The Interossei dorsales (Dorsal interossei), four in number, are situated between the metatarsal bones. They are bipenniform muscles, each arising by two heads from the adjacent sides of the metatarsal bones between which it is placed; their tendons are inserted into the bases of the first phalanges, and into the aponeurosis of the tendons of the Extensor digitorum longus. In the angular interval left between the heads of each of the three lateral muscles, one of the perforating arteries passes to the dorsum of the foot; through the space between the heads of the first muscle the deep plantar branch of the dorsalis pedis artery enters the sole of the foot. The first is inserted into the medial side of the second toe; the other three are inserted into the lateral sides of the second, third, and fourth toes

The Interossei plantares (Plantar interossei), three in number, lie beneath rather than between the metatarsal bones, and each is connected with but one metatarsal bone. They arise from the bases and medial sides of the bodies of the third, fourth, and fifth metatarsal bones, and are inserted into the medial sides of the bases of the first phalanges of the same toes, and into the aponeuroses of the tendons of the Extensor digitorum longus.

Nerves. —The Flexor digitorum brevis, the Flexor hallucis brevis, the Abductor hallucis, and the first Lumbricalis are supplied by the medial plantar nerve; all the other muscles in the sole of the foot by the lateral plantar. The first Interosseous dorsalis frequently receives an extra filament from the medial branch of the deep peroneal nerve on the dorsum of the foot, and the second Interosseous dorsalis a twig from the lateral branch of the same nerve.

Actions. —All the muscles of the foot act upon the toes, and may be grouped as abductors, adductors, flexors, or extensors. The abductors are the Interossei dorsales, the Abductor hallucis, and the Abductor digiti quinti. The Interossei dorsales are abductors from an imaginary line passing through the axis of the second toe, so that the first muscle draws the second toe medialward, toward the great toe, the second muscle draws the same toe lateralward, and the third and fourth draw the third and fourth toes in the same direction. Like the Interossei in the hand, each assists in flexing the first phalanx and extending the second and third phalanges. The Abductor hallucis abducts the great toe from the second, and also flexes its proximal phalanx. In the same way the action of the Abductor digiti quinti is twofold, as an abductor of this toe from the fourth, and also as a flexor of its proximal phalanx. The adductors are the Interossei plantares and the Adductor hallucis. The Interossei plantares adduct the third, fourth, and fifth toes toward the imaginary line passing through the second toe, and by means of their insertions into the aponeuroses of the Extensor tendons they assist in flexing the proximal phalanges and extending the middle and terminal phalanges. The oblique head of the Adductor hallucis is chiefly concerned in adducting the great toe toward the second one, but also assists in flexing this toe; the transverse head approximates all the toes and thus increases the curve of the transverse arch of the metatarsus. The flexors are the Flexor digitorum brevis, the Quadratus plantæ, the Flexor hallucis brevis, the Flexor digiti quinti brevis, and the Lumbricales. The Flexor digitorum brevis flexes the second phalanges upon the first, and, continuing its action, flexes the first phalanges also, and brings the toes together. The Quadratus plantæ assists the Flexor digitorum longus and converts the oblique pull of the tendons of that muscle into a direct backward pull upon the toes. The Flexor digiti quinti brevis flexes the little toe and draws its metatarsal bone downward and medialward. The Lumbricales, like the corresponding muscles in the hand, assist in flexing the proximal phalanges, and by their insertions into the tendons of the Extensor digitorum longus aid that muscle in straightening the middle and terminal phalanges. The Extensor digitorum brevis extends the first phalanx of the great toe and assists the long Extensor in extending the next three toes, and at the same time gives to the toes a lateral direction when they are extended.

The Muscles and Fasciæ of the Abdomen

The muscles of the abdomen may be divided into two groups: (1) the anterolateral muscles; (2) the posterior muscles.

The Superficial Fascia. —The superficial fascia of the abdomen consists, over the greater part of the abdominal wall, of a single layer containing a variable amount of fat; but near the groin it is easily divisible into two layers, between which are found the superficial vessels and nerves and the superficial inguinal lymph glands.

The superficial layer (fascia of Camper) is thick, areolar in texture, and contains in its meshes a varying quantity of adipose tissue. Below, it passes over the inguinal ligament, and is continuous with the superficial fascia of the thigh. In the male, Camper's fascia is continued over the penis and outer surface of the spermatic cord to the scrotum, where it helps to form the dartos. As it passes to the scrotum it changes its characteristics, becoming thin, destitute of adipose tissue, and of a pale reddish color, and in the scrotum it acquires some involuntary muscular fibers. From the scrotum it may be traced backward into continuity with the superficial fascia of the perineum. In the female, Camper's fascia is continued from the abdomen into the labia majora.

The deep layer (fascia of Scarpa) is thinner and more membranous in character than the superficial, and contains a considerable quantity of yellow elastic fibers. It is loosely connected by areolar tissue to the aponeurosis of the Obliquus externus abdominis, but in the middle line it is more intimately adherent to the linea alba and to the symphysis pubis, and is prolonged on to the dorsum of the penis, forming the fundiform ligament; above, it is continuous with the superficial fascia over the rest of the trunk; below and laterally, it blends with the fascia lata of the thigh a little below the inguinal ligament; medially and below, it is continued over the penis and spermatic cord to the scrotum, where it helps to form the dartos. From the scrotum it may be traced backward into continuity with the deep layer of the superficial fascia of the perineum (fascia of Colles). In the female, it is continued into the labia majora and thence to the fascia of Colles.

The Obliquus externus abdominis (External or descending oblique muscle), situated on the lateral and anterior parts of the abdomen, is the largest and the most superficial of the three flat muscles in this region. It is broad, thin, and irregularly quadrilateral, its muscular portion occupying the side, its aponeurosis the anterior wall of the abdomen. It arises, by eight fleshy digitations, from the external surfaces and inferior borders of the lower eight ribs; these digitations are arranged in an oblique line which runs downward and backward, the upper ones being attached close to the cartilages of the corresponding ribs, the lowest to the apex of the cartilage of the last rib, the intermediate ones to the ribs at some distance from their cartilages. The five superior serrations increase in size from above downward, and are received between corresponding processes of the Serratus anterior; the three lower ones diminish in size from above downward and receive between them corresponding processes from the Latissimus dorsi. From these attachments the fleshy fibers proceed in various directions. Those from the lowest ribs pass nearly vertically downward, and are inserted into the anterior half of the outer lip of the iliac crest; the middle and upper fibers, directed downward and forward, end in an aponeurosis, opposite a line drawn from the prominence of the ninth costal cartilage to the anterior superior iliac spine.

The aponeurosis of the Obliquus externus abdominis is a thin but strong membranous structure, the fibers of which are directed downward and medialward. It is joined with that of the opposite muscle along the middle line, and covers the whole of the front of the abdomen; above, it is covered by and gives origin to the lower fibers of the Pectoralis major; below, its fibers are closely aggregated together, and extend obliquely across from the anterior superior iliac spine to the public tubercle and the pectineal line. In the middle line, it interlaces with the aponeurosis of the opposite muscle, forming the linea alba, which extends from the xiphoid process to the symphysis pubis.

That portion of the aponeurosis which extends between the anterior superior iliac spine and the pubic tubercle is a thick band, folded inward, and continuous below with the fascia lata; it is called the inguinal ligament. The portion which is reflected from the inguinal ligament at the pubic tubercle is attached to the pectineal line and is called the lacunar ligament. From the point of attachment of the latter to the pectineal line, a few fibers pass upward and medialward, behind the medial crus of the subcutaneous inguinal ring, to the linea alba; they diverge as they ascend, and form a thin triangular fibrous band which is called the reflected inguinal ligament.

In the aponeurosis of the Obliquus externus, immediately above the crest of the pubis, is a triangular opening, the subcutaneous inguinal ring, formed by a separation of the fibers of the aponeurosis in this situation.

The following structures require further description, viz., the subcutaneous inguinal ring, the intercrural fibers and fascia, and the inguinal, lacunar, and reflected inguinal ligaments.

The Subcutaneous Inguinal Ring (annulus inguinalis subcutaneus; external abdominal ring). — The subcutaneous inguinal ring is an interval in the aponeurosis of the Obliquus externus, just above and lateral to the crest of the pubis. The aperture is oblique in direction, somewhat triangular in form, and corresponds with the course of the fibers of the aponeurosis. It usually measures from base to apex about 2.5 cm., and transversely about 1.25 cm. It is bounded below by the crest of the pubis; on either side by the margins of the opening in the aponeurosis, which are called the crura of the ring; and above, by a series of curved intercrural fibers. The inferior crus (external pillar) is the stronger and is formed by that portion of the inguinal ligament which is inserted into the pubic tubercle; it is curved so as to form a kind of groove, upon which, in the male, the spermatic cord rests. The superior crus (internal pillar) is a broad, thin, flat band, attached to the front of the symphysis pubis and interlacing with its fellow of the opposite side.

The subcutaneous inguinal ring gives passage to the spermatic cord and ilioinguinal nerve in the male, and to the round ligament of the uterus and the ilioinguinal nerve in the female; it is much larger in men than in women, on account of the large size of the spermatic cord.

The Intercrural Fibers (fibræ intercrurales; intercolumnar fibers). —The intercrural fibers are a series of curved tendinous fibers, which arch across the lower part of the aponeurosis of the Obliquus externus, describing curves with the convexities downward. They have received their name from stretching across between the two crura of the subcutaneous inguinal ring, and they are much thicker and stronger at the inferior crus, where they are connected to the inguinal ligament, than superiorly, where they are inserted into the linea alba. The intercrural fibers increase the strength of the lower part of the aponeurosis, and prevent the divergence of the crura from one another; they are more strongly developed in the male than in the female.

As they pass across the subcutaneous inguinal ring, they are connected together by delicate fibrous tissue, forming a fascia, called the intercrural fascia. This intercrural fascia is continued down as a tubular prolongation around the spermatic cord and testis, and encloses them in a sheath; hence it is also called the external spermatic fascia. The subcutaneous inguinal ring is seen as a distinct aperture only after the intercrural fascia has been removed

The Inguinal Ligament (ligamentum inguinale [Pouparti]; Poupart’s ligament). —The inguinal ligament is the lower border of the aponeurosis of the Obliquus externus, and extends from the anterior superior iliac spine to the pubic tubercle. From this latter point it is reflected backward and lateralward to be attached to the pectineal line for about 1.25 cm., forming the lacunar ligament. Its general direction is convex downward toward the thigh, where it is continuous with the fascia lata. Its lateral half is rounded, and oblique in direction; its medial half gradually widens at its attachment to the pubis, is more horizontal in direction, and lies beneath the spermatic cord.

The Lacunar Ligament (ligamentum lacunare [Gimbernati]; Gimbernat’s ligament). —The lacunar ligament is that part of the aponeurosis of the Obliquus externus which is reflected backward and lateralward, and is attached to the pectineal line. It is about 1.25 cm. long, larger in the male than in the female, almost horizontal in direction in the erect posture, and of a triangular form with the base directed lateralward. Its base is concave, thin, and sharp, and forms the medial boundary of the femoral ring. Its apex corresponds to the pubic tubercle. Its posterior margin is attached to the pectineal line, and is continuous with the pectineal fascia. Its anterior margin is attached to the inguinal ligament. Its surfaces are directed upward and downward.

The Reflected Inguinal Ligament (ligamentum inguinale reflexum [Collesi]; triangular fascia). —The reflected inguinal ligament is a layer of tendinous fibers of a triangular shape, formed by an expansion from the lacunar ligament and the inferior crus of the subcutaneous inguinal ring. It passes medialward behind the spermatic cord, and expands into a somewhat fan-shaped band, lying behind the superior crus of the subcutaneous inguinal ring, and in front of the inguinal aponeurotic falx, and interlaces with the ligament of the other side of the linea alba.

Ligament of Cooper. —This is a strong fibrous band, which was first described by Sir Astley Cooper. It extends lateralward from the base of the lacunar ligament along the pectineal line, to which it is attached. It is strengthened by the pectineal fascia, and by a lateral expansion from the lower attachment of the linea alba (adminiculum lineæ albæ).

Variations. —The Obliquus externus may show decrease or doubling of its attachments to the ribs; addition slips from lumbar aponeurosis; doubling between lower ribs and ilium or inguinal ligament. Rarely tendinous inscriptions occur.

The Obliquus internus abdominis (Internal or ascending oblique muscle), thinner and smaller than the Obliquus externus, beneath which it lies, is of an irregularly quadrilateral form, and situated at the lateral and anterior parts of the abdomen. It arises, by fleshy fibers, from the lateral half of the grooved upper surface of the inguinal ligament, from the anterior two-thirds of the middle lip of the iliac crest, and from the posterior lamella of the lumbodorsal fascia. From this origin the fibers diverge; those from the inguinal ligament, few in number and paler in color than the rest, arch downward and medialward across the spermatic cord in the male and the round ligament of the uterus in the female, and, becoming tendinous, are inserted, conjointly with those of the Transversus, into the crest of the pubis and medial part of the pectineal line behind the lacunar ligament, forming what is known as the inguinal aponeurotic falx. Those from the anterior third of the iliac origin are horizontal in their direction, and, becoming tendinous along the lower fourth of the linea semilunaris, pass in front of the Rectus abdominis to be inserted into the linea alba. Those arising from the middle third of the iliac origin run obliquely upward and medialward, and end in an aponeurosis; this divides at the lateral border of the Rectus into two lamellæ, which are continued forward, one in front of and the other behind this muscle, to the linea alba: the posterior lamella has an attachment to the cartilages of the seventh, eighth, and ninth ribs. The most posterior fibers pass almost vertically upward, to be inserted into the inferior borders of the cartilages of the three lower ribs, being continuous with the Intercostales interni

Variations. —Occasionally, tendinous inscriptions occur from the tips of the tenth or eleventh cartilages or even from the ninth; an additional slip to the ninth cartilage is sometimes found; separation between iliac and inguinal parts may occur.

The Cremaster is a thin muscular layer, composed of a number of fasciculi which arise from the middle of the inguinal ligament where its fibers are continuous with those of the Obliquus internus and also occasionally with the Transversus. It passes along the lateral side of the spermatic cord, descends with it through the subcutaneous inguinal ring upon the front and sides of the cord, and forms a series of loops which differ in thickness and length in different subjects. At the upper part of the cord the loops are short, but they become in succession longer and longer, the longest reaching down as low as the testis, where a few are inserted into the tunica vaginalis. These loops are united together by areolar tissue, and form a thin covering over the cord and testis, the cremasteric fascia. The fibers ascend along the medial side of the cord, and are inserted by a small pointed tendon into the tubercle and crest of the pubis and into the front of the sheath of the Rectus abdominis.

The Transversus abdominis (Transversalis muscle), so called from the direction of its fibers, is the most internal of the flat muscles of the abdomen, being placed immediately beneath the Obliquus internus. It arises, by fleshy fibers, from the lateral third of the inguinal ligament, from the anterior three-fourths of the inner lip of the iliac crest, from the inner surfaces of the cartilages of the lower six ribs, interdigitating with the diaphragm, and from the lumbodorsal fascia. The muscle ends in front in a broad aponeurosis, the lower fibers of which curve downward and medialward, and are inserted, together with those of the Obliquus internus, into the crest of the pubis and pectineal line, forming the inguinal aponeurotic falx. Throughout the rest of its extent the aponeurosis passes horizontally to the middle line, and is inserted into the linea alba; its upper three-fourths lie behind the Rectus and blend with the posterior lamella of the aponeurosis of the Obliquus internus; its lower fourth is in front of the Rectus.

Variations. —It may be more or less fused with the Obliquus internus or absent. The spermatic cord may pierce its lower border. Slender muscle slips from the ileopectineal line to transversalis fascia, the aponeurosis of the Transversus abdominis or the outer end of the linea semicircularis and other slender slips are occasionally found.

The inguinal aponeurotic falx (falx aponeurotica inguinalis; conjoined tendon of Internal oblique and Transversalis muscle) of the Obliquus internus and Transversus is mainly formed by the lower part of the tendon of the Transversus, and is inserted into the crest of the pubis and pectineal line immediately behind the subcutaneous inguinal ring, serving to protect what would otherwise be aweak point in the abdominal wall. Lateral to the falx is a ligamentous band connected with the lower margin of the Transversus and extending down in front of the inferior epigastric artery to the superior ramus of the pubis; it is termed the interfoveolar ligament of Hesselbach and sometimes contains a few muscular fibers.

The Rectus abdominis is a long flat muscle, which extends along the whole length of the front of the abdomen, and is separated from its fellow of the opposite side by the linea alba. It is much broader, but thinner, above than below, and arises by two tendons; the lateral or larger is attached to the crest of the pubis, the medial interlaces with its fellow of the opposite side, and is connected with the ligaments covering the front of the symphysis pubis. The muscle is inserted by three portions of unequal size into the cartilages of the fifth, sixth, and seventh ribs. The upper portion, attached principally to the cartilage of the fifth rib, usually has some fibers of insertion into the anterior extremity of the rib itself.

Some fibers are occasionally connected with the costoxiphoid ligaments, and the side of the xiphoid process.

The Rectus is crossed by fibrous bands, three in number, which are named the tendinous inscriptions; one is usually situated opposite the umbilicus, one at the extremity of the xiphoid process, and the third about midway between the xiphoid process and the umbilicus. These inscriptions pass transversely or obliquely across the muscle in a zigzag course; they rarely extend completely through its substance and may pass only halfway across it; they are intimately adherent in front to the sheath of the muscle. Sometimes one or two additional inscriptions, generally incomplete, are present below the umbilicus.

The Rectus is enclosed in a sheath formed by the aponeuroses of the Obliqui and Transversus, which are arranged in the following manner. At the lateral margin of the Rectus, the aponeurosis of the Obliquus internus divides into two lamellæ, one of which passes in front of the Rectus, blending with the aponeurosis of the Obliquus externus, the other, behind it, blending with the aponeurosis of the Transversus, and these, joining again at the medial border of the Rectus, are inserted into the linea alba. This arrangement of the aponeurosis exists from the costal margin to midway between the umbilicus and symphysis pubis, where the posterior wall of the sheath ends in a thin curved margin, the linea semicircularis, the concavity of which is directed downward: below this level the aponeuroses of all three muscles pass in front of the Rectus. The Rectus, in the situation where its sheath is deficient below, is separated from the peritoneum by the transversalis fascia. Since the tendons of the Obliquus internus and Transversus only reach as high as the costal margin, it follows that above this level the sheath of the Rectus is deficient behind, the muscle resting directly on the cartilages of the ribs, and being covered merely by the tendon of the Obliquus externus.

The Pyramidalis is a small triangular muscle, placed at the lower part of the abdomen, in front of the Rectus, and contained in the sheath of that muscle. It arises by tendinous fibers from the front of the pubis and the anterior pubic ligament; the fleshy portion of the muscle passes upward, diminishing in size as it ascends, and ends by a pointed extremity which is inserted into the linea alba, midway between the umbilicus and pubis. This muscle may be wanting on one or both sides; the lower end of the Rectus then becomes proportionately increased in size. Occasionally it is double on one side, and the muscles of the two sides are sometimes of unequal size. It may extend higher than the level stated.

Besides the Rectus and Pyramidalis, the sheath of the Rectus contains the superior and inferior epigastric arteries, and the lower intercostal nerves.

Variations. —The Rectus may insert as high as the fourth or third rib or may fail to reach the fifth. Fibers may spring from the lower part of the linea alba.

Nerves. —The abdominal muscles are supplied by the lower intercostal nerves. The Obliquus internus and Transversus also receive filaments from the anterior branch of the iliohypogastric and sometimes from the ilioinguinal. The Cremaster is supplied by the external spermatic branch of the genitofemoral and the Pyramidalis usually by the twelfth thoracic.

The Linea Alba. —The linea alba is a tendinous raphé in the middle line of the abdomen, stretching between the xiphoid process and the symphysis pubis. It is placed between the medial borders of the Recti, and is formed by the blending of the aponeuroses of the Obliqui and Transversi. It is narrow below, corresponding to the linear interval existing between the Recti; but broader above, where these muscles diverge from one another. At its lower end the linea alba has a double attachment—its superficial fibers passing in front of the medial heads of the Recti to the symphysis pubis, while its deeper fibers form a triangular lamella, attached behind the Recti to the posterior lip of the crest of the pubis, and named the adminiculum lineæ albæ. It presents apertures for the passage of vessels and nerves; the umbilicus, which in the fetus exists as an aperture and transmits the umbilical vessels, is closed in the adult

The Lineæ Semilunares. —The lineæ semilunares are two curved tendinous lines placed one on either side of the linea alba. Each corresponds with the lateral border of the Rectus, extends from the cartilage of the ninth rib to the pubic tubercle, and is formed by the aponeurosis of the Obliquus internus at its line of division to enclose the Rectus, reinforced in front by that of the Obliquus externus, and behind by that of the Transversus.

Actions. —When the pelvis and thorax are fixed, the abdominal muscles compress the abdominal viscera by constricting the cavity of the abdomen, in which action they are materially assisted by the descent of the diaphragm. By these means assistance is given in expelling the feces from the rectum, the urine from the bladder, the fetus from the uterus, and the contents of the stomach in vomiting.

If the pelvis and vertebral column be fixed, these muscles compress the lower part of the thorax, materially assisting expiration. If the pelvis alone be fixed, the thorax is bent directly forward, when the muscles of both sides act; when the muscles of only one side contract, the trunk is bent toward that side and rotated toward the opposite side.

If the thorax be fixed, the muscles, acting together, draw the pelvis upward, as in climbing; or, acting singly, they draw the pelvis upward, and bend the vertebral column to one side or the other. The Recti, acting from below, depress the thorax, and consequently flex the vertebral column; when acting from above, they flex the pelvis upon the vertebral column. The Pyramidales are tensors of the linea alba.

The Transversalis Fascia. —The transversalis fascia is a thin aponeurotic membrane which lies between the inner surface of the Transversus and the extraperitoneal fat. It forms part of the general layer of fascia lining the abdominal parietes, and is directly continuous with the iliac and pelvic fasciæ. In the inguinal region, the transversalis fascia is thick and dense in structure and is joined by fibers from the aponeurosis of the Transversus, but it becomes thin as it ascends to the diaphragm, and blends with the fascia covering the under surface of this muscle. Behind, it is lost in the fat which covers the posterior surfaces of the kidneys. Below, it has the following attachments: posteriorly, to the whole length of the iliac crest, between the attachments of the Transversus and Iliacus; between the anterior superior iliac spine and the femoral vessels it is connected to the posterior margin of the inguinal ligament, and is there continuous with the iliac fascia. Medial to the femoral vessels it is thin and attached to the pubis and pectineal line, behind the inguinal aponeurotic falx, with which it is united; it descends in front of the femoral vessels to form the anterior wall of the femoral sheath. Beneath the inguinal ligament it is strengthened by a band of fibrous tissue, which is only loosely connected to the ligament, and is specialized as the deep crural arch. The spermatic cord in the male and the round ligament of the uterus in the female pass through the transversalis fascia at a spot called the abdominal inguinal ring. This opening is not visible externally, since the transversalis fascia is prolonged on these structures as the infundibuliform fascia.

The Abdominal Inguinal Ring (annulus inguinalis abdominis; internal or deep abdominal ring). —The abdominal inguinal ring is situated in the transversalis fascia, midway between the anterior superior iliac spine and the symphysis pubis, and about 1.25 cm. above the inguinal ligament. It is of an oval form, the long axis of the oval being vertical; it varies in size in different subjects, and is much larger in the male than in the female. It is bounded, above and laterally, by the arched lower margin of the Transversus; below and medially, by the inferior epigastric vessels. It transmits the spermatic cord in the male and the round ligament of the uterus in the female. From its circumference a thin funnel-shaped membrane, the infundibuliform fascia, is continued around the cord and testis, enclosing them in a distinct covering.

The Inguinal Canal (canalis inguinalis; spermatic canal). —The inguinal canal contains the spermatic cord and the ilioinguinal nerve in the male, and the round ligament of the uterus and the ilioinguinal nerve in the female. It is an oblique canal about 4 cm. long, slanting downward and medialward, and placed parallel with and a little above the inguinal ligament; it extends from the abdominal inguinal ring to the subcutaneous inguinal ring. It is bounded, in front, by the integument and superficial fascia, by the aponeurosis of the Obliquus externus throughout its whole length, and by the Obliquus internus in its lateral third; behind, by the reflected inguinal ligament, the inguinal aponeurotic falx, the transversalis fascia, the extraperitoneal connective tissue and the peritoneum; above, by the arched fibers of Obliquus internus and Transversus abdominis; below, by the union of the transversalis fascia with the inguinal ligament, and at its medial end by the lacunar ligament.

Extraperitoneal Connective Tissue. —Between the inner surface of the general layer of the fascia which lines the interior of the abdominal and pelvic cavities, and the peritoneum, there is a considerable amount of connective tissue, termed the extraperitoneal or subperitoneal connective tissue.

The parietal portion lines the cavity in varying quantities in different situations. It is especially abundant on the posterior wall of the abdomen, and particularly around the kidneys, where it contains much fat. On the anterior wall of the abdomen, except in the public region, and on the lateral wall above the iliac crest, it is scanty, and here the transversalis fascia is more closely connected with the peritoneum. There is a considerable amount of extraperitoneal connective tissue in the pelvis.

The visceral portion follows the course of the branches of the abdominal aorta between the layers of the mesenterics and other folds of peritoneum which connect the various viscera to the abdominal wall. The two portions are directly continuous with each other.

The Deep Crural Arch.—Curving over the external iliac vessels, at the spot where they become femoral, on the abdominal side of the inguinal ligaments and loosely connected with it, is a thickened band of fibers called the deep crural arch. It is apparently a thickening of the transversalis fascia joined laterally to the center of the lower margin of the inguinal ligament, and arching across the front of the femoral sheath to be inserted by a broad attachment into the pubic tubercle and pectineal line, behind the inguinal aponeurotic falx. In some subjects this structure is not very prominently marked, and not infrequently it is altogether wanting.

2. The Posterior Muscles of the Abdomen

Psoas major.	Iliacus.
Psoas minor.	Quadratus lumborum.

The Psoas major, the Psoas minor, and the Iliacus, with the fasciæ covering them, will be described with the muscles of the lower extremity.

The Fascia Covering the Quadratus Lumborum. —This is a thin layer attached, medially, to the bases of the transverse processes of the lumbar vertebræ; below, to the iliolumbar ligament; above, to the apex and lower border of the last rib. The upper margin of this fascia, which extends from the transverse process of the first lumbar vertebra to the apex and lower border of the last rib, constitutes the lateral lumbocostal arch. Laterally, it blends with the lumbodorsal fascia, the anterior layer of which intervenes between the Quadratus lumborum and the Sacrospinalis.

The Quadratus lumborum is irregularly quadrilateral in shape, and broader below than above. It arises by aponeurotic fibers from the iliolumbar ligament and the adjacent portion of the iliac crest for about 5 cm., and is inserted into the lower border of the last rib for about half its length, and by four small tendons into the apices of the transverse processes of the upper four lumbar vertebræ. Occasionally a second portion of this muscle is found in front of the preceding. It arises from the upper borders of the transverse processes of the lower three or four lumbar vertebræ, and is inserted into the lower margin of the last rib. In front of the Quadratus lumborum are the colon, the kidney, the Psoas major and minor, and the diaphragm; between the fascia and the muscle are the twelfth thoracic, ilioinguinal, and iliohypogastric nerves.

Variations. —The number of attachments to the vertebræ and the extent of its attachment to the last rib vary.

Nerve Supply. —The twelfth thoracic and first and second lumbar nerves supply this muscle.

Actions. —The Quadratus lumborum draws down the last rib, and acts as a muscle of inspiration by helping to fix the origin of the diaphragm. If the thorax and vertebral column are fixed, it may act upon the pelvis, raising it toward its own side when only one muscle is put in action; and when both muscles act together, either from below or above, they flex the trunk.

Muscles of the back

Superficial muscles

- The **trapezius muscle** (or simply **trapezius**, Latin: *musculus trapezius*) is a significant muscle of the back lying in the most superficial layer. It extends from the occipital bone down to the lower thoracic vertebrae and laterally to the scapula. The trapezius moves and stabilizes the scapula. This shape of this muscle resembles a trapezium or diamond-shaped quadrilateral. The trapezius has three functional parts:
  - upper (descending) part - supports the upper arm;
  - middle (transverse) part - retracts the scapula;
  - lower (ascending) part - medially rotates and depresses the scapula.

Origin

The trapezius originates from the spinous processes of the seventh cervical vertebrae and the following twelve thoracic vertebrae (C7 - T12), the nuchal ligament, also from the occipital protuberance, and the superior nuchal line - landmarks on the occipital bone.

Insertion

The trapezius inserts onto the lateral third of the clavicle, the acromion process, and the spine of the scapula.

Action

Upon activation, the trapezius rotates, raises, lowers, and adducts (retracts) the scapula. It also aids in the rotation of the head. When the spinal origins are stable, it moves the scapula, but when the scapula is fixed, it provides movements in the spine. The trapezius also is important in stabilizing the scapula and supporting the weight of the arm.

Innervation

Several nerves participate in the innervation of the trapezius. The accessory nerve (CN XI) provides motor innervation to the trapezius muscle. Motor innervation, together with proprioception, comes from the third and fourth cervical spinal nerves (C3 - C4) that arise from cervical plexus.

- The **latissimus dorsi** (also known as “**the lats**,” Latin: *musculus latissimus dorsi*) is one of the widest muscles in the human body, and it belongs to the superficial back muscles. It is a large, flat triangular muscle that runs across the trunk to reach the humerus, providing movements at the shoulder joint. Besides moving the arm, the latissimus dorsi also can move the trunk, and it functions as an accessory muscle of respiration.

Together with the teres major, this muscle participates in forming the posterior axillary fold in the armpit, where it is easily palpable.

Origin

The muscle fibers of the latissimus dorsi arise from several structures, including:

- spinous processes of seventh thoracic to fifth lumbar vertebrae (T7 - L5), and the thoracolumbar fascia;
- iliac crest of the sacrum;
- lower three or four ribs;
- inferior angle of the scapula.

Based on its origins, the latissimus dorsi may be divided into four corresponding parts: vertebral, iliac, costal, and scapular part.

Insertion

All fibers of the latissimus dorsi together insert into the intertubercular sulcus of the humerus via a tendon. The muscle attaches to the humerus between the pectoralis major and teres major muscles.

Action

By acting on the shoulder joint, the latissimus dorsi provides internal rotation, adduction, and extension of the arm.

When the humerus is fixed, the latissimus dorsi may participate in trunk movements: it elevates the trunk (for example, necessary during climbing and pull-ups) or move the trunk anteriorly (useful, for example, in cross-country skiing). It also supports other muscles of the back during lateral flexion of the lumbar part of the spine.

The latissimus dorsi is also one of the accessory respiratory muscles. Contractions of the latissimus dorsi on both sides of the body compress the rib cage, therefore, facilitating expiration.

Innervation

The latissimus dorsi is innervated by the **thoracodorsal nerve** (C6-C8), which is a branch of the brachial plexus.

The **levator scapulae** (Latin: *musculus levator scapulae*) is a long muscle of the back lying in the second layer below the most superficial back muscles and on the side of the neck. It may also be categorized as a muscle of the shoulder. Its main action is lifting the scapula.

The upper part of this muscle lies beneath the splenius capitis and sternocleidomastoid muscle, while its lower part is located below the trapezius. The middle part is the only portion of the levator scapulae uncovered in the lateral neck region, where the muscle is, therefore, easily palpable.

Origin

Fibers of the levator scapulae originate from the transverse processes of the atlas (C1) and axis (C2), as well as from the posterior tubercles of the third and fourth cervical vertebrae (C3, C4).

Insertion

The levator scapulae inserts into the posterior surface of the medial scapular border - from the superior angle to the root of the spine of the scapula.

Action

The main action provided by the levator scapulae is to elevate the scapula.

Innervation

The levator scapulae is innervated by branches of the third and fourth cervical spinal nerves (C3, C4), and also the dorsal scapular nerve, which arises from the fifth cervical spinal nerve (C5)

There are usually two **rhomboid muscles** (Latin: *musculi rhomboidei*) - rhomboid minor and rhomboid major, which belong to the superficial muscle group of the back that collectively connect the upper limb to the trunk. The rhomboid muscles are located in the upper back and participate in maintaining upper body posture and contribute to stabilizing the shoulder. Sometimes both rhomboid muscles are fused into a single muscle.

The **rhomboid major** (Latin: *musculus rhomboideus major*) is one of the superficial muscles of the back that connects the scapula with the vertebral column. It lies deep to the trapezius muscle and inferior to the rhomboid minor.

Origin

The rhomboid major arises from the spinous processes of the second to fifth thoracic vertebrae (T2 - T5).

Insertion

The rhomboid major muscle inserts into the medial border of the scapula - from the inferior angle to the root of the spine of the scapula.

Action

The rhomboid major acts upon the **scapulothoracic joint**: it pulls the scapula posteromedially, rotates the glenoid cavity inferiorly. It also supports the position of the scapula.

Innervation

The **dorsal scapular nerve** (C4 - C5) provides motor innervation to the rhomboid major muscle.

Blood supply

The rhomboid major receives arterial blood supply via the **dorsal scapular artery**, which typically arises from the subclavian artery but may originate from the transverse cervical artery.

The **rhomboid minor** (Latin: *musculus rhomboideus major*) is a small muscle of the upper back that connects the scapula to the spine. It lies deep to the trapezius, inferior to the levator scapulae, and superior to the rhomboid major.

Origin

The rhomboid minor typically arises from the nuchal ligament and spinous processes of the seventh cervical vertebra (C7) and the first thoracic vertebra (T1).

Insertion

Fibers of the rhomboid minor insert into the root (medial end) of the spine of the scapula.

Action

The actions provided of the rhomboid minor are the same as those of rhomboid major. This muscle also acts upon the scapulothoracic joint by pulling the scapula posteromedially, rotating the glenoid cavity inferiorly, as well as supporting the position of the scapula.

Innervation

The dorsal scapular nerve (C4 - C5) innervates the rhomboid minor.

Blood supply

Along with the rhomboid major, this muscle also receives oxygenated blood from the dorsal scapular artery.

Intermediate muscles

- The **serratus posterior superior** (Latin: *musculus serratus posterior superior*) is a thin rectangular muscle that is located in the upper back and back part of the thorax. It lies deep to the rhomboid muscles.

Origin

The serratus posterior originates from the inferior part of the nuchal ligament, and the cervical and thoracic parts of the vertebral column (usually C7 - T3).

Insertion

The muscle fibers pass in an inferolateral direction and insert into ribs 2 to 5 slightly beyond their angles.

Action

The serratus posterior superior acts to elevate ribs 2 to 5, therefore, aiding in deep respiration.

Innervation

The **intercostal nerves** (2nd through 5th) innervate the serratus posterior superior.

Blood supply

The serratus posterior superior is supplied by the **intercostal arteries**.

- The **serratus posterior inferior** (Latin: *musculus serratus posterior inferior*) is a broad muscle that lies underneath the latissimus dorsi. It is located at the junction of the thoracic and lumbar regions. The muscle has an irregular quadrilateral form, and it is larger than the serratus posterior superior. Both serratus posterior muscles are separated by a wide interval.

Origin

The muscle originates from the thoracic and lumbar portions of the spine (usually T11 - L3).

Insertion

Fibers of the serratus posterior inferior extend in a superolateral direction and insert into the lower borders of ribs 9 to 12.

Action

The main action of the serratus posterior inferior is the depression of the ribs 9 to 12. It draws the ribs backward and downward to assist in extension and rotation of the trunk. This action also aids in forced expiration.

Innervation

The serratus posterior inferior is innervated by the **intercostal nerves** (9th through 12th).

Blood supply

Oxygenated blood is supplied to the serratus posterior inferior via the **intercostal arteries**.

Deep muscles

The **splenius capitis** (Latin: *musculus splenius capitis*) is a broad straplike muscle located in the back of the neck that belongs to the deep or intrinsic muscles of the back. The upper part of the muscle lies deep below the sternocleidomastoid, while its lower part - underneath the trapezius.

Origin

The splenius capitis originates from the lower half of the nuchal ligament and the spinous processes of the seventh cervical to third thoracic vertebrae (C7 - T3).

Insertion

The fibers of the splenius capitis insert into the mastoid process of the temporal bone and the adjacent occipital bone - into its rough surface just below the superior nuchal line.

Action

The main actions provided by the splenius capitis are extension of the head, as well as rotation and lateral flexion of the cervical spine. It is involved in movements such as shaking the head.

Innervation

The splenius capitis is innervated by the posterior branches (dorsal rami) of the third to sixth cervical nerves (C3 - C6).

The **splenius cervicis** (also known as **splenius colli**, Latin: *musculus splenius cervicis*) is a deep muscle of the back, which is located in the back of the neck.

Origin

The splenius cervicis originates from the spinous processes of the third to sixth thoracic vertebrae (T3 - T6).

Insertion

The fibers of the splenius cervicis insert into the transverse process of the atlas (C1), the tip of the transverse process of the axis (C2), and into the posterior tubercle of the third cervical vertebra (C3).

Action

The actions provided by the splenius cervicis are rotation and lateral flexion of the head when acting unilaterally. It extends the head when acting on both sides or bilaterally.

Innervation

The splenius cervicis is innervated by the lateral branches of the posterior branches (dorsal rami) of the lower cervical spinal nerves that arise from cervical plexus.

- The **iliocostalis** (Latin: *musculus iliocostalis*) is a deep back muscle that lies lateral to the longissimus. It is one of the three muscles forming the **erector spinae** - the most powerful extensor of the back, the other two being the longissimus and spinalis muscles. The main function of the iliocostalis is to extend the spine when contracting on both sides and to flex the spine laterally when contracting on one side.

The muscle has three parts according to their origin: iliocostalis cervicis, iliocostalis thoracis, and iliocostalis lumborum.

The **iliocostalis cervicis** (also known as **cervicalis ascendens**, Latin: *musculus iliocostalis cervicis*) is the portion of the iliocostalis that is located deep in the back of the neck.

Origin

The muscle fibers of the iliocostalis cervicis originate from the third to sixth rib angles.

Insertion

The iliocostalis cervicis inserts into the posterior tubercles of the fourth to sixth cervical vertebrae (C4 - C6).

Action

Upon bilateral activation (on both sides), the iliocostalis cervicis extends the cervical spine. Upon unilateral activation (on one side), it laterally flexes the spine to the same side (ipsilaterally). However, the iliocostalis cervicis is a muscle with very little force capacity.

Innervation

The iliocostalis cervicis is innervated by the lateral branches of the posterior (dorsal) rami of the lower cervical spinal nerves (C6 - C8).

Blood supply

The iliocostalis cervicis receives oxygenated blood via the occipital, deep cervical, and vertebral arteries.

The **iliocostalis thoracis** (also known as **iliocostalis dorsalis** or **musculus accessorius**, Latin: *musculus iliocostalis thoracis*) is the thoracic portion of the iliocostalis muscle.

Origin

The iliocostalis thoracis muscle fibers originate from the seventh to twelfth rib angles.

Insertion

The fibers of the iliocostalis thoracis insert into the angles of the first to sixth ribs. However, some of its fibers attach to the transverse process of the seventh cervical vertebra (C7).

Action

Upon bilateral activation, the iliocostalis thoracis extends the thoracic part of the vertebral spine, while upon unilateral activation, it laterally flexes the thoracic spine to the same side.

Innervation

The innervation of the iliocostalis thoracis is provided by the lateral branches of the posterior (dorsal) rami of the spinal nerves.

Blood supply

The iliocostalis thoracis is supplied by the dorsal branches of the posterior intercostal and subcostal arteries.

The **iliocostalis lumborum** (or **sacrolumbalis muscle** Latin: *musculus iliocostalis lumborum*) is the third part of the iliocostalis located in the lower back.

Origin

The iliocostalis lumborum arises from the lateral crest of the sacrum, the medial end of the iliac crest, and the thoracolumbar fascia.

Insertion

The iliocostalis lumborum inserts via flat tendons into the fifth to twelfth rib angles, the transverse processes of the first to fourth lumbar vertebrae (L1 - L4), as well as the adjacent thoracolumbar fascia.

Action

The iliocostalis lumborum extends the lumbar spine by contracting bilaterally, while upon contracting unilaterally, it flexes the spine laterally to the same side.

Innervation

The iliocostalis lumborum is innervated by the lateral branches of the posterior (dorsal) rami of the spinal nerves.

Blood supply

The dorsal branches of the lumbar and the lateral sacral arteries provide blood supply to the iliocostalis lumborum.

The **longissimus** (Latin: *musculus longissimus*) is a deep muscle of the back that forms the **erector spinae** along with both iliocostalis and spinalis muscles. The longissimus is the most central erector spinae muscle. It is also the longest and thickest of the three. The longissimus is divided into three parts based on location and superior attachment: longissimus capitis, longissimus cervicis, and longissimus thoracis.

The **longissimus capitis** (also known as **trachelomastoid muscle**, Latin: *musculus longissimus capitis*) is a portion of the longissimus muscle in the neck region that lies medial to the longissimus cervicis.

Origin

The longissimus capitis originates by tendons arising from the transverse processes of the lower three or four cervical vertebrae (C4/C5 - C7) and upper four thoracic vertebrae (T1 - T4).

Insertion

The fibers of the longissimus capitis insert into the posterior edge of the mastoid process of the temporal bone.

Action

This muscle has very little force capacity. Bilateral activation of the longissimus capitis may aid in extending the head and neck. Unilateral activation laterally flexes and rotates the head ipsilaterally (to the same side).

Innervation

The longissimus capitis is innervated by the lateral branches of the dorsal rami of cervical and thoracic spinal nerves (C6 - T4).

Blood supply

The blood supply to the longissimus capitis and cervicis is provided by the muscular branches of the occipital artery, which itself arises from the external carotid artery, as well as by the vertebral artery, deep cervical artery, and transverse cervical artery.

The **longissimus cervicis** (also known as **transversalis cervicis**, Latin: *musculus longissimus cervicis; musculus longissimus colli*) is a portion of the longissimus muscle that lies medial to the longissimus thoracis.

Origin

The longissimus cervicis originates by tendons from the transverse processes of the upper four or five thoracic vertebrae (T1 - T4/T5).

Insertion

The fibers of the longissimus cervicis insert into the posterior tubercles of transverse processes of the second to sixth cervical vertebrae (C2 - C6).

Action

When acting bilaterally, the longissimus cervicis extends the cervical spine while unilaterally laterally flexes the cervical spine ipsilaterally (to the same side). However, this muscle has very little force capacity.

Innervation

The longissimus cervicis is innervated by the lateral branches of the dorsal rami of the thoracic spinal nerves.

Blood supply

The blood supply to the longissimus capitis and cervicis is provided by the muscular branches of the occipital artery, which itself arises from the external carotid artery, as well as by the vertebral artery, deep cervical artery, and transverse cervical artery.

The longissimus thoracis (Latin: *musculus longissimus thoracis*) is the lower portion of the longissimus muscle. It is divided into two parts: the lumbar part and the thoracic part.

Origin

The lumbar part of the longissimus thoracis originates from the lumbar intermuscular aponeurosis, the anteromedial aspect of the ilium, and the posterior sacroiliac ligament.

The thoracic part arises from the spinous and transverse processes of the first to fifth lumbar vertebrae (L1 - L5), the medial sacral crest, posterior surface of the sacrum and the posterior iliac crest.

Insertion

The muscle fibers of the lumbar part insert into the accessory and transverse processes of the first to fifth lumbar vertebrae (L1 - L5).

The thoracic part of the longissimus inserts into the transverse processes of the twelve thoracic vertebrae (T1 - T12) and the angles of ribs 7 to 12.

Action

Upon bilateral contraction, the longissimus thoracis like other parts of the longissimus muscle extends the spine, and upon bilateral contraction, it laterally flexes the spine to the same side.

Innervation

The longissimus thoracis is innervated by the lateral branches of the dorsal (posterior) rami of the thoracic and lumbar spinal nerves (T7 - L5).

Blood supply

The longissimus thoracis is supplied by the dorsal branches of the posterior intercostal arteries and the subcostal arteries arising from the thoracic aorta, as well as by the lateral sacral and median sacral arteries.

- The **spinalis** (Latin: *musculus spinalis*) is one of the muscles forming the **erector spinae** - a muscle group of the deep back muscles. The other two are the longissimus and iliocostalis. The spinalis is the most medial of the three erector spinae muscles.

The spinalis mainly originates from and inserts into spinous processes of cervical and thoracic vertebrae, but its upper part also attaches to the occipital bone.

This muscle`s actions provide extension and lateral flexion of the cervical and thoracic parts of the spine.

The spinalis is innervated by the lateral branches of the posterior rami of the spinal nerves.

It receives blood supply via the dorsal branches of the posterior intercostal arteries, the deep cervical artery, and the muscular branches of the vertebral artery.

Thie spinalis is formed of three parts: capitis, cervicis, and thoracis.

Origin

The spinalis capitis originates from the spinous processes of the C7 to T1 vertebrae.

Insertion

It inserts into the occipital bone, near its midline.

Action

Upon bilateral contraction, the spinalis capitis extends the head and neck, while upon unilateral contraction, it provides lateral flexion of the cervical spine to the same side (ipsilaterally).

Innervation

The muscle is innervated by the lateral branches of the posterior rami of the spinal nerves.

Origin

The spinalis cervicis originates from the spinous processes of the C7 to T1 vertebrae and the nuchal ligament.

Insertion

The fibers of the spinalis cervicis insert into the spinous processes of the C2 to C4 vertebrae.

Action

Upon bilateral contraction, the spinalis cervicis extends the cervical spine, while upon unilateral contraction, it provides lateral flexion of the cervical spine to the same side (ipsilaterally).

Innervation

The muscle is innervated by the lateral branches of the posterior rami of the spinal nerves.

Origin

The spinalis thoracis arises from the spinous processes of the T11 - L2 vertebrae.

Insertion

The thoracic part of the spinalis muscle inserts into the spinous processes of the T2 to T8 vertebrae.

Action

A bilateral contraction of the spinalis thoracis provides an extension of the thoracic spine, while a unilateral contraction provides lateral flexion of the thoracic spine to the same side (ipsilaterally).

Innervation

The muscle is innervated by the lateral branches of the posterior rami of the spinal nerves.

- The **rotatores** (or **rotatores spinae muscles**, Latin: *musculi rotatores*) are deep muscles of the back located laterally along the spine. Each muscle extends between the transverse and spinous processes of the vertebrae. The main functions of the rotatores include stabilizing, rotating, and extending the spine.

There are eleven rotatores on each side of the vertebral column. These muscles are present in all regions of the spine, but the **thoracic rotatores** are the most developed. They can be subdivided into **long rotatores** and **short rotatores** based on the length of their muscle fibers.

Origin

The rotatores muscles originate from the transverse processes of vertebrae.

Insertion

The muscle fibers of the rotatores insert into the junctions of transverse processes and laminae, extending to the spinous processes of the vertebrae. The short rotatores attach to the vertebrae one level above their origin, while the long rotatores insert - two levels above.

Action

The main actions provided by the rotatores include extending the spine when contracting on both sides, and rotating the thoracic spine contralaterally when contracting on one side. These muscles also serve as proprioceptive transducers that monitor the position and movements of the vertebral column.

Innervation

The rotatores are innervated by the medial branches of the dorsal rami of spinal nerves.

Blood supply

These muscles are supplied mainly by the dorsal branches of the posterior intercostal arteries and the lumbar arteries.

- The **semispinalis muscles** are the longest and most superficial set of the transversospinalis group. They are subdivided based on their location into semispinalis capitis, cervicis, and thoracis.

The **semispinalis capitis** (Latin: *musculus semispinalis capitis*) is a long thin muscle lying deep in the back of the neck, overlying the semispinalis cervicis. It is involved in head and neck movements.

Origin

The muscle fibers of the semispinalis capitis arise from the transverse processes of the fourth to seventh cervical vertebrae (C4 - C7), and the first to sixth thoracic vertebrae (T1 - T6).

Insertion

The semispinalis capitis inserts into the spinous processes of the second to fifth cervical vertebrae (C2 - C5).

Action

By contracting on both sides (bilaterally), the semispinalis capitis provides extension of the head and neck. By contracting on one side (unilaterally), it rotates the head and neck to the opposite side and laterally flexes the head and neck to the same side of activation.

Innervation

The semispinalis capitis is innervated by descending branches of the greater occipital nerve (C2) and the third cervical nerve (C3).

The **semispinalis cervicis** (also known as the **semispinalis colli**, Latin: *musculus semispinalis cervicis*) is a deep back muscle that lies over the cervical and thoracic parts of the multifidus muscle.

Origin

The semispinalis cervicis arises from the transverse processes of the first to sixth thoracic vertebrae (T1 - T6).

Insertion

The muscle fibers of the semispinalis cervicis insert into the spinous processes of the second to fifth cervical vertebrae (C2 - C5).

Action

By contracting on one side, the semispinalis cervicis rotates the neck to the contralateral (opposite) side of activation and provides lateral flexion to the ipsilateral (same) side. By contracting on both sides, this muscle extends the spine.

Innervation

The semispinalis cervicis is innervated by the medial branches of the posterior rami of the spinal nerves.

The **semispinalis thoracis** (Latin: *musculus semispinalis thoracis*) is a deep muscle of the back that overlies the thoracic part of the multifidus.

Origin

The semispinalis thoracis has thin fascicles with long tendons extending from both ends. They arise from the transverse processes of the sixth to tenth thoracic vertebrae (T6 - T10).

Insertion

The tendons of the semispinalis insert into the spinous processes of the sixth cervical to fourth thoracic vertebrae (C6 - T4).

Action

When it contracts on both sides, the semispinalis thoracis provides extension of the thoracic spine. When it contracts on one side, it causes lateral flexion of the spine to the same side, but rotation to the opposite side.

Innervation

The semispinalis thoracis is innervated by the medial branches of the posterior rami of the spinal nerves.

The **multifidus** (Latin: *musculus multifidus spinae*) muscle group consists of short and triangular muscles that, along with the semispinalis and rotatores, comprise the transversospinalis group of the deep back muscles. They are shorter than the semispinalis and longer than the rotatores, and the thickest of the three.

The multifidus muscles are found on each side of the vertebral column, extending from the cervical part to the lumbar portion of the spine. The multifidus muscles are divided into three portions based on the regions that they occupy. These parts are named the **cervical multifidus**, **thoracic multifidus**, and **lumbar multifidus**.

Each multifidus muscle extends between transverse and spinous processes of vertebrae, bridging over three to six vertebral levels. The contractions of the multifidus have a role in several movements of the spine, including extension, lateral flexion, and rotation of the cervical, thoracic, and lumbar portions of the spine.

Origin

The **cervical multifidus** muscles originate from the superior articular processes of the fourth to seventh cervical vertebrae (C4 - C7).

Insertion

The fibers of the cervical multifidus extend superomedially and insert into the spinous processes of the second to fifth cervical vertebrae (C2 - C5).

Action

When contracted bilaterally, the cervical multifidus aids in extending the cervical spine, while unilateral contraction aids in lateral flexion (ipsilateral) and rotation of the cervical spine (contralateral).

Innervation

The multifidus muscles are innervated by the medial branches of the posterior rami of the spinal nerves.

Blood supply

The multifidus muscles that are located in the cervical region receive arterial blood supply mainly via the vertebral and deep cervical arteries, which arise from the subclavian artery, and the occipital arteries - a branch of the external carotid.

Origin

The **thoracic multifidus** muscles arise from the transverse processes of the thoracic vertebrae.

Insertion

The muscle fibers of the thoracic multifidus extend superomedially and insert variably into the spinous processes of the vertebrae 2 to 5 levels above their origin.

Action

When contracted bilaterally, the thoracic multifidus aids in the extension of the thoracic spine, while unilateral contraction participates in lateral flexion (ipsilateral) and rotation of the thoracic spine (contralateral).

Innervation

The multifidus muscles are innervated by the medial branches of the posterior rami of the spinal nerves.

Blood supply

The thoracic multifidus muscles are mainly supplied by the dorsal branches of the posterior intercostal and subcostal arteries, which themselves are direct branches of the descending thoracic aorta.

Origin

The lumbar multifidus muscles originate from the transverse processes of the lumbar vertebrae and the posterior surface of the sacrum. Additionally, some fibers also arise from the posterior superior iliac spine of the ilium and the posterior sacroiliac ligament.

Insertion

The fibers of the lumbar multifidus extend superiorly and insert into the spinous processes of the vertebrae that are 2 to 5 levels above the origin sites.

Action

When contracted bilaterally, the thoracic multifidus aids in the extension of the thoracic spine, while unilateral contraction participates in lateral flexion (ipsilateral) and rotation of the thoracic spine (contralateral).

Innervation

The multifidus muscles are innervated by the medial branches of the posterior rami of the spinal nerves.

Blood supply

The lumbar multifidus muscles are mainly supplied by the lumbar and lateral sacral arteries - direct branches of the abdominal aorta.

- The **interspinales** (Latin: *musculi interspinales*) are short, paired muscles of the back lying in the deepest layer, extending between spinous processes of two adjacent vertebrae. These muscles extend through the entire spine; however, they are most developed in the cervical and lumbar regions. In the thoracic region, they are underdeveloped or often completely absent.

The primary function of the interspinales is to stabilize the spine during movement and maintain normal posture. They also aid other deep back muscles in extending the spine.

The **interspinales cervicis** (Latin: *musculi interspinales cervicis*) are paired muscles lying deep in the back of the neck, extending between spinous processes of two contiguous cervical vertebrae.

Origin and insertion

The interspinales cervicis originate from the superior aspect of spinous processes of cervical vertebrae C2 to C7 and insert into the inferior aspect of the adjacent vertebrae C1 to C6, respectively. These muscles are located on either side of the interspinous ligament.

Action

The action aided by the interspinales cervicis is extension of the cervical spine. Most importantly, these muscles participate in stabilizing the cervical spine and maintaining a healthy body posture.

Innervation

The dorsal rami of spinal nerves innervate the interspinales cervicis.

Blood supply

The arterial blood supply to the interspinales cervicis is provided by the vertebral artery, deep cervical artery, occipital artery, as well as the transverse cervical artery.

The **interspinales thoracis** (Latin: *musculi interspinales thoracis*) are deep muscles of the thoracic region of the back, extending between spinous processes of two adjacent thoracic vertebrae. These muscles are usually underdeveloped or even absent, with only some portions having distinct muscle fascicles. There are typically three pairs of interspinales thoracis present.

Origin and insertion

The three interspinales thoracis muscles arise from the superior aspect of the spinous processes of the second (T2), eleventh (T11), and twelfth thoracic vertebra (T12), but this can be variable. Each attaches to the inferior aspect of the spinous processes of the vertebra one level above (T1, T10, and T11, accordingly).

Action

These muscles are usually underdeveloped, but they may aid in the extension of the thoracic spine.

Innervation

The dorsal rami of spinal nerves innervate the interspinales thoracis.

Blood supply

These muscles are supplied by the superior intercostal artery, posterior intercostal arteries, and subcostal artery.

The **interspinales lumborum** (Latin: *musculi interspinales lumborum*) are a group of four paired muscles located deep in the lumbar part of the back.

Origin and insertion

The fibers of the interspinales lumborum originate from the superior aspect of spinous processes of second to fifth lumbar vertebrae (L2 - L5) and insert into the inferior aspect of the spinous processes of the adjacent vertebrae (L1 - L4, accordingly).

Action

The interspinales lumborum participates in stabilizing the lumbar spine movements and providing a normal body posture, and they also aid in the extension of the lumbar spine.

Innervation

The dorsal rami of spinal nerves innervate the interspinales lumborum.

Blood supply

The arterial blood supply to the interspinales lumborum is provided mainly by the lumbar arteries.

- The **intertransversarii muscles** (Latin: *musculi intertransversarii*) are small muscles that stretch between the transverse processes of vertebrae. Most of these muscles lie in the cervical and lumbar parts of the spine; however, small muscular slips are present in the lower thoracic region. Along with interspinales and levatores costarum the intertransversarii comprise the deepest layer of the deep back muscles.

The **intertransversarii cervicis** (also known as **intertransversarii colli**; Latin: *musculi intertransversarii cervicis*) are more developed than the intertransversarii lumborum. They consist of seven pairs of **anterior and posterior intertransversarii colli muscles**.

Origin

The origin site of each anterior intertransversarii cervicis muscle is on an anterior tubercle of a cervical vertebra.

Each posterior intertransversarii cervicis muscle originates from a posterior tubercle of a vertebra.

Insertion

Each anterior intertransversarii inserts onto the anterior tubercle of the adjacent vertebra above the insertion site.

The insertion site of each posterior intertransversarii muscle is on the posterior tubercle of the vertebra above.

Action

The anterior and posterior intertransversarii cervicis have a proprioceptive function in controlling the vertebral column position and its movements.

Innervation

The intertransversarii cervicis are innervated by the anterior and posterior rami of spinal nerves.

Blood supply

The arterial blood to the anterior intertransversarii cervicis muscles is supplied via the occipital, deep cervical, and vertebral arteries. The ascending cervical artery supplies the posterior intertransversarii cervicis.

The **intertransversarii lumborum** (Latin: *musculi intertransversarii lumborum*) consists of four pairs of muscles located on each side of the lumbar spine, extending between transverse processes of two adjacent lumbar vertebrae. Each pair consists of a medial and lateral component, namely, **medial and lateral intertransversarii lumborum**.

Origin

The lateral intertransversarii lumborum originates from the transverse and accessory processes of the first to fourth lumbar vertebrae (L1 - L4).

The medial intertransversarii lumborum muscles arise from the accessory processes of the first four lumbar vertebrae (L1 - L4).

Insertion

The muscle fibers of the lateral intertransversarii lumborum insert into the transverse process of the succeeding vertebra.

The medial intertransversarii lumborum insert into the mammillary process of the succeeding vertebra.

Action

The intertransversarii lumborum muscles aid in lateral flexion of the lumbar spine and also stabilizes the spine.

Innervation

The anterior rami of spinal nerves innervate the medial and lateral intertransversarii lumborum.

Blood supply

The intertransversarii lumborum muscles are supplied by the dorsal branches of the lumbar arteries.

- The **levatores costarum** (Latin: *musculi levatores costarum*) are a group of 12 pairs of muscles located in the posterior thorax. They are located on each side of the vertebral column and stretch between transverse processes of vertebrae and ribs found one level below. These muscles lie superficially to the external intercostal muscles.

The levatores costarum are considered as intrinsic muscles of the chest wall, as well as one of the deep muscles of the back. Together with other thoracic muscles, they possibly play a role in forced respiration and preventing the chest from moving inwards during inspiration. Along with the interspinales and intertransversarii muscles, they form the fourth (deepest) layer of the deep back muscles, participating in movements of the spine.

Origin

The levatores costarum arise from transverse processes of the seventh cervical to eleventh thoracic vertebrae (C7 - T11). Each muscle originates from one transverse process and passes obliquely downward.

Insertion

Each muscle inserts into the superior border or external surface of a rib one level below its origin. To be more precise, the insertion site is between the costal angle and the tubercle of a rib.

Each levatores costarum muscle is triangular-shaped, with the base at its insertion and the apex pointing toward the origin. The upper eight muscle pairs appear as single muscular bands, while the lower four split into two fasciculi - a long and a short fasciculus. These two bundles are called **levatores costarum longi** and **levatores costarum breves**, and both have a common origin site. The short (breves) fascicles insert into the ribs one level below their origin, while the long (longi) fascicle descends further and attaches to the rib located two levels below.

Action

The functions of the levatores costarum include elevating the ribs and producing rotation and lateral flexion of the thoracic spine. Although these muscles can elevate ribs, they are thought to play a relatively unimportant role during inspiration.

Innervation

Lateral branches of the dorsal rami of the spinal nerves C8 - T11 (intercostal nerves) innervate the levatores costarum muscles.

Blood supply

The levatores costarum are supplied by the dorsal branches of the posterior intercostal arteries, which travel along the lower border of each rib and are direct branches of the thoracic aorta.

The Muscles and Fasciae of the Lower Extremity.

The Muscles and Fasciae of the Iliac Region

The muscles of the lower extremity are subdivided into groups corresponding with the different regions of the limb.

I. Muscles of the Iliac Region. III. Muscles of the Leg.

II. Muscles of the Thigh. IV. Muscles of the Foot.

The Muscles and Fasciae of the Iliac Region.

Psoas major. Psoas minor. Iliacus.

The Fascia Covering the Psoas and Iliacus is thin above, and becomes gradually thicker below as it approaches the inguinal ligament.

The portion covering the Psoas is thickened above to form the medial lumbocostal arch, which stretches from the transverse process of the first lumbar vertebra to the body of the second. Medially, it is attached by a series of arched processes to the intervertebral fibrocartilages, and prominent margins of the bodies of the vertebræ, and to the upper part of the sacrum; the intervals left, opposite the constricted portions of the bodies, transmit the lumbar arteries and veins and filaments of the sympathetic trunk. Laterally, above the crest of the ilium, it is continuous with the fascia covering the front of the Quadratus lumborum, while below the crest of the ilium it is continuous with the fascia covering the Iliacus.

The portions investing the Iliacus (fascia iliaca; iliac fascia) is connected, laterally to the whole length of the inner lip of the iliac crest; and medially, to the linea terminalis of the lesser pelvis, where it is continuous with the periosteum. At the iliopectineal eminence it receives the tendon of insertion of the Psoas minor, when that muscle exists. Lateral to the femoral vessels it is intimately connected to the posterior margin of the inguinal ligament, and is continuous with the transversalis fascia. Immediately lateral to the femoral vessels the iliac fascia is prolonged backward and medialward from the inguinal ligament as a band, the iliopectineal fascia, which is attached to the iliopectineal eminence. This fascia divides the space between the inguinal ligament and the hip bone into two lacunæ or compartments, the medial of which transmits the femoral vessels, the lateral the Psoas major and Iliacus and the femoral nerve. Medial to the vessels the iliac fascia is attached to the pectineal line behind the inguinal aponeurotic falx, where it is again continuous with the transversalis fascia. On the thigh the fasciæ of the Iliacus and Psoas form a single sheet termed the iliopectineal fascia. Where the external iliac vessels pass into the thigh, the fascia descends behind them, forming the posterior wall of the femoral sheath. The portion of the iliopectineal fascia which passes behind the femoral vessels is also attached to the pectineal line beyond the limits of the attachment of the inguinal aponeurotic falx; at this part it is continuous with the pectineal fascia. The external iliac vessels lie in front of the iliac fascia, but all the branches of the lumbar plexus are behind it; it is separated from the peritoneum by a quantity of loose areolar tissue.

The Psoas major (Psoas magnus) is a long fusiform muscle placed on the side of the lumbar region of the vertebral column and brim of the lesser pelvis. It arises from the anterior surfaces of the bases and lower borders of the transverse processes of all the lumbar vertebræ from the sides of the bodies and the corresponding intervertebral fibrocartilages of the last thoracic and all the lumbar vertebræ by five slips, each of which is attached to the adjacent upper and lower margins of two vertebræ, and to the intervertebral fibrocartilage; from a series of tendinous arches which extend across the constricted parts of the bodies of the lumbar vertebræ between the previous slips; the lumbar arteries and veins, and filaments from the sympathetic trunk pass beneath these tendinous arches. The muscle proceeds downward across the brim of the lesser pelvis, and diminishing gradually in size, passes beneath the inguinal ligament and in front of the capsule of the hip-joint and ends in a tendon; the tendon receives nearly the whole of the fibers of the Iliacus and is inserted into the lesser trochanter of the femur. A large bursa which may communicate with the cavity of the hip-joint, separates the tendon from the pubis and the capsule of the joint.

The Psoas minor (Psoas parvus) is a long slender muscle, placed in front of the Psoas major. It arises from the sides of the bodies of the twelfth thoracic and first lumbar vertebræ and from the fibrocartilage between them. It ends in a long flat tendon which is inserted into the pectineal line and iliopectineal eminence, and, by its lateral border, into the iliac fascia. This muscle is often absent.

The Iliacus is a flat, triangular muscle, which fills the iliac fossa. It arises from the upper two-thirds of this fossa, and from the inner lip of the iliac crest; behind, from the anterior sacroiliac and the iliolumbar ligaments, and base of the sacrum; in front, it reaches as far as the anterior superior and anterior inferior iliac spines, and the notch between them. The fibers converge to be inserted into the lateral side of the tendon of the Psoas major, some of them being prolonged on to the body of the femur for about 2.5 cm. below and in front of the lesser trochanter.

Variations. —The Iliacus minor or Iliocapsularis, a small detached part of the Iliacus is frequently present. It arises from the anterior inferior spine of the ilium and is inserted into the lower part of the intertrochanteric line of the femur or into the iliofemoral ligament.

Nerves. —The Psoas major is supplied by branches of the second and third lumbar nerve; the Psoas minor by a branch of the first lumbar nerve; and the Iliacus by branches of the second and third lumbar nerves through the femoral nerve.

Actions. —The Psoas major, acting from above, flexes the thigh upon the pelvis, being assisted by the Iliacus; acting from below, with the femur fixed, it bends the lumbar portion of the vertebral column forward and to its own side, and then, in conjunction with the Iliacus, tilts the pelvis forward. When the muscles of both sides are acting from below, they serve to maintain the erect posture by supporting the vertebral column and pelvis upon the femora, or in continued action bend the trunk and pelvis forward, as in raising the trunk from the recumbent posture.

Superficial Fascia. —The superficial fascia forms a continuous layer over the whole of the thigh; it consists of areolar tissue containing in its meshes much fat, and may be separated into two or more layers, between which are found the superficial vessels and nerves. It varies in thickness in different parts of the limb; in the groin it is thick, and the two layers are separated from one another by the superficial inguinal lymph glands, the great saphenous vein, and several smaller vessels. The superficial layer is continuous above with the superficial fascia of the abdomen. The deep layer of the superficial fascia is a very thin, fibrous stratum, best marked on the medial side of the great saphenous vein and below the inguinal ligament. It is placed beneath the subcutaneous vessels and nerves and upon the surface of the fascia lata. It is intimately adherent to the fascia lata a little below the inguinal ligament. It covers the fossa ovalis (saphenous opening), being closely united to its circumference, and is connected to the sheath of the femoral vessels. The portion of fascia covering this fossa is perforated by the great saphenous vein and by numerous blood and lymphatic vessels, hence it has been termed the fascia cribrosa, the openings for these vessels having been likened to the holes in a sieve. A large subcutaneous bursa is found in the superficial fascia over the patella.

Deep Fascia. —The deep fascia of the thigh is named, from its great extent, the fascia lata; it constitutes an investment for the whole of this region of the limb, but varies in thickness in different parts. Thus, it is thicker in the upper and lateral part of the thigh, where it receives a fibrous expansion from the Glutæus maximus, and where the Tensor fasciæ latæ is inserted between its layers; it is very thin behind and at the upper and medial part, where it covers the Adductor muscles, and again becomes stronger around the knee, receiving fibrous expansions from the tendon of the Biceps femoris laterally, from the Sartorius medially, and from the Quadriceps femoris in front. The fascia lata is attached, above and behind, to the back of the sacrum and coccyx; laterally, to the iliac crest; in front, to the inguinal ligament, and to the superior ramus of the pubis; and medially, to the inferior ramus of the pubis, to the inferior ramus and tuberosity of the ischium, and to the lower border of the sacrotuberous ligament. From its attachment to the iliac crest it passes down over the Glutæus medius to the upper border of the Glutæus maximus, where it splits into two layers, one passing superficial to and the other beneath this muscle; at the lower border of the muscle the two layers reunite. Laterally, the fascia lata receives the greater part of the tendon of insertion of the Glutæus maximus, and becomes proportionately thickened. The portion of the fascia lata attached to the front part of the iliac crest, and corresponding to the origin of the Tensor fasciæ latæ, extends down the lateral side of the thigh as two layers, one superficial to and the other beneath this muscle; at the lower end of the muscle these two layers unite and form a strong band, having first received the insertion of the muscle. This band is continued downward, under the name of the iliotibial band (tractus iliotibialis) and is attached to the lateral condyle of the tibia. The part of the iliotibial band which lies beneath the Tensor fasciæ latæ is prolonged upward to join the lateral part of the capsule of the hip-joint. Below, the fasciæ lata is attached to all the prominent points around the knee-joint, viz., the condyles of the femur and tibia, and the head of the fibula. On either side of the patella it is strengthened by transverse fibers from the lower parts of the Vasti, which are attached to and support this bone. Of these the lateral are the stronger, and are continuous with the iliotibial band. The deep surface of the fascia lata gives off two strong intermuscular septa, which are attached to the whole length of the linea aspera and its prolongations above and below; the lateral and stronger one, which extends from the insertion of the Glutæus maximus to the lateral condyle, separates the Vastus lateralis in front from the short head of the Biceps femoris behind, and gives partial origin to these muscles; the medial and thinner one separates the Vastus medialis from the Adductores and Pectineus. Besides these there are numerous smaller septa, separating the individual muscles, and enclosing each in a distinct sheath.

The Fossa Ovalis (saphenous opening) — At the upper and medial part of the thigh, a little below the medial end of the inguinal ligament, is a large oval-shaped aperture in the fascia lata; it transmits the great saphenous vein, and other, smaller vessels, and is termed the fossa ovalis. The fascia cribrosa, which is pierced by the structures passing through the opening, closes the aperture and must be removed to expose it. The fascia lata in this part of the thigh is described as consisting of a superficial and a deep portion.

The superficial portion of the fascia lata is the part on the lateral side of the fossa ovalis. It is attached, laterally, to the crest and anterior superior spine of the ilium, to the whole length of the inguinal ligament, and to the pectineal line in conjunction with the lacunar ligament. From the tubercle of the pubis it is reflected downward and lateralward, as an arched margin, the falciform margin, forming the lateral boundary of the fossa ovalis; this margin overlies and is adherent to the anterior layer of the sheath of the femoral vessels: to its edge is attached the fascia cribrosa. The upward and medial prolongation of the falciform margin is named the superior cornu; its downward and medial prolongation, the inferior cornu. The latter is well-defined, and is continuous behind the great saphenous vein with the pectineal fascia.

The deep portion is situated on the medial side of the fossa ovalis, and at the lower margin of the fossa is continuous with the superficial portion; traced upward, it covers the Pectineus, Adductor longus, and Gracilis, and, passing behind the sheath of the femoral vessels, to which it is closely united, is continuous with the iliopectineal fascia, and is attached to the pectineal line.

From this description it may be observed that the superficial portion of the fascia lata lies in front of the femoral vessels, and the deep portion behind them, so that an apparent aperture exists between the two, through which the great saphenous passes to join the femoral vein.

The Inguinal Canal

The **inguinal canal** is a short passage that extends inferiorly and medially through the inferior part of the abdominal wall. It is superior and parallel to the inguinal ligament.

The canal serves as a pathway by which structures can pass from the abdominal wall to the external genitalia. It is of clinical importance as a potential **weakness** in the abdominal wall, and thus a common site of herniation.

In this article, we shall look at the anatomy of the inguinal canal – its development, borders and contents.

Development of the Inguinal Canal

During development, the tissue that will become gonads (either testes or ovaries) establish in the posterior abdominal wall, and descend through the abdominal cavity. A fibrous cord of tissue called the **gubernaculum** attaches the inferior portion of the gonad to the future scrotum or labia, and guides them during their descent.

The inguinal canal is the pathway by which the **testes** (in an individual with an XY karyotype) leave the abdominal cavity and enter the scrotum. In the embryological stage, the canal is flanked by an out-pocketing of the peritoneum (processus vaginalis) and the abdominal musculature.

The processus vaginalis normally **degenerates**, but a failure to do so can cause an indirect inguinal hernia, a hydrocele, or interfere with the descent of the testes. The gubernaculum (once it has shortened in the process of the descent of the testes) becomes a small scrotal ligament, tethering the testes to the scrotum and limiting their movement.

Individuals with an XX karyotype also have a gubernaculum, which attaches the **ovaries** to the uterus and future labia majora. Because the ovaries are attached to the uterus by the gubernaculum, they are prevented from descending as far as the testes, instead moving into the **pelvic cavity**. The gubernaculum then becomes two structures in the adult: the ovarian ligament and round ligament of uterus

Boundaries

The inguinal canal is bordered by anterior, posterior, superior (roof) and inferior (floor) walls. It has two **openings** – the superficial and deep rings.

Walls

- **Anterior wall** – aponeurosis of the external oblique, reinforced by the internal oblique muscle laterally.
- **Posterior wall** – transversalis fascia.
- **Roof** – transversalis fascia, internal oblique, and transversus abdominis.
- **Floor** – inguinal ligament (a ‘rolled up’ portion of the external oblique aponeurosis), thickened medially by the lacunar ligament.

During periods of increased **intra-abdominal** pressure, the abdominal viscera are pushed into the posterior wall of the inguinal canal. To prevent herniation of viscera into the canal, the muscles of the anterior and posterior wall contract, and ‘clamp down’ on the canal.

The two openings to the inguinal canal are known as rings.

The **deep (internal) ring** is found above the midpoint of the inguinal ligament. which is lateral to the epigastric vessels. The ring is created by the transversalis fascia, which invaginates to form a covering of the contents of the inguinal canal.

The **superficial (external) ring** marks the end of the inguinal canal, and lies just superior to the pubic tubercle. It is a triangle shaped opening, formed by the evagination of the external oblique, which forms another covering of the inguinal canal contents. This opening contains intercrural fibres, which run perpendicular to the aponeurosis of the external oblique and prevent the ring from widening.

Contents

The contents of the inguinal canal include:

- **Spermatic cord** (biological males only) – contains neurovascular and reproductive structures that supply and drain the testes. See here for more information.
- **Round ligament** (biological females only) – originates from the uterine horn and travels through the inguinal canal to attach at the labia majora.

- **Ilioinguinal nerve** – contributes towards the sensory innervation of the genitalia
    - Note: only travels through *part* of the inguinal canal, exiting via the superficial inguinal ring (it does not pass through the deep inguinal ring)
    - This is the nerve most at risk of damage during an inguinal hernia repair.
- **Genital branch of the genitofemoral nerve** – supplies the cremaster muscle and anterior scrotal skin in males, and the skin of the mons pubis and labia majora in females.

The walls of the inguinal canal are usually **collapsed** around their contents, preventing other structures from potentially entering the canal and becoming stuck.

Clinical Relevance: Inguinal Hernia

A hernia is defined as the protrusion of an organ or fascia through the wall of a cavity that normally contains it. Hernias involving the inguinal canal can be divided into two main categories:

- **Indirect** – where the peritoneal sac enters the inguinal canal through the deep inguinal ring.
- **Direct** – where the peritoneal sac enters the inguinal canal though the posterior wall of the inguinal canal.

Both types of inguinal hernia can present as lumps in the scrotum or labia majora.

Indirect Inguinal Hernia

Indirect inguinal hernias are the more common of the two types. They are caused by the failure of the processus vaginalis to **regress**.

The peritoneal sac (and potentially loops of bowel) enters the inguinal canal via the deep inguinal ring. The degree to which the sac herniates depends on the amount of **processus vaginalis** still present.

Large herniations are possible in which the peritoneal sac and its contents may traverse the entire inguinal canal, emerge through the superficial inguinal ring, and reach the scrotum.

Direct Inguinal Hernia

In contrast to the indirect hernia, direct inguinal hernias are acquired, usually in adulthood, due to **weakening** in the abdominal musculature.

The peritoneal sac bulges into the inguinal canal via the posterior wall medial to the epigastric vessels and can enter the superficial inguinal ring. The sac is **not** covered with the coverings of the contents of the canal.

Mid-Inguinal Point and Midpoint of the Inguinal Ligament

These two terms are mentioned frequently in this article, and are often (mistakenly) used interchangeably:

Mid-inguinal point – halfway between the pubic symphysis and the anterior superior iliac spine. The femoral pulse can be palpated here.

Midpoint of the inguinal ligament – halfway between the pubic tubercle and the anterior superior iliac spine (the two attachments of the inguinal ligament). The opening to the inguinal canal is located just above this point.

The Muscles and Fasciæ of the Shoulder

In this group are included:

Deltoideus.	Infraspinatus.
Subscapularis.	Teres minor.
Supraspinatus.	Teres major.

Deep Fascia.—The deep fascia covering the Deltoideus invests the muscle, and sends numerous septa between its fasciculi. In front it is continuous with the fascia covering the Pectoralis major; behind, where it is thick and strong, with that covering the Infraspinatus; above, it is attached to the clavicle, the acromion, and the spine of the scapula; below, it is continuous with the deep fascia of the arm.

The **Deltoideus** (*Deltoid muscle*) (Fig. 410) is a large, thick, triangular muscle, which covers the shoulder-joint in front, behind, and laterally. It *arises* from the anterior border and upper surface of the lateral third of the clavicle; from the lateral margin and upper surface of the acromion, and from the lower lip of the posterior border of the spine of the scapula, as far back as the triangular surface at its medial end. From this extensive origin the fibers converge toward their insertion, the middle passing vertically, the anterior obliquely backward and lateralward, the posterior obliquely forward and lateralward; they unite in a thick tendon, which is inserted into the deltoid prominence on the middle of the lateral side of the body of the humerus. At its *insertion* the muscle gives off an expansion to the deep fascia of the arm. This muscle is remarkably coarse in texture, and the arrangement of its fibers is somewhat peculiar; the central portion of the muscle—that is to say, the part arising from the acromion—consists of oblique fibers; these arise in a bipenniform manner from the sides of the tendinous intersections, generally four in number, which are attached above to the acromion and pass downward parallel to one another in the substance of the muscle. The oblique fibers thus formed are inserted into similar tendinous intersections, generally three in number, which pass upward from the insertion of the muscle and alternate with the descending septa. The portions of the muscle arising from the clavicle and spine of the scapula are not arranged in this manner, but are inserted into the margins of the inferior tendon.

Variations.—Large variations uncommon. More or less splitting common. Continuation into the Trapezius; fusion with the Pectoralis major; additional slips from the vertebral border of the scapula, infraspinous fascia and axillary border of scapula not uncommon. Insertion varies in extent or rarely is prolonged to origin of Brachioradialis.

Nerves.—The Deltoideus is supplied by the fifth and sixth cervical through the axillary nerve.

Actions.—The Deltoideus raises the arm from the side, so as to bring it at right angles with the trunk. Its anterior fibers, assisted by the Pectoralis major, draw the arm forward; and its posterior fibers, aided by the Teres major and Latissimus dorsi, draw it backward.

Subscapular Fascia (*fascia subscapularis*).—The subscapular fascia is a thin membrane attached to the entire circumference of the subscapular fossa, and affording attachment by its deep surface to some of the fibers of the Subscapularis.

The **Subscapularis** (Fig. 411) is a large triangular muscle which fills the subscapular fossa, and *arises* from its medial two-thirds and from the lower two-thirds of the groove on the axillary border of the bone. Some fibers *arise* from tendinous laminæ which intersect the muscle and are attached to ridges on the bone; others from an aponeurosis, which separates the muscle from the Teres major and the long head of the Triceps brachii. The fibers pass lateralward, and, gradually converging, end in a tendon which is *inserted* into the lesser tubercle of the humerus and the front of the capsule of the shoulder-joint. The tendon of the muscle is separated from the neck of the scapula by a large bursa, which communicates with the cavity of the shoulder-joint through an aperture in the capsule.

Nerves.—The Subscapularis is supplied by the fifth and sixth cervical nerves through the upper and lower subscapular nerves.

Actions.—The Subscapularis rotates the head of the humerus inward; when the arm is raised, it draws the humerus forward and downward. It is a powerful defence to the front of the shoulder-joint, preventing displacement of the head of the humerus.

Supraspinatous Fascia (*fascia supraspinata*).—The supraspinatous fascia completes the osseofibrous case in which the Supraspinatus muscle is contained; it affords attachment, by its deep surface, to some of the fibers of the muscle. It is thick medially, but thinner laterally under the coracoacromial ligament.

The **Supraspinatus** (Fig. 412) occupies the whole of the supraspinatous fossa, *arising* from its medial two-thirds, and from the strong supraspinatous fascia. The muscular fibers converge to a tendon, which crosses the upper part of the shoulder-joint, and is *inserted* into the highest of the three impressions on the greater tubercle of the humerus; the tendon is intimately adherent to the capsule of the shoulder-joint.

Infraspinatous Fascia (*fascia infraspinata*).—The infraspinatous fascia is a dense fibrous membrane, covering the Infraspinatous muscle and fixed to the circum ference of the infraspinatous fossa; it affords attachment, by its deep surface, to some fibers of that muscle. It is intimately attached to the deltoid fascia along the over-lapping border of the Deltoideus.

The **Infraspinatus** (Fig. 412) is a thick triangular muscle, which occupies the chief part of the infraspinatous fossa; it *arises* by fleshy fibers from its medial two-thirds, and by tendinous fibers from the ridges on its surface; it also arises from the infraspinatous fascia which covers it, and separates it from the Teretes major and minor. The fibers converge to a tendon, which glides over the lateral border of the spine of the scapula, and, passing across the posterior part of the capsule of the shoulder-joint, is *inserted* into the middle impression on the greater tubercle of the humerus. The tendon of this muscle is sometimes separated from the capsule of the shoulder-joint by a bursa, which may communicate with the joint cavity.

The **Teres minor** (Fig. 412) is a narrow, elongated muscle, which *arises* from the dorsal surface of the axillary border of the scapula for the upper two-thirds of its extent, and from two aponeurotic laminæ, one of which separates it from the Infraspinatus, the other from the Teres major. Its fibers run obliquely upward and lateralward; the upper ones end in a tendon which is *inserted* into the lowest of the three impressions on the greater tubercle of the humerus; the lowest fibers are *inserted* directly into the humerus immediately below this impression. The tendon of this muscle passes across, and is united with, the posterior part of the capsule of the shoulder-joint.

Variations.—It is sometimes inseparable from the Infraspinatus.

The **Teres major** (Fig. 412) is a thick but somewhat flattened muscle, which *arises* from the oval area on the dorsal surface of the inferior angle of the scapula, and from the fibrous septa interposed between the muscle and the Teres minor and Infraspinatus; the fibers are directed upward and lateralward, and end in a flat tendon, about 5 cm. long, which is *inserted* into the crest of the lesser tubercle of the humerus. The tendon, at its insertion, lies behind that of the Latissimus dorsi, from which it is separated by a bursa, the two tendons being, however, united along their lower borders for a short distance.

Nerves.—The Supraspinatus and Infraspinatus are supplied by the fifth and sixth cervical nerves through the suprascapular nerve; the Teres minor, by the fifth cervical, through the axillary; and the Teres major, by the fifth and sixth cervical, through the lowest subscapular.

Actions.—The Supraspinatus assists the Deltoideus in raising the arm from the side of the trunk and fixes the head of the humerus in the glenoid cavity. The Infraspinatus and Teres minor rotate the head of the humerus outward; they also assist in carrying the arm backward. One of the most important uses of these three muscles is to protect the shoulder-joint, the Supraspinatus supporting it above, and the Infraspinatus and Teres minor behind. The Teres major assists the Latissimus dorsi in drawing the previously raised humerus downward and backward, and in rotating it inward; when the arm is fixed it may assist the Pectorales and the Latissimus dorsi in drawing the trunk forward.

he muscles of the arm are:

Coracobrachialis.	Brachialis.
Biceps brachii.	Triceps brachii.

Brachial Fascia (*fascia brachii; deep fascia of the arm*).—The brachial fascia is continuous with that covering the Deltoideus and the Pectoralis major, by means of which it is attached, above, to the clavicle, acromion, and spine of the scapula; it forms a thin, loose, membranous sheath for the muscles of the arm, and sends septa between them; it is composed of fibers disposed in a circular or spiral direction, and connected together by vertical and oblique fibers. It differs in thickness at different parts, being thin over the Biceps brachii, but thicker where it covers the Triceps brachii, and over the epicondyles of the humerus: it is strengthened by fibrous aponeuroses, derived from the Pectoralis major and Latissimus dorsi medially, and from the Deltoideus laterally. On either side it gives off a strong intermuscular septum, which is attached to the corresponding supracondylar ridge and epicondyle of the humerus. The **lateral intermuscular septum** extends from the lower part of the crest of the greater tubercle, along the lateral supracondylar ridge, to the lateral epicondyle; it is blended with the tendon of the Deltoideus, gives attachment to the Triceps brachii behind, to the Brachialis, Brachioradialis, and Extensor carpi radialis longus in front, and is perforated by the radial nerve and profunda branch of the branchial artery. The **medial intermuscular septum,** thicker than the preceding, extends from the lower part of the crest of the lesser tubercle of the humerus below the Teres major, along the medial supracondylar ridge to the medial epicondyle; it is blended with the tendon of the Coracobrachialis, and affords attachment to the Triceps brachii behind and the Brachialis in front. It is perforated by the ulnar nerve, the superior ulnar collateral artery, and the posterior branch of the inferior ulnar collateral artery. At the elbow, the deep fascia is attached to the epicondyles of the humerus and the olecranon of the ulna, and is continuous with the deep fascia of the forearm. Just below the middle of the arm, on its medial side, is an oval opening in the deep fascia, which transmits the basilic vein and some lymphatic vessels.

The **Coracobrachialis** (Fig. 411), the smallest of the three muscles in this region, is situated at the upper and medial part of the arm. It *arises* from the apex of the coracoid process, in common with the short head of the Biceps brachii, and from the intermuscular septum between the two muscles; it is *inserted* by means of a flat tendon into an impression at the middle of the medial surface and border of the body of the humerus between the origins of the Triceps brachii and Brachialis. It is perforated by the musculocutaneous nerve.

Brachial Fascia (fascia brachii; deep fascia of the arm).—The brachial fascia is continuous with that covering the Deltoideus and the Pectoralis major, by means of which it is attached, above, to the clavicle, acromion, and spine of the scapula; it forms a thin, loose, membranous sheath for the muscles of the arm, and sends septa between them; it is composed of fibers disposed in a circular or spiral direction, and connected together by vertical and oblique fibers. It differs in thickness at different parts, being thin over the Biceps brachii, but thicker where it covers the Triceps brachii, and over the epicondyles of the humerus: it is strengthened by fibrous aponeuroses, derived from the Pectoralis major and Latissimus dorsi medially, and from the Deltoideus laterally. On either side it gives off a strong intermuscular septum, which is attached to the corresponding supracondylar ridge and epicondyle of the humerus. The lateral intermuscular septum extends from the lower part of the crest of the greater tubercle, along the lateral supracondylar ridge, to the lateral epicondyle; it is blended with the tendon of the Deltoideus, gives attachment to the Triceps brachii behind, to the Brachialis, Brachioradialis, and Extensor carpi radialis longus in front, and is perforated by the radial nerve and profunda branch of the branchial artery. The medial intermuscular septum, thicker than the preceding, extends from the lower part of the crest of the lesser tubercle of the humerus below the Teres major, along the medial supracondylar ridge to the medial epicondyle; it is blended with the tendon of the Coracobrachialis, and affords attachment to the Triceps brachii behind and the Brachialis in front. It is perforated by the ulnar nerve, the superior ulnar collateral artery, and the posterior branch of the inferior ulnar collateral artery. At the elbow, the deep fascia is attached to the epicondyles of the humerus and the olecranon of the ulna, and is continuous with the deep fascia of the forearm. Just below the middle of the arm, on its medial side, is an oval opening in the deep fascia, which transmits the basilic vein and some lymphatic vessels.

The Coracobrachialis (Fig. 411), the smallest of the three muscles in this region, is situated at the upper and medial part of the arm. It arises from the apex of the coracoid process, in common with the short head of the Biceps brachii, and from the intermuscular septum between the two muscles; it is inserted by means of a flat tendon into an impression at the middle of the medial surface and border of the body of the humerus between the origins of the Triceps brachii and Brachialis. It is perforated by the musculocutaneous nerve.

Antibrachial Fascia (fascia antibrachii; deep fascia of the forearm).—The antibrachial fascia continuous above with the brachial fascia, is a dense, membranous investment, which forms a general sheath for the muscles in this region; it is attached, behind, to the olecranon and dorsal border of the ulna, and gives off from its deep surface numerous intermuscular septa, which enclose each muscle separately. Over the Flexor tendons as they approach the wrist it is especially thickened, and forms the volar carpal ligament. This is continuous with the transverse carpal ligament, and forms a sheath for the tendon of the Palmaris longus which passes over the transverse carpal ligament to be inserted into the palmar aponeurosis. Behind, near the wrist-joint, it is thickened by the addition of many transverse fibers, and forms the dorsal carpal ligament. It is much thicker on the dorsal than on the volar surface, and at the lower than at the upper part of the forearm, and is strengthened above by tendinous fibers derived from the Biceps brachii in front, and from the Triceps brachii behind. It gives origin to muscular fibers, especially at the upper part of the medial and lateral sides of the forearm, and forms the boundaries of a series of cone-shaped cavities, in which the muscles are contained. Besides the vertical septa separating the individual muscles, transverse septa are given off both on the volar and dorsal surfaces of the forearm, separating the deep from the superficial layers of muscles. Apertures exist in the fascia for the passage of vessels and nerves; one of these apertures of large size, situated at the front of the elbow, serves for the passage of a communicating branch between the superficial and deep veins.

The antibrachial or forearm muscles may be divided into a volar and a dorsal group.

1. The Volar Antibrachial Muscles—These muscles are divided for convenience of description into two groups, superficial and deep.

The muscles of this group take origin from the medial epicondyle of the humerus by a common tendon; they receive additional fibers from the deep fascia of the forearm near the elbow, and from the septa which pass from this fascia between the individual muscles.

The Pronator teres has two heads of origin—humeral and ulnar. The humeral head, the larger and more superficial, arises immediately above the medial epicondyle, and from the tendon common to the origin of the other muscles; also from the intermuscular septum between it and the Flexor carpi radialis and from the antibrachial fascia. The ulnar head is a thin fasciculus, which arises from the medial side of the coronoid process of the ulna, and joins the preceding at an acute angle. The median nerve enters the forearm between the two heads of the muscle, and is separated from the ulnar artery by the ulnar head. The muscle passes obliquely across the forearm, and ends in a flat tendon, which is inserted into a rough impression at the middle of the lateral surface of the body of the radius. The lateral border of the muscle forms the medial boundary of a triangular hollow situated in front of the elbow-joint and containing the brachial artery, median nerve, and tendon of the Biceps brachii.

Variations.—Absence of ulnar head; additional slips from the medial intermuscular septum, from the Biceps and from the Brachialis anticus occasionally occur.

The Flexor carpi radialis lies on the medial side of the preceding muscle. It arises from the medial epicondyle by the common tendon; from the fascia of the forearm; and from the intermuscular septa between it and the Pronator teres laterally, the Palmaris longus medially, and the Flexor digitorum sublimis beneath. Slender and aponeurotic in structure at its commencement, it increases in size, and ends in a tendon which forms rather more than the lower half of its length. This tendon passes through a canal in the lateral part of the transverse carpal ligament and runs through a groove on the greater multangular bone; the groove is converted into a canal by fibrous tissue, and lined by a mucous sheath. The tendon is inserted into the base of the second metacarpal bone, and sends a slip to the base of the third metacarpal bone. The radial artery, in the lower part of the forearm, lies between the tendon of this muscle and the Brachioradialis.

Variations.—Slips from the tendon of the Biceps, the lacertus fibrosus, the coronoid, and the radius have been found. Its insertion often varies and may be mostly into the annular ligament, the trapezium, or the fourth metacarpal as well as the second or third. The muscle may be absent.

The Palmaris longus is a slender, fusiform muscle, lying on the medial side of the preceding. It arises from the medial epicondyle of the humerus by the common tendon, from the intermuscular septa between it and the adjacent muscles, and from the antibrachial fascia. It ends in a slender, flattened tendon, which passes over the upper part of the transverse carpal ligament, and is inserted into the central part of the transverse carpal ligament and lower part of the palmar aponeurosis, frequently sending a tendinous slip to the short muscles of the thumb.

Variations.—One of the most variable muscles in the body. This muscle is often absent about (10 per cent.), and is subject to many variations; it may be tendinous above and muscular below; or it may be muscular in the center with a tendon above and below; or it may present two muscular bundles with a central tendon; or finally it may consist solely of a tendinous band. The muscle may be double. Slips of origin from the coronoid process or from the radius have been seen.Partial or complete insertion into the fascia of the forearm, into the tendon of the Flexor carpi ulnaris and pisiform bone, into the navicular, and into the muscles of the little finger have been observed.

The Flexor carpi ulnaris lies along the ulnar side of the forearm. It arises by two heads, humeral and ulnar, connected by a tendinous arch, beneath which the ulnar nerve and posterior ulnar recurrent artery pass. The humeral head arises from the medial epicondyle of the humerus by the common tendon; the ulnar head arises from the medial margin of the olecranon and from the upper two-thirds of the dorsal border of the ulna by an aponeurosis, common to it and the Extensor carpi ulnaris and Flexor digitorum profundus; and from the intermuscular septum between it and the Flexor digitorum sublimis. The fibers end in a tendon, which occupies the anterior part of the lower half of the muscle and is inserted into the pisiform bone, and is prolonged from this to the hamate and fifth metacarpal bones by the pisohamate and pisometacarpal ligaments; it is also attached by a few fibers to the transverse carpal ligament. The ulnar vessels and nerve lie on the lateral side of the tendon of this muscle, in the lower two-thirds of the forearm.

Variations.—Slips of origin from the coronoid. The Epitrochleo-anconæus, a small muscle often present runs from the back of the inner condyle to the olecranon, over the ulnar nerve.

The Flexor digitorum sublimis is placed beneath the previous muscle; it is the largest of the muscles of the superficial group, and arises by three heads—humeral, ulnar, and radial. The humeral head arises from the medial epicondyle of the humerus by the common tendon, from the ulnar collateral ligament of the elbow-joint, and from the intermuscular septa between it and the preceding muscles. The ulnar head arises from the medial side of the coronoid process, above the ulnar origin of the Pronator teres (see Fig. 213, page 216). The radial head arises from the oblique line of the radius, extending from the radial tuberosity to the insertion of the Pronator teres. The muscle speedily separates into two planes of muscular fibers, superficial and deep: the superficial plane divides into two parts which end in tendons for the middle and ring fingers; the deep plane gives off a muscular slip to join the portion of the superficial plane which is associated with the tendon of the ring finger, and then divides into two parts, which end in tendons for the index and little fingers. As the four tendons thus formed pass beneath the transverse carpal ligament into the palm of the hand, they are arranged in pairs, the superficial pair going to the middle and ring fingers, the deep pair to the index and little fingers. The tendons diverge from one another in the palm and form dorsal relations to the superficial volar arch and digital branches of the median and ulnar nerves. Opposite the bases of the first phalanges each tendon divides into two slips to allow of the passage of the corresponding tendon of the Flexor digitorum profundus; the two slips then reunite and form a grooved channel for the reception of the accompanying tendon of the Flexor digitorum profundus. Finally the tendon divides and is inserted into the sides of the second phalanx about its middle.

Variations.—Absence of radial head, of little finger portion; accessory slips from ulnar tuberosity to the index and middle finger portions; from the inner head to the Flexor profundus; from the ulnar or annular ligament to the little finger.

The **Flexor digitorum profundus** is situated on the ulnar side of the forearm, immediately beneath the superficial Flexors. It *arises* from the upper three-fourths of the volar and medial surfaces of the body of the ulna, embracing the insertion of the Brachialis above, and extending below to within a short distance of the Pronator quadratus. It also arises from a depression on the medial side of the coronoid process; by an aponeurosis from the upper three-fourths of the dorsal border of the ulna, in common with the Flexor and Extensor carpi ulnaris; and from the ulnar half of the interosseous membrane. The muscle ends in four tendons which run under the transverse carpal ligament dorsal to the tendons of the Flexor digitorum sublimis. Opposite the first phalanges the tendons pass through the openings in the tendons of the Flexor digitorum sublimis, and are finally *inserted* into the bases of the last phalanges. The portion of the muscle for the index finger is usually distinct throughout, but the tendons for the middle, ring, and little fingers are connected together by areolar tissue and tendinous slips, as far as the palm of the hand.

Fibrous Sheaths of the Flexor Tendons.—After leaving the palm, the tendons of the Flexores digitorum sublimis and profundus lie in osseo-aponeurotic canals (Fig. 427), formed behind by the phalanges and in front by strong fibrous bands, which arch across the tendons, and are attached on either side to the margins of the phalanges. Opposite the middle of the proximal and second phalanges the bands (digital vaginal ligaments) are very strong, and the fibers are transverse; but opposite the joints they are much thinner, and consist of *annular* and *cruciate* ligamentous fibers. Each canal contains a mucous sheath, which is reflected on the contained tendons.

Within each canal the tendons of the Flexores digitorum sublimis and profundus are connected to each other, and to the phalanges, by slender, tendinous bands, called **vincula tendina** (Fig. 416). There are two sets of these; (*a*) the **vincula brevia,** which are two in number in each finger, and consist of triangular bands of fibers, one connecting the tendon of the Flexor digitorum sublimis to the front of the first interphalangeal joint and head of the first phalanx, and the other the tendon of the Flexor digitorum profundus to the front of the second interphalangeal joint and head of the second phalanx; (*b*) the **vincula longa,** which connect the under surfaces of the tendons of the Flexor digitorum profundus to those of the subjacent Flexor sublimis after the tendons of the former have passed through the latter.

Variations.—The index finger portion may arise partly from the upper part of the radius. Slips from the inner head of the Flexor sublimis, medial epicondyle, or the coronoid are found. Connection with the Flexor pollicis longus.

Four small muscles, the Lumbricales, are connected with the tendons of the Flexor profundus in the palm. They will be described with the muscles of the hand (page 464).

The **Flexor pollicis longus** is situated on the radial side of the forearm, lying in the same plane as the preceding. It *arises* from the grooved volar surface of the body of the radius, extending from immediately below the tuberosity and oblique line to within a short distance of the Pronator quadratus. It *arises* also from the adjacent part of the interosseous membrane, and generally by a fleshy slip from the medial border of the coronoid process, or from the medial epicondyle of the humerus. The fibers end in a flattened tendon, which passes beneath the transverse carpal ligament, is then lodged between the lateral head of the Flexor pollicis brevis and the oblique part of the Adductor pollicis, and, entering an osseoaponeurotic canal similar to those for the Flexor tendons of the fingers, is *inserted* into the base of the distal phalanx of the thumb. The volar interosseous nerve and vessels pass downward on the front of the interosseous membrane between the Flexor pollicis longus and Flexor digitorum profundus.

Variations.—Slips may connect with Flexor sublimis, or Profundus, or Pronator teres. An additional tendon to the index finger is sometimes found.

The **Pronator quadratus** is a small, flat, quadrilateral muscle, extending across the front of the lower parts of the radius and ulna. It *arises* from the pronator ridge on the lower part of the volar surface of the body of the ulna; from the medial part of the volar surface of the lower fourth of the ulna; and from a strong aponeurosis which covers the medial third of the muscle. The fibers pass lateralward and slightly downward, to be inserted into the lower fourth of the lateral border and the volar surface of the body of the radius. The deeper fibers of the muscle are inserted into the triangular area above the ulnar notch of the radius—an attachment comparable with the origin of the Supinator from the triangular area below the radial notch of the ulna.

Variations.—Rarely absent; split into two or three layers; increased attachment upward or downward.

Nerves.—All the muscles of the superficial layer are supplied by the median nerve, excepting the Flexor carpi ulnaris, which is supplied by the ulnar. The Pronator teres, the Flexor carpi radialis, and the Palmaris longus derive their supply primarily from the sixth cervical nerve; the Flexor digitorum sublimis from the seventh and eighth cervical and first thoracic nerves, and the Flexor carpi ulnaris from the eighth cervical and first thoracic. Of the deep layer, the Flexor digitorum profundus is supplied by the eighth cervical and first thoracic through the ulnar, and the volar interosseous branch of the median. The Flexor pollicis longus and Pronator quadratus are supplied by the eighth cervical and first thoracic through the volar interosseous branch of the median.

Actions.—These muscles act upon the forearm, the wrist, and hand. The Pronator teres rotates the radius upon the ulna, rendering the hand prone; when the radius is fixed, it assists in flexing the forearm. The Flexor carpi radialis is a flexor and abductor of the wrist; it also assists in pronating the hand, and in bending the elbow. The Flexor carpi ulnaris is a flexor and adductor of the wrist; it also assists in bending the elbow. The Palmaris longus is a flexor of the wrist-joint; it also assists in flexing the elbow. The Flexor digitorum sublimis flexes first the middle and then the proximal phalanges; it also assists in flexing the wrist and elbow. The Flexor digitorum profundus is one of the flexors of the phalanges. After the Flexor sublimis has bent the second phalanx, the Flexor profundus flexes the terminal one; but it cannot do so until after the contraction of the superficial muscle. It also assists in flexing the wrist. The Flexor pollicis longus is a flexor of the phalanges of the thumb; when the thumb is fixed, it assists in flexing the wrist. The Pronator quadratus rotates the radius upon the ulna, rendering the hand prone.

The Dorsal Antibrachial Muscles—These muscles are divided for convenience of description into two groups, superficial and deep.

The Superficial Group (Fig. 418).

Brachioradialis.	Extensor digitorum communis.
Extensor carpi radialis longus.	Extensor digiti quinti proprius.

Extensor carpi radialis brevis. Anconæus.	Extensor carpi ulnaris.

The **Brachioradialis** (*Supinator longus*) is the most superficial muscle on the radial side of the forearm. It *arises* from the upper two-thirds of the lateral supracondylar ridge of the humerus, and from the lateral intermuscular septum, being limited above by the groove for the radial nerve. Interposed between it and the Brachialis are the radial nerve and the anastomosis between the anterior branch of the profunda artery and the radial recurrent. The fibers end above the middle of the forearm in a flat tendon, which is *inserted* into the lateral side of the base of the styloid process of the radius. The tendon is crossed near its insertion by the tendons of the Abductor pollicis longus and Extensor pollicis brevis; on its ulnar side is the radial artery.

Variations.—Fusion with the Brachialis; tendon of insertion may be divided into two or three slips; insertion partial or complete into the middle of the radius, fasciculi to the tendon of the Biceps, the tuberosity or oblique line of the radius; slips to the Extensor carpi radialis longus or Abductor pollicis longus; absence; rarely doubled.

The **Extensor carpi radialis longus** (*Extensor carpi radialis longior*) is placed partly beneath the Brachioradialis. It *arises* from the lower third of the lateral supracondylar ridge of the humerus, from the lateral intermuscular septum, and by a few fibers from the common tendon of origin of the Extensor muscles of the forearm. The fibers end at the upper third of the forearm in a flat tendon, which runs along the lateral border of the radius, beneath the Abductor pollicis longus and Extensor pollicis brevis; it then passes beneath the dorsal carpal ligament, where it lies in a groove on the back of the radius common to it and the Extensor carpi radialis brevis, immediately behind the styloid process. It is *inserted* into the dorsal surface of the base of the second metacarpal bone, on its radial side.

The **Extensor carpi radialis brevis** (*Extensor carpi radialis brevior*) is shorter and thicker than the preceding muscle, beneath which it is placed. It *arises* from the lateral epicondyle of the humerus, by a tendon common to it and the three following muscles; from the radial collateral ligament of the elbow-joint; from a strong aponeurosis which covers its surface; and from the intermuscular septa between it and the adjacent muscles. The fibers end about the middle of the forearm in a flat tendon, which is closely connected with that of the preceding muscle, and accompanies it to the wrist; it passes beneath the Abductor pollicis longus and Extensor pollicis brevis, then beneath the dorsal carpal ligament, and is *inserted* into the dorsal surface of the base of the third metacarpal bone on its radial side. Under the dorsal carpal ligament the tendon lies on the back of the radius in a shallow groove, to the ulnar side of that which lodges the tendon of the Extensor carpi radialis, longus, and separated from it by a faint ridge.

The tendons of the two preceding muscles pass through the same compartment of the dorsal carpal ligament in a single mucous sheath.

Variations.—Either muscle may split into two or three tendons of insertion to the second and third or even the fourth metacarpal. The two muscles may unite into a single belly with two tendons. Cross slips between the two muscles may occur. The *Extensor carpi radialis intermedius* rarely arises as a distinct muscle from the humerus, but is not uncommon as an accessory slip from one or both muscles to the second or third or both metacarpals. The *Extensor carpi radialis accessorius* is occasionally found arising from the humerus with or below the Extensor carpi radialis longus and inserted into the first metacarpal, the Abductor pollicis brevis, the First dorsal interosseous, or elsewhere.

The **Extensor digitorum communis** *arises* from the lateral epicondyle of the humerus, by the common tendon; from the intermuscular septa between it and the adjacent muscles, and from the antibrachial fascia. It divides below into four tendons, which pass, together with that of the Extensor indicis proprius, through a separate compartment of the dorsal carpal ligament, within a mucous sheath. The tendons then diverge on the back of the hand, and are *inserted* into the second and third phalanges of the fingers in the following manner. Opposite the metacarpophalangeal articulation each tendon is bound by fasciculi to the collateral ligaments and serves as the dorsal ligament of this joint; after having crossed the joint, it spreads out into a broad aponeurosis, which covers the dorsal surface of the first phalanx and is reinforced, in this situation, by the tendons of the Interossei and Lumbricalis. Opposite the first interphalangeal joint this aponeurosis divides into three slips; an intermediate and two collateral: the former is inserted into the base of the second phalanx; and the two collateral, which are continued onward along the sides of the second phalanx, unite by their contiguous margins, and are *inserted* into the dorsal surface of the last phalanx. As the tendons cross the interphalangeal joints, they furnish them with dorsal ligaments. The tendon to the index finger is accompanied by the Extensor indicis proprius, which lies on its ulnar side. On the back of the hand, the tendons to the middle, ring, and little fingers are connected by two obliquely placed bands, one from the third tendon passing downward and lateralward to the second tendon, and the other passing from the same tendon downward and medialward to the fourth. Occasionally the first tendon is connected to the second by a thin transverse band.

Variations.—An increase or decrease in the number of tendons is common; an additional slip to the thumb is sometimes present.

The **Extensor digiti quinti proprius** (*Extensor minimi digiti*) is a slender muscle placed on the medial side of the Extensor digitorum communis, with which it is generally connected. It *arises* from the common Extensor tendon by a thin tendinous slip, from the intermuscular septa between it and the adjacent muscles. Its tendon runs through a compartment of the dorsal carpal ligament behind the distal radio-ulnar joint, then divides into two as it crosses the hand, and finally joins the expansion of the Extensor digitorum communis tendon on the dorsum of the first phalanx of the little finger.

Variations.—An additional fibrous slip from the lateral epicondyle; the tendon of insertion may not divide or may send a slip to the ring finger.

Absence of muscle rare; fusion of the belly with the Extensor digitorum communis not uncommon.

The **Extensor carpi ulnaris** lies on the ulnar side of the forearm. It *arises* from the lateral epicondyle of the humerus, by the common tendon; by an aponeurosis from the dorsal border of the ulna in common with the Flexor carpi ulnaris and the Flexor digitorum profundus; and from the deep fascia of the forearm. It ends in a tendon, which runs in a groove between the head and the styloid process of the ulna, passing through a separate compartment of the dorsal carpal ligament, and is *inserted* into the prominent tubercle on the ulnar side of the base of the fifth metacarpal bone.

Variations.—Doubling; reduction to tendinous band; insertion partially into fourth metacarpal. In many cases (52 per cent.) a slip is continued from the insertion of the tendon anteriorly over the Opponens digiti quinti, to the fascia covering that muscle, the metacarpal bone, the capsule of the metacarpophalangeal articulation, or the first phalanx of the little finger. This slip may be replaced by a muscular fasciculus arising from or near the pisiform.

The **Anconæus** is a small triangular muscle which is placed on the back of the elbow-joint, and appears to be a continuation of the Triceps brachii. It *arises* by a separate tendon from the back part of the lateral epicondyle of the humerus; its fibers diverge and are *inserted* into the side of the olecranon, and upper fourth of the dorsal surface of the body of the ulna.

The **Supinator** (*Supinator brevis*) (Fig. 420) is a broad muscle, curved around the upper third of the radius. It consists of two planes of fibers, between which the deep branch of the radial nerve lies. The two planes *arise* in common—the superficial one by tendinous and the deeper by muscular fibers—from the lateral epicondyle of the humerus; from the radial collateral ligament of the elbow-joint, and the annular ligament; from the ridge on the ulna, which runs obliquely downward from the dorsal end of the radial notch; from the triangular depression below the notch; and from a tendinous expansion which covers the surface of the muscle. The superficial fibers surround the upper part of the radius, and are inserted into the lateral edge of the radial tuberosity and the oblique line of the radius, as low down as the insertion of the Pronator teres. The upper fibers of the deeper plane form a sling-like fasciculus, which encircles the neck of the radius above the tuberosity and is attached to the back part of its medial surface; the greater part of this portion of the muscle is inserted into the dorsal and lateral surfaces of the body of the radius, midway between the oblique line and the head of the bone.

The **Abductor pollicis longus** (*Extensor oss. metacarpi pollicis*) lies immediately below the Supinator and is sometimes united with it. It *arises* from the lateral part of the dorsal surface of the body of the ulna below the insertion of the Anconæus, from the interosseous membrane, and from the middle third of the dorsal surface of the body of the radius. Passing obliquely downward and lateralward, it ends in a tendon, which runs through a groove on the lateral side of the lower end of the radius, accompanied by the tendon of the Extensor pollicis brevis, and is *inserted* into the radial side of the base of the first metacarpal bone. It occasionally gives off two slips near its insertion: one to the greater multangular bone and the other to blend with the origin of the Abductor pollicis brevis.

Variations.—More or less doubling of muscle and tendon with insertion of the extra tendon into the first metacarpal, the greater multangular, or into the Abductor pollicis brevis or Opponens pollicis.

The **Extensor pollicis brevis** (*Extensor primi internodii pollicis*) lies on the medial side of, and is closely connected with, the Abductor pollicis longus. It *arises* from the dorsal surface of the body of the radius below that muscle, and from the interosseous membrane. Its direction is similar to that of the Abductor pollicis longus, its tendon passing the same groove on the lateral side of the lower end of the radius, to be *inserted* into the base of the first phalanx of the thumb.

Variations.—Absence; fusion of tendon with that of the Extensor pollicis longus.

The **Extensor pollicis longus** (*Extensor secundi internodii pollicis*) is much larger than the preceding muscle, the origin of which it partly covers. It *arises* from the lateral part of the middle third of the dorsal surface of the body of the ulna below the origin of the Abductor pollicis longus, and from the interosseous membrane. It ends in a tendon, which passes through a separate compartment in the dorsal carpal ligament, lying in a narrow, oblique groove on the back of the lower end of the radius. It then crosses obliquely the tendons of the Extensores carpi radialis longus and brevis, and is separated from the Extensor brevis pollicis by a triangular interval, in which the radial artery is found; and is finally *inserted* into the base of the last phalanx of the thumb. The radial artery is crossed by the tendons of the Abductor pollicis longus and of the Extensores pollicis longus and brevis.

The **Extensor indicis proprius** (*Extensor indicis*) is a narrow, elongated muscle, placed medial to, and parallel with, the preceding. It *arises*, from the dorsal surface of the body of the ulna below the origin of the Extensor pollicis longus, and from the interosseous membrane. Its tendon passes under the dorsal carpal ligament in the same compartment as that which transmits the tendons of the Extensor digitorum communis, and opposite the head of the second metacarpal bone, joins the ulnar side of the tendon of the Extensor digitorum communis which belongs to the index finger.

Variations.—Doubling; the ulnar part may pass beneath the dorsal carpal ligament with the Extensor digitorum communis; a slip from the tendon may pass to the index finger.

Nerves.—The Brachioradialis is supplied by the fifth and sixth, the Extensores carpi radialis longus and brevis by the sixth and seventh, and the Anconæus by the seventh and eighth cervical nerves, through the radial nerve; the remaining muscles are innervated through the deep radial nerve, the Supinator being supplied by the sixth, and all the other muscles by the

seventh cervical.
Actions.—The muscles of the lateral and dorsal aspects of the forearm, which comprise all the Extensor muscles and the Supinator, act upon the forearm, wrist, and hand; they are the direct antagonists of the Pronator and Flexor muscles. The Anconæus assists the Triceps in extending the forearm. The Brachioradialis is a flexor of the elbow-joint, but only acts as such when the movement of flexion has been initiated by the Biceps brachii and Brachialis. The action of the Supinator is suggested by its name; it assists the Biceps in bringing the hand into the supine position. The Extensor carpi radialis longus extends the wrist and abducts the hand. It may also assist in bending the elbow-joint; at all events it serves to fix or steady this articulation. The Extensor carpi radialis brevis extends the wrist, and may also act slightly as an abductor of the hand. The Extensor carpi ulnaris extends the wrist, but when acting alone inclines the hand toward the ulnar side; by its continued action it extends the elbow-joint. The Extensor digitorum communis extends the phalanges, then the wrist, and finally the elbow. It acts principally on the proximal phalanges, the middle and terminal phalanges being extended mainly by the Interossei and Lumbricales. It tends to separate the fingers as it extends them. The Extensor digiti quinti proprius extends the little finger, and by its continued action assists in extending the wrist. It is owing to this muscle that the little finger can be extended or pointed while the others are flexed. The chief action of the Abductor pollicis longus is to carry the thumb laterally from the palm of the hand. By its continued action it helps to extend and abduct the wrist. The Extensor pollicis brevis extends the proximal phalanx, and the Extensor pollicis longus the terminal phalanx of the thumb; by their continued action they help to extend and abduct the wrist. The Extensor indicis proprius extends the index finger, and by its continued action assists in extending the wrist

The Muscles and Fasciæ of the Hand

The muscles of the hand are subdivided into three groups: (1) those of the thumb, which occupy the radial side and produce the **thenar eminence;** (2) those of the little finger, which occupy the ulnar side and give rise to the **hypothenar eminence;** (3) those in the middle of the palm and between the metacarpal bones.

Volar Carpal Ligament (*ligamentum carpi volare*).—The volar carpal ligament is the thickened band of antibrachial fascia which extends from the radius to the ulna over the Flexor tendons as they enter the wrist.

Transverse Carpal Ligament (*ligamentum carpi transversum; anterior annular ligament*) (Figs. 421, 422).—**The transverse carpal ligament is a strong, fibrous band, which arches over the carpus, converting the deep groove on the front of the carpal bones into a tunnel, through which the Flexor tendons of the digits and the median nerve pass. It is attached, medially, to the pisiform and the hamulus of the hamate bone; laterally, to the tuberosity of the navicular, and to the medial part of the volar surface and the ridge of the greater**

multangular. It is continuous, above, with the volar carpal ligament; and below, with the palmar aponeurosis. It is crossed by the ulnar vessels and nerve, and the cutaneous branches of the median and ulnar nerves. At its lateral end is the tendon of theFlexor carpi radialis, which lies in the groove on the greater multangular between the attachments of the ligament to the bone. On its volar surface the tendons of the Palmaris longus and Flexor carpi ulnaris are partly *inserted;* below, it gives origin to the short muscles of the thumb and little finger

The Mucous Sheaths of the Tendons on the Front of the Wrist.**—Two sheaths envelop the tendons as they pass beneath the transverse carpal ligament, one for the Flexores digitorum sublimis and profundus, the other for the Flexor pollicis longus (Fig. 423). They extend into the forearm for about 2.5 cm. above the transverse carpal ligament, and occasionally communicate with each other under the ligament. The sheath which surrounds the Flexores digitorum extends downward about half-way along the metacarpal bones, where it ends in blind diverticula around the tendons to the index, middle, and ring fingers. It is prolonged on the tendons to the little finger and usually communicates with the mucous sheath of these tendons. The sheath of the tendon of the Flexor pollicis longus is continued along the thumb as far as the insertion of the tendon. The mucous sheaths enveloping the terminal parts of the tendons of the Flexores digitorum have been described on page 449.**

Dorsal Carpal Ligament (*ligamentum carpi dorsale; posterior annular ligament*) (Figs. 421, 422).**—The dorsal carpal ligament is a strong, fibrous band, extending obliquely downward and medialward across the back of the wrist, and consisting of part of the deep fascia of the back of the forearm, strengthened by the addition of some transverse fibers. It is attached, *medially,* to the styloid process of the ulna and to the triangular and pisiform bones; *laterally,* to the lateral margin of the radius; and, in its passage across the wrist, to the ridges on the dorsal surface of the radius.**

The Mucous Sheaths of the Tendons on the Back of the Wrist.**—Between the dorsal carpal ligament and the bones six compartments are formed for the passage of tendons, each compartment having a separate mucous sheath. One is found in each of the following positions (Fig. 424): (1) on the lateral side of the styloid process, for the tendons of the Abductor pollicis longus and Extensor pollicis brevis; (2) behind the styloid process, for the tendons of the Extensores carpi radialis longus and brevis; (3) about the middle of the dorsal surface of the radius, for the tendon of the Extensor pollicis longus; (4) to the medial side of the latter, for the tendons of the Extensor digitorum communis and Extensor indicis proprius; (5) opposite the interval between the radius and ulna, for the Extensor digiti quinti proprius; (6) between the head and styloid process of the ulna, for the tendon of the Extensor carpi ulnaris. The sheaths lining these compartments extends from above the dorsal carpal ligament; those for the tendons of Abductor pollicis longus, Extensor brevis pollicis, Extensores carpi radialis, and Extensor carpi ulnaris stop immediately proximal to the bases of the metacarpal bones, while the sheaths for Extensor communis digitorum, Extensor indicis proprius, and Extensor digiti quinti proprius are prolonged to the junction of the proximal and intermediate thirds of the metacarpus**

Palmar Aponeurosis (*aponeurosis palmaris; palmar fascia*) (Fig. 425).— The palmar aponeurosis invests the muscles of the palm, and consists of central, lateral, and medial portions.

The **central portion** occupies the middle of the palm, is triangular in shape, and of great strength and thickness. Its apex is continuous with the lower margin of the transverse carpal ligament, and receives the expanded tendon of the Palmaris longus. Its base divides below into four slips, one for each finger. Each slip gives off superficial fibers to the skin of the palm and finger, those to the palm joining the skin at the furrow corresponding to the metacarpophalangeal articulations, and those to the fingers passing into the skin at the transverse fold at the bases of the fingers. The deeper part of each slip subdivides into two processes, which are inserted into the fibrous sheaths of the Flexor tendons. From the sides of these processes offsets are attached to the transverse metacarpal ligament. By this arrangement short channels are formed on the front of the heads of the metacarpal bones; through these the Flexor tendons pass. The intervals between the four slips transmit the digital vessels and nerves, and the tendons of the Lumbricales. At the points of division into the slips mentioned, numerous strong, transverse fasciculi bind the separate processes together. The central part of the palmar aponeurosis is intimately bound to the integument by dense fibroareolar tissue forming the superficial palmar fascia, and gives origin by its medial margin to the Palmaris brevis. It covers the superficial volar arch, the tendons of the Flexor muscles, and the branches of the median and ulnar nerves; and on either side it gives off a septum, which is continuous with the interosseous aponeurosis, and separates the intermediate from the collateral groups of muscles.

The **lateral** and **medial portions** of the palmar aponeurosis are thin, fibrous layers, which cover, on the radial side, the muscles of the ball of the thumb, and, on the ulnar side, the muscles of the little finger; they are continuous with the central portion and with the fascia on the dorsum of the hand.

The **Superficial Transverse Ligament of the Fingers** is a thin band of transverse fasciculi (Fig. 425); it stretches across the roots of the four fingers, and is closely attached to the skin of the clefts, and medially to the fifth metacarpal bone, forming a sort of rudimentary web. Beneath it the digital vessels and nerves pass to their destinations.

The **Abductor pollicis brevis** (*Abductor pollicis*) is a thin, flat muscle, placed immediately beneath the integument. It *arises* from the transverse carpal ligament, the tuberosity of the navicular, and the ridge of the greater multangular, frequently by two distinct slips. Running lateralward and downward, it is *inserted* by a thin, flat tendon into the radial side of the base of the first phalanx of the thumb and the capsule of the metacarpophalangeal articulation.

The **Opponens pollicis** is a small, triangular muscle, placed beneath the preceding. It *arises* from the ridge on the greater multangular and from the transverse carpal ligament, passes downward and lateralward, and is *inserted* into the whole length of the metacarpal bone of the thumb on its radial side.

The **Flexor pollicis brevis** consists of two portions, lateral and medial. The **lateral** and more **superficial portion** *arises* from the lower border of the transverse carpal ligament and the lower part of the ridge on the greater multangular bone; it passes along the radial side of the tendon of the Flexor pollicis longus, and, becoming tendinous, is *inserted* into the radial side of the base of the first phalanx of the thumb; in its tendon of insertion there is a sesamoid bone. The **medial** and **deeper portion** of the muscle is very small, and *arises* from the ulnar side of the first metacarpal bone between the Adductor pollicis (obliquus) and the lateral head of the first Interosseous dorsalis, and is *inserted* into the ulnar side of the base of the first phalanx with the Adductor pollicis (obliquus). The medial part of the Flexor brevis pollicis is sometimes described as the **first Interosseous volaris.**

The **Adductor pollicis** (**obliquus**) (*Adductor obliquus pollicis*) *arises* by several slips from the capitate bone, the bases of the second and third metacarpals, the intercarpal ligaments, and the sheath of the tendon of the Flexor carpi radialis. From this origin the greater number of fibers pass obliquely downward and converge to a tendon, which, uniting with the tendons of the medial portion of the Flexor pollicis brevis and the transverse part of the Adductor, is *inserted* into the ulnar side of the base of the first phalanx of the thumb, a sesamoid bone being present in the tendon. A considerable fasciculus, however, passes more obliquely beneath the tendon of the Flexor pollicis longus to join the lateral portion of the Flexor brevis and the Abductor pollicis brevis.

The **Adductor pollicis** (**transversus**) (*Adductor transversus pollicis*) (Fig. 426) is the most deeply seated of this group of muscles. It is of a triangular form arising by a broad base from the lower two-thirds of the volar surface of the third metacarpal bone; the fibers converge, to be *inserted* with the medial part of the Flexor pollicis brevis and the Adductor pollicis (obliquus) into the ulnar side of the base of the first phalanx of the thumb.

Variations.—The Abductor pollicis brevis is often divided into an outer and an inner part; accessory slips from the tendon of the Abductor pollicis longus or Palmaris longus, more rarely from the Extensor carpi radialis longus, from the styloid process or Opponens pollicis or from the skin over the thenar eminence. The deep head of the Flexor pollicis brevis may be absent or enlarged. The two adductors vary in their relative extent and in the closeness of their connection. The Adductor obliquus may receive a slip from the transverse metacarpal ligament.

Nerves.—The Abductor brevis, Opponens, and lateral head of the Flexor pollicis brevis are supplied by the sixth and seventh cervical nerves through the median nerve; the medial head of the Flexor brevis, and the Adductor, by the eighth cervical through the ulnar nerve.

Actions.—The Abductor pollicis brevis draws the thumb forward in a plane at right angles to that of the palm of the hand. The Adductor pollicis is the opponent of this muscle, and approximates the thumb to the palm. The Opponens pollicis flexes the metacarpal bone, *i. e.,* draws it medialward over the palm; the Flexor pollicis brevis flexes and adducts the proximal phalanx.

The Medial Volar Muscles (Figs. 426, 427)

Palmaris brevis.	Flexor digiti quinti brevis.
Abductor digiti quinti.	Opponens digiti quinti.

The **Palmaris brevis** is a thin, quadrilateral muscle, placed beneath the integument of the ulnar side of the hand. It *arises* by tendinous fasciculi from the transverse carpal ligament and palmar aponeurosis; the fleshy fibers are inserted into the skin on the ulnar border of the palm of the hand.

The **Abductor digiti quinti** (*Abductor minimi digiti*) is situated on the ulnar border of the palm of the hand. It *arises* from the pisiform bone and from the tendon of the Flexor carpi ulnaris, and ends in a flat tendon, which divides into two slips; one is *inserted* into the ulnar side of the base of the first phalanx of the little finger; the other into the ulnar border of the aponeurosis of the Extensor digiti quinti proprius.

The **Flexor digiti quinti brevis** (*Flexor brevis minimi digiti*) lies on the same plane as the preceding muscle, on its radial side. It *arises* from the convex surface of the hamulus of the hamate bone, and the volar surface of the transverse carpal ligament, and is *inserted* into the ulnar side of the base of the first phalanx of the little finger. It is separated from the Abductor, at its origin, by the deep branches of the ulnar artery and nerve. This muscle is sometimes wanting; the Abductor is then, usually, of large size.

The **Opponens digiti quinti** (*Opponens minimi digiti*) (Fig. 426) is of a triangular form, and placed immediately beneath the preceding muscles. It *arises* from the convexity of the hamulus of the hamate bone, and contiguous portion of the transverse carpal ligament; it is inserted into the whole length of the metacarpal bone of the little finger, along its ulnar margin.

Variations.—The Palmaris brevis varies greatly in size. The Abductor digiti quinti may be divided into two or three slips or united with the Flexor digiti quinti brevis. Accessory head from the tendon of the Flexor carpi ulnaris, the transverse carpal ligament, the fascia of the forearm or the tendon of the Palmaris longus. A portion of the muscle may insert into the metacarpal, or separate slips the *Pisimetacarpus*, *Pisiuncinatus* or the *Pisiannularis* muscle may exist.

Nerves.—All the muscles of this group are supplied by the eighth cervical nerve through the ulnar nerve.

Actions.—The Abductor and Flexor digiti quinti brevis abduct the little finger from the ring finger and assist in flexing the proximal phalanx. The Opponens digiti quinti draws forward the fifth metacarpal bone, so as to deepen the hollow of the palm. The Palmaris brevis corrugates the skin on the ulnar side of the palm.

3. The Intermediate Muscles

Lumbricales. Interossei.

The **Lumbricales** (Fig. 427) are four small fleshy fasciculi, associated with the tendons of the Flexor digitorum profundus. The first and second *arise* from the radial sides and volar surfaces of the tendons of the index and middle fingers respectively; the third, from the contiguous sides of the tendons of the middle and ring fingers; and the fourth, from the contiguous sides of the tendons of the ring and little fingers. Each passes to the radial side of the corresponding finger, and opposite the metacarpophalangeal articulation is *inserted* into the tendinous expansion of the Extensor digitorum communis covering the dorsal aspect of the finger.

Variations.—The Lumbricales vary in number from two to five or six and there is considerable variation in insertions.

The **Interossei** (Figs. 428, 429) are so named from occupying the intervals between the metacarpal bones, and are divided into two sets, a dorsal and a volar.

The **Interossei dorsales** (*Dorsal interossei*) are *four* in number, and occupy the intervals between the metacarpal bones. They are bipenniform muscles, each *arising* by two heads from the adjacent sides of the metacarpal bones, but more extensively from the metacarpal bone of the finger into which the muscle is inserted. They are inserted into the bases of the first phalanges and into the aponeuroses of the tendons of the Extensor digitorum communis. Between the double origin of each of these muscles is a narrow triangular interval; through the first of these the radial artery passes; through each of the other three a perforating branch from the deep volar arch is transmitted.

The **first** or **Abductor indicis** is larger than the others. It is flat, triangular in form, and *arises* by two heads, separated by a fibrous arch for the passage of the radial artery from the dorsum to the palm of the hand. The lateral head *arises* from the proximal half of the ulnar border of the first metacarpal bone; the medial head, from almost the entire length of the radial border of the second metacarpal bone; the tendon is inserted into the radial side of the index finger. The **second** and **third** are inserted into the middle finger, the former into its radial, the latter into its ulnar side. The **fourth** is inserted into the ulnar side of the ring finger.

The **Interossei volares** (*Palmar interossei*), three in number, are smaller than the Interossei dorsales, and placed upon the volar surfaces of the metacarpal bones, rather than between them. Each *arises* from the entire length of the metacarpal bone of one finger, and is *inserted* into the side of the base of the first phalanx and aponeurotic expansion of the Extensor communis tendon to the same finger.

The **first** *arises* from the ulnar side of the second metacarpal bone, and is *inserted* into the same side of the first phalanx of the index finger. The **second** *arises* from the radial side of the fourth metacarpal bone, and is *inserted* into the same side of the ring finger. The **third** *arises* from the radial side of the fifth metacarpal bone, and is *inserted* into the same side of the little finger. From this account it may be seen that each finger is provided with two Interossei, with the exception of the little finger, in which the Abductor takes the place of one of the pair.

As already mentioned (p. 461), the medial head of the Flexor pollicis brevis is sometimes described as the **Interosseus volaris primus.**

Nerves.—The two lateral Lumbricales are supplied by the sixth and seventh cervical nerves, through the third and fourth digital branches of the median nerve; the two medial Lumbricales and all the Interossei are supplied by the eighth cervical nerve, through the deep palmar branch of the ulnar nerve.

The third Lumbricalis frequently receives a twig from the median.

Actions.—The Interossei volares adduct the fingers to an imaginary line drawn longitudinally through the center of the middle finger; and the Interossei dorsales abduct the fingers from that line. In addition to this the Interossei, in conjunction with the Lumbricales, flex the first phalanges at the metacarpophalangeal joints, and extend the second and third phalanges in consequence of their insertions into the expansions of the Extensor tendons. The Extensor digitorum communis is believed to act almost entirely on the first phalanges.

Practical lesson № 1
Theme: A general overview of the abdominal cavity. Stomach. Thin and large intestine.

Teaching technology of practical lesson

Class time - 3 hours	Number of students: 20-24
Form of lesson	Practical lesson on deepening, expansion and practical implementation of knowledge.
The plan of practical lesson	• Stomach: structure, topography, functions, the structure of the wall. • Age-specific stomach. • Intestine. Duodenum: parts, topography, structure of wall. • Colon. Parts: cecum, ascending, descending, rectum.
The purpose of the lesson: Explain to the students general information on build and topography of the stomach, small intestine, duodenum, colon.	
Method and technique of teaching	Interactive methods and multimedia
Form of training	Deepening and expanding knowledge. Individual and group training.
Means of education	Lecture material, textbook, tables, computer-multimedia textbooks, atlases.
Teaching conditions	The audience is equipped with the theme (models of the digestive system, wet preparations).
Monitoring and control	1. Describe the structure and parts of the stomach. 2.The structure of the stomach wall. 3.Which part is divided into the small intestine? 4.Which part is divided into the large intestine? 5.What distinguishes the small intestine from the large intestine? 6.What part is the wall of the intestine and colon?

Technological map of practical lesson

Stages, time	Teacher	Students
Preparatory stage (10 minutes)	1. Controls the purity of the audience. 2.Check the readiness of students to study. 3. Controls the attendance of students.	Preparation of training tools. Listen, write
Stage 1 Introduction (20 minutes)	1.1. Announces the topic, the purpose of the lesson is to plan the learning outcomes, justify their significance and relevance. Informs that the classes will be held using joint technologies 1.2. Using the interactive method "Brainstorming" checks the readiness of the audience: A general overview of the abdominal cavity. Stomach. Thin and large intestine.	1.1. Writes a topic and answers questions.
Stage 2 Main part (45 minutes)	2.1. It divides students into 3 subgroups and gives each a separate task. Recalls the expected learning outcomes. 2.2. Familiar with the rules of work in small groups and the criteria for their evaluation. 2.3. Recalls the possible use of educational materials (lecture material, teaching aid) in the performance of assignments. It suggests starting work in small groups. 2.4. After preparation, the beginning of practical work is announced. Students choose the bones they need 2.5. Students pay attention and clarify the conclusion about the structure of bones and their individual characteristics.	2.1. Show the educational results. 2.2. Ask questions. 2.3. Supplement the answers.
Stage 3 Main part (45 min.)	3.1. Responds to questions and corrects answers given by students. Gives a total score of three subgroups.	3.1. Complete the table and participate in the discussion.
Stage 4 Final (15 minutes)	4.1. Finishes the lesson,evaluates students and encourages active participants.	4.1. Listen.

	4.2. Gives the task to write an independent work on the topic: “Postnatal development of organs of the digestive system. The impact of environmental factors on the development of the teeth and the digestive organs”. 4.3.To draw in the albums artwork to the appropriate theme.	4.2. Take the task.

Theoretical part:

The **stomach** is the most dilated part of the digestive tube, and is situated between the end of the esophagus and the beginning of the small intestine. It lies in the epigastric, umbilical, and left hypochondriac regions of the abdomen, and occupies a recess bounded by the upper abdominal viscera, and completed in front and on the left side by the anterior abdominal wall and the diaphragm.

The **shape and position** of the stomach are so greatly modified by changes within itself and in the surrounding viscera that no one form can be described as typical. The chief modifications are determined by (1) the amount of the stomach contents, (2) the stage which the digestive process has reached, (3) the degree of development of the gastric musculature, and (4) the condition of the adjacent intestines. It is, however, possible by comparing a series of stomachs to determine certain markings more or less common to all.

The stomach presents two **openings,** two **borders** or **curvatures,**and two **surfaces.**

Openings.—The opening by which the esophagus communicates with the stomach is known as the **cardiac orifice,** and is situated on the left of the middle line at the level of the tenth thoracic vertebra. The short abdominal portion of the esophagus (*antrum cardiacum*) is conical in shape and curved sharply to the left, the base of the cone being continuous with the cardiac orifice of the stomach. The right margin of the esophagus is continuous with the lesser curvature of the stomach, while the left margin joins the greater curvature at an acute angle, termed the **incisura cardiaca.**

The **pyloric orifice** communicates with the duodenum, and its position is usually indicated on the surface of the stomach by a circular groove, the **duodenopyloric constriction.** This orifice lies to the right of the middle line at the level of the upper border of the first lumbar vertebra.

Curvatures.—The **lesser curvature** (*curvatura ventriculi minor*), extending between the cardiac and pyloric orifices, forms the right or posterior border of the stomach. It descends as a continuation of the right margin of the esophagus in front of the fibers of the right crus of the diaphragm, and then, turning to the right, it crosses the first lumbar vertebra and ends at the pylorus. Nearer its pyloric than its cardiac end is a well-marked notch, the **incisura angularis,** which varies somewhat in position with the state of distension of the viscus; it serves to separate the stomach into a right and a left portion. The lesser curvature gives attachment to the two layers of the hepatogastric ligament, and between these two layers are the left gastric artery and the right gastric branch of the hepatic artery.

The **greater curvature** (*curvatura ventriculi major*) is directed mainly forward, and is four or five times as long as the lesser curvature. Starting from the cardiac orifice at the incisura cardiaca, it forms an arch backward, upward, and to the left; the highest point of the convexity is on a level with the sixth left costal cartilage. From this level it may be followed downward and forward, with a slight convexity to the left as low as the cartilage of the ninth rib; it then turns to the right, to the end of the pylorus. Directly opposite the incisura angularis of the lesser curvature the greater curvature presents a dilatation, which is the left extremity of the **pyloric part;**this dilatation is limited on the right by a slight groove, the **sulcus intermedius,** which is about 2.5 cm, from the duodenopyloric constriction. The portion between the sulcus intermedius and the duodenopyloric constriction is termed the **pyloric antrum.** At its commencement the greater curvature is covered by peritoneum continuous with that covering the front of the organ. The left part of the curvature gives attachment to the gastrolienal ligament, while to its anterior portion are attached the two layers of the greater omentum, separated from each other by the gastroepiploic vessels.

Surfaces.—When the stomach is in the contracted condition, its surfaces are directed upward and downward respectively, but when the viscus is distended they are directed forward, and backward. They may therefore be described as anterosuperior and postero-inferior.

Antero-superior Surface.—The left half of this surface is in contact with the diaphragm, which separates it from the base of the left lung, the pericardium, and the seventh, eighth, and ninth ribs, and intercostal spaces of the left side. The right half is in relation with the left and quadrate lobes of the liver and with the anterior abdominal wall. When the stomach is empty, the transverse colon may lie on the front part of this surface. The whole surface is covered by peritoneum.

The **Postero-inferior Surface** is in relation with the diaphragm, the spleen, the left suprarenal gland, the upper part of the front of the left kidney, the anterior surface of the pancreas, the left colic flexure, and the upper layer of the transverse mesocolon. These structures form a shallow bed, the **stomach bed,** on which the viscus rests. The transverse mesocolon separates the stomach from the duodenojejunal flexure and small intestine. The postero-inferior surface is covered by peritoneum, except over a small area close to the cardiac orifice; this area is limited by the lines of attachment of the **gastrophrenic ligament,** and lies in apposition with the diaphragm, and frequently with the upper portion of the left suprarenal gland.

Component Parts of the Stomach.—A plane passing through the incisura angularis on the lesser curvature and the left limit of the opposed dilatation on the greater curvature divides the stomach into a left portion or **body** and a right or **pyloric portion.** The left portion of the body is known as the **fundus,** and is marked off from the remainder of the body by a plane passing horizontally through the cardiac orifice. The pyloric portion is divided by a plane through the sulcus intermedius at right angles to the long axis of this portion; the part to the right of this plane is the **pyloric antrum**

If the stomach be examined during the process of digestion it will be found divided by a muscular constriction into a large dilated left portion, and a narrow contracted tubular right portion. The constriction is in the body of the stomach, and does not follow any of the anatomical landmarks; indeed, it shifts gradually toward the left as digestion progresses, *i. e.,* more of the body is gradually absorbed into the tubular part.

Position of the Stomach.—The position of the stomach varies with the posture, with the amount of the stomach contents and with the condition of the intestines on which it rests. In the erect posture the empty stomach is somewhat J-shaped; the part above the cardiac orifice is usually distended with gas; the pylorus descends to the level of the second lumbar vertebra and the most dependent part of the stomach is at the level of the umbilicus. Variation in the amount of its contents affects mainly the cardiac portion, the pyloric portion remaining in a more or less contracted condition during the process of digestion. As the stomach fills it tends to expand forward and downward in the direction of least resistance, but when this is interfered with by a distended condition of the colon or intestines the fundus presses upward on the liver and diaphragm and gives rise to the feelings of oppression and palpitation complained of in such cases. His (*166 and Cunningham (*167 have shown by hardening the viscera *in situ* that the contracted stomach has a sickle shape, the fundus looking directly backward. The surfaces are directed upward and downward, the upper surface having, however, a gradual downward slope to the right. The greater curvature is in front and at a slightly higher level than the lesser.

The position of the full stomach depends, as already indicated, on the state of the intestines; when these are empty the fundus expands vertically and also forward, the pylorus is displaced toward the right and the whole organ assumes an oblique position, so that its surfaces are directed more forward and backward. The lowest part of the stomach is at the pyloric vestibule, which reaches to the region of the umbilicus. Where the intestines interfere with the downward expansion of the fundus the stomach retains the horizontal position which is characteristic of the contracted viscus.

Examination of the stomach during life by *x*-rays has confirmed these findings, and has demonstrated that, in the erect posture, the full stomach usually presents a hook-like appearance, the long axis of the clinical fundus being directed downward, medialward, and forward toward the umbilicus, while the pyloric portion curves upward to the duodenopyloric junction.

Interior of the Stomach.—When examined after death, the stomach is usually fixed at some temporary stage of the digestive process. A common form is that shown in Fig. 1050. If the viscus be laid open by a section through the plane of its two curvatures, it is seen to consist of two segments: (*a*) a large globular portion on the left and (*b*) a narrow tubular part on the right. These correspond to the clinical subdivisions of fundus and pyloric portions already described, and are separated by a constriction which indents the body and greater curvature, but does not involve the lesser curvature. To the left of the cardiac orifice is the incisura cardiaca: the projection of this notch into the cavity of the stomach increases as the organ distends, and has been supposed to act as a valve preventing regurgitation into the esophagus. In the pyloric portion are seen: (*a*) the elevation corresponding to the incisura angularis, and (*b*) the circular projection from the duodenopyloric constriction which forms the pyloric valve; the separation of the pyloric antrum from the rest of the pyloric part is scarcely indicated.

The pyloric valve (valvula pylori) is formed by a reduplication of the mucous membrane of the stomach, covering a muscular ring composed of a thickened portion of the circular layer of the muscular coat. Some of the deeper longitudinal fibers turn in and interlace with the circular fibers of the valve.

Structure.—The wall of the stomach consists of four coats: serous, muscular, areolar, and mucous, together with vessels and nerves.

The serous coat (tunica serosa) is derived from the peritoneum, and covers the entire surface of the organ, excepting along the greater and lesser curvatures at the points of attachment of the greater and lesser omenta; here the two layers of peritoneum leave a small triangular space, along which the nutrient vessels and nerves pass. On the posterior surface of the stomach, close to the cardiac orifice, there is also a small area uncovered by peritoneum, where the organ is in contact with the under surface of the diaphragm.

The muscular coat (tunica muscularis) (Figs. 1051, 1052) is situated immediately beneath the serous covering, with which it is closely connected. It consists of three sets of smooth muscle fibers: longitudinal, circular and oblique.

The longitudinal fibers (stratum longitudinale) are the most superficial, and are arranged in two sets. The first set consists of fibers continuous with the longitudinal fibers of the esophagus; they radiate in a stellate manner from the cardiac orifice and are practically all lost before the pyloric portion is reached. The second set commences on the body of the stomach and passes to the right, its fibers becoming more thickly distributed as they approach the pylorus. Some of the more superficial fibers of this set pass on to the duodenum, but the deeper fibers dip inward and interlace with the circular fibers of the pyloric valve.

The circular fibers (stratum circulare) form a uniform layer over the whole extent of the stomach beneath the longitudinal fibers. At the pylorus they are most abundant, and are aggregated into a circular ring, which projects into the lumen, and forms, with the fold of mucous membrane covering its surface, the pyloric valve. They are continuous with the circular fibers of the esophagus, but are sharply marked off from the circular fibers of the duodenum.

The oblique fibers (fibræ obliquæ) internal to the circular layer, are limited chiefly to the cardiac end of the stomach, where they are disposed as a thick uniform layer, covering both surfaces, some passing obliquely from left to right, others from right to left, around the cardiac end.

The areolar or submucous coat (tela submucosa) consists of a loose, areolar tissue, connecting the mucous and muscular layers.

The mucous membrane (tunica mucosa) is thick and its surface is smooth, soft, and velvety. In the fresh state it is of a pinkish tinge at the pyloric end, and of a red or reddish-brown color over the rest of its surface. In infancy it is of a brighter hue, the vascular redness being more marked. It is thin at the cardiac extremity, but thicker toward the pylorus. During the contracted state of the organ it is thrown into numerous plaits or rugæ, which, for the most part, have a longitudinal direction, and are most marked toward the pyloric end of the stomach, and along the greater curvature (Fig. 1050). These folds are entirely obliterated when the organ becomes distended.

Structure of the Mucous Membrane.—When examined with a lens, the inner surface of the mucous membrane presents a peculiar honeycomb appearance from being covered with small shallow depressions or alveoli, of a polygonal or hexagonal form, which vary from 0.12 to 0.25 mm. in diameter. These are the ducts of the gastric glands, and at the bottom of each may be seen one or more minute orifices, the openings of the gland tubes. The surface of the mucous membrane is covered by a single layer of columnar epithelium with occasional goblet cells. This epithelium commences very abruptly at the cardiac orifice, where there is a sudden transition from the stratified epithelium of the esophagus. The epithelial lining of the gland ducts is of the same character and is continuous with the general epithelial lining of the stomach (Fig. 1055).

The Gastric Glands.—The gastric glands are of three kinds: (a) pyloric, (b) cardiac, and (c) fundus or oxyntic glands. They are tubular in character, and are formed of a delicate basement membrane, consisting of flattened transparent endothelial cells lined by epithelium. The pyloric glands (Fig. 1054) are found in the pyloric portion of the stomach. They consist of two or three short closed tubes opening into a common duct or mouth. These tubes are wavy, and are about one-half the length of the duct. The duct is lined by columnar cells, continuous with the epithelium lining the surface of the mucous membrane of the stomach, the tubes by shorter and more cubical cell which are finely granular. The cardiac glands (Fig. 1053), few in number, occur close to the cardiac orifice. They are of two kinds: (1) simple tubular glands resembling those of the pyloric end of the stomach, but with short ducts; (2) compound racemose glands resembling the duodenal glands. The fundus glands (Fig. 1055) are found in the body and fundus of the stomach; they are simple tubes, two or more of which open into a single duct. The duct, however, in these glands is shorter than in the pyloric variety, sometimes not amounting to more than one-sixth of the whole length of the gland; it is lined throughout by columnar epithelium. The gland tubes are straight and parallel to each other. At the point where they open into the duct, which is termed the neck, the epithelium alters, and consists of short columnar or polyhedral, granular cells, which almost fill the tube, so that the lumen becomes suddenly constricted and is continued down as a very fine channel. They are known as the chief or central cells of the glands. Between these cells and the basement membrane, larger oval cells, which stain deeply with eosin, are found; these cells are studded throughout the tube at intervals, giving it a beaded or varicose appearance. These are known as the parietal or oxyntic cells, and they are connected with the lumen by fine channels which run into their substance. Between the glands the mucous membrane consists of a connective-tissue frame-work, with lymphoid tissue. In places, this later tissue, especially in early life, is collected into little masses, which to a certain extent resemble the solitary nodules of the intestine, and are termed the lenticular glands of the stomach. They are not, however, so distinctly circumscribed as the solitary nodules. Beneath the mucous membrane, and between it and the submucous coat, is a thin stratum of involuntary muscular fiber (muscularis mucosæ), which in some parts consists only of a single longitudinal layer; in others of two layers, an inner circular and an outer longitudinal.

The small intestine is a convoluted tube, extending from the pylorus to the colic valve, where it ends in the large intestine. It is about 7 meters long, (*168 and gradually diminishes in size from its commencement to its termination. It is contained in the central and lower part of the abdominal cavity, and is surrounded above and at the sides by the large intestine; a portion of it extends below the superior aperture of the pelvis and lies in front of the rectum. It is in relation, in front, with the greater omentum and abdominal parietes, and is connected to the vertebral column by a fold of peritoneum, the mesentery. The small intestine is divisible into three portions: the duodenum, the jejunum, and the ileum.

The Duodenum (Fig. 1056) has received its name from being about equal in length to the breadth of twelve fingers (25 cm.). It is the shortest, the widest, and the most fixed part of the small intestine, and has no mesentery, being only partially covered by peritoneum. Its course presents a remarkable curve, somewhat of the shape of an imperfect circle, so that its termination is not far removed from its starting-point.

In the adult the course of the duodenum is as follows: commencing at the pylorus it passes backward, upward, and to the right, beneath the quadrate lobe of the liver to the neck of the gall-bladder, varying slightly in direction according to the degree of distension of the stomach: it then takes a sharp curve and descends along the right margin of the head of the pancreas, for a variable distance, generally to the level of the upper border of the body of the fourth lumbar vertebra. It now takes a second bend, and passes from right to left across the vertebral column, having a slight inclination upward; and on the left side of the vertebral column it ascends for about 2.5 cm., and then ends opposite the second lumbar vertebra in the jejunum. As it unites with the jejunum it turns abruptly forward, forming the duodendojejunal flexure. From the above description it will be seen that the duodenum may be divided into four portions: superior, descending, horizontal, and ascending.

Relations.—The superior portion (pars superior; first portion) is about 5 cm. long. Beginning at the pylorus, it ends at the neck of the gall-bladder. It is the most movable of the four portions. It is almost completely covered by peritoneum, but a small part of its posterior surface near the neck of the gall-bladder and the inferior vena cava is uncovered; the upper border of its first half has the hepatoduodenal ligament attached to it, while to the lower border of the same segment the greater omentum is connected. It is in such close relation with the gall-bladder that it is usually found to be stained by bile after death, especially on its anterior surface. It is in relation above and in front with the quadrate lobe of the liver and the gall-bladder; behind with the gastroduodenal artery, the common bile duct, and the portal vein; and below and behind with the head and neck of the pancreas.

The descending portion (pars descendens; second portion) is from 7 to 10 cm. long, and extends from the neck of the gall-bladder, on a level with the first lumbar vertebra, along the right side of the vertebral column as low as the upper border of the body of the fourth lumbar vertebra. It is crossed in its middle third by the transverse colon, the posterior surface of which is uncovered by peritoneum and is connected to the duodenum by a small quantity of connective tissue. The supra- and infracolic portions are covered in front by peritoneum, the infracolic part by the right leaf of the mesentery. Posteriorly the descending portion of the duodenum is not covered by peritoneum. The descending portion is in relation, in front, from above downward, with the duodenal impression on the right lobe of the liver, the transverse colon, and the small intestine; behind, it has a variable relation to the front of the right kidney in the neighborhood of the hilum, and is connected to it by loose areolar tissue; the renal vessels, the inferior vena cava, and the Psoas below, are also behind it. At its medial side is the head of the pancreas, and the common bile duct; to its lateral side is the right colic flexure. The common bile duct and the pancreatic duct together perforate the medial side of this portion of the intestine obliquely (Figs. 1057 and 1100), some 7 to 10 cm. below the pylorus; the accessory pancreatic duct sometimes pierces it about 2 cm. above and slightly in front of these.

The horizontal portion (pars horizontalis; third or preaortic or transverse portion) is from 5 to 7.5 cm. long. It begins at the right side of the upper border of the fourth lumbar vertebra and passes from right to left, with a slight inclination upward, in front of the great vessels and crura of the diaphragm, and ends in the ascending portion in front of the abdominal aorta. It is crossed by the superior mesenteric vessels and the mesentery. Its front surface is covered by peritoneum, except near the middle line, where it is crossed by the superior mesenteric vessels. Its posterior surface is uncovered by peritoneum, except toward its left extremity, where the posterior layer of the mesentery may sometimes be found covering it to a variable extent. This surface rests upon the right crus of the diaphragm, the inferior vena cava, and the aorta. The upper surface is in relation with the head of the pancreas.

The ascending portion (pars ascendens; fourth portion) of the duodenum is about 2.5 cm long. It ascends on the left side of the aorta, as far as the level of the upper border of the second lumbar vertebra, where it turns abruptly forward to become the jejunum, forming the duodenojejunal flexure. It lies in front of the left Psoas major and left renal vessels, and is covered in front, and partly at the sides, by peritoneum continuous with the left portion of the mesentery.

The superior part of the duodenum, as stated above, is somewhat movable, but the rest is practically fixed, and is bound down to neighboring viscera and the posterior abdominal wall by the peritoneum. In addition to this, the ascending part of the duodenum and the duodenojejunal flexure are fixed by a structure to which the name of Musculus suspensorius duodeni has been given. This structure commences in the connective tissue around the celiac artery and left crus of the diaphragm, and passes downward to be inserted into the superior border of the duodenojejunal curve and a part of the ascending duodenum, and from this it is continued into the mesentery. It possesses, according to Treitz, plain muscular fibers mixed with the fibrous tissue of which it is principally made up. It is of little importance as a muscle, but acts as a suspensory ligament.

Jejunum and Ileum.—The remainder of the small intestine from the end of the duodenum is named jejunum and ileum; the former term being given to the upper two-fifths and the latter to the lower three-fifths. There is no morphological line of distinction between the two, and the division is arbitrary; but at the same time the character of the intestine gradually undergoes a change from the commencement of the jejunum to the end of the ileum, so that a portion of the bowel taken from these two situations would present characteristic and marked differences. These are briefly as follows:

The Jejunum (intestinum jejunum) is wider, its diameter being about 4 cm., and is thicker, more vascular, and of a deeper color than the ileum, so that a given length weighs more. The circular folds (valvulæ conniventes) of its mucous membrane are large and thickly set, and its villi are larger than in the ileum. The aggregated lymph nodules are almost absent in the upper part of the jejunum, and in the lower part are less frequently found than in the ileum, and are smaller and tend to assume a circular form. By grasping the jejunum between the finger and thumb the circular folds can be felt through the walls of the gut; these being absent in the lower part of the ileum, it is possible in this way to distinguish the upper from the lower part of the small intestine.

The **Ileum** (*intestinum ileum*) is narrow, its diameter being 3.75 cm., and its coats thinner and less vascular than those of the jejunum. It possesses but few circular folds, and they are small and disappear entirely toward its lower end, but aggregated lymph nodules (Peyer's patches) are larger and more numerous. The jejunum for the most part occupies the umbilical and left iliac regions, while the ileum occupies chiefly the umbilical, hypogastric, right iliac, and pelvic regions. The terminal part of the ileum usually lies in the pelvis, from which it ascends over the right Psoas and right iliac vessels; it ends in the right iliac fossa by opening into the medial side of the commencement of the large intestine. The jejunum and ileum are attached to the posterior abdominal wall by an extensive fold of peritoneum, the **mesentery,** which allows the freest motion, so that each coil can accommodate itself to changes in form and position. The mesentery is fan-shaped; its posterior border or root, about 15 cm. long, is attached to the posterior abdominal wall from the left side of the body of the second lumbar vertebra to the right sacroiliac articulation, crossing successively the horizontal part of the duodenum, the aorta, the inferior vena cava, the ureter, and right Psoas muscle (Fig. 1040). Its breadth between its vertebral and intestinal borders averages about 20 cm., and is greater in the middle than at its upper and lower ends. According to Lockwood it tends to increase in breadth as age advances. Between the two layers of which it is composed are contained bloodvessels, nerves, lacteals, and lymph glands, together with a variable amount of fat.

Meckel's Diverticulum (*diverticulum ilei*).—This consists of a pouch which projects from the lower part of the ileum in about 2 per cent. of subjects. Its average position is about 1 meter above the colic valve, and its average length about 5 cm. Its caliber is generally similar to that of the ileum, and its blind extremity may be free or may be connected with the abdominal wall or with some other portion of the intestine by a fibrous band. It represents the remains of the proximal part of the vitelline duct, the duct of communication between the yolk-sac and the primitive digestive tube in early fetal life.

Structure.—The wall of the small intestine (Fig. 1058) is composed of four coats: **serous, muscular, areolar,** and **mucous.**

The **serous coat** (*tunica serosa*) is derived from the peritoneum. The superior portion of the duodenum is almost completely surrounded by this membrane near its pyloric end, but is only covered in front at the other extremity; the descending portion is covered by it in front, except where it is carried off by the transverse colon; and the inferior portion lies behind the peritoneum which passes over it without being closely incorporated with the other coats of this part of the intestine, and is separated from it in and near the middle line by the superior mesenteric vessels. The rest of the small intestine is surrounded by the peritoneum, excepting along its attached or mesenteric border; here a space is left for the vessels and nerves to pass to the gut.

The **muscular coat** (*tunica muscularis*) consists of two layers of unstriped fibers: an external, longitudinal, and an internal, circular layer. The *longitudinal fibers* are thinly scattered over the surface of the intestine, and are more distinct along its free border. The *circular fibers* form a thick, uniform layer, and are composed of plain muscle cells of considerable length. The muscular coat is thicker at the upper than at the lower part of the small intestine.

The **areolar** or **submucous coat** (*tela submucosa*) connects together the mucous and muscular layers. It consists of loose, filamentous areolar tissue containing bloodvessels, lymphatics, and nerves. It is the strongest layer of the intestine.

The **mucous membrane** (*tunica mucosa*) is thick and highly vascular at the upper part of the small intestine, but somewhat paler and thinner below. It consists of the following structures: next the areolar or submucous coat is a double layer of unstriped muscular fibers, outer longitudinal and inner circular, the **muscularis mucosæ** internal to this is a quantity of retiform tissue, enclosing in its meshes lymph corpuscles, and in this the bloodvessels and nerves ramify; lastly, a basement membrane, supporting a single layer of epithelial cells, which throughout the intestine are columnar in character. The cells are granular in appearance, and each possesses a clear oval nucleus. At their superficial or unattached ends they present a distinct layer of highly refracting material, marked by vertical striæ, the **striated border.**

The **circular folds** (*plicæ circulares* [*Kerkringi*]; *valvulæ conniventes; valves of Kerkring*) are large valvular flaps projecting into the lumen of the bowel. They are composed of reduplications of the mucous membrane, the two layers of the fold being bound together by submucous tissue; unlike the folds in the stomach, they are permanent, and are not obliterated when the intestine is distended. The majority extend transversely around the cylinder of the intestine for about one-half or two-thirds of its circumference, but some form complete circles, and others have a spiral direction; the latter usually extend a little more than once around the bowel, but occasionally two or three times. The larger folds are about 8 mm. in depth at their broadest part; but the greater number are of smaller size. The larger and smaller folds alternate with each other. They are not found at the commencement of the duodenum, but begin to appear about 2.5 or 5 cm. beyond the pylorus. In the lower part of the descending portion, below the point where the bile and pancreatic ducts enter the intestine, they are very large and closely approximated. In the horizontal and ascending portions of the duodenum and upper half of the jejunum they are large and numerous, but from this point, down to the middle of the ileum, they diminish considerably in size. In the lower part of the ileum they almost entirely disappear; hence the comparative thinness of this portion of the intestine, as compared with the duodenum and jejunum. The circular folds retard the passage of the food along the intestines, and afford an increased surface for absorption.

The **intestinal villi** (*villi intestinales*) are highly vascular processes, projecting from the mucous membrane of the small intestine throughout its whole extent, and giving to its surface a velvety appearance. They are largest and most numerous in the duodenum and jejunum, and become fewer and smaller in the ileum.

Structure of the villi (Figs. 1059, 1060).—The essential parts of a villus are: the lacteal vessel, the bloodvessels, the epithelium, the basement membrane, and the muscular tissue of the mucosa, all being supported and held together by retiform lymphoid tissue.

The *lacteals* are in some cases double, and in some animals multiple, but usually there is a single vessel. Situated in the axis of the villus, each commences by dilated cecal extremities near to, but not quite at, the summit of the villus. The walls are composed of a single layer of endothelial cells.

The *muscular fibers* are derived from the muscularis mucosæ, and are arranged in longitudinal bundless around the lacteal vessel, extending from the base to the summit of the villus, and giving off, laterally, individual muscle cells, which are enclosed by the reticulum, and by it are attached to the basement-membrane and to the lacteal.

The *bloodvessels* (Fig. 1061) form a plexus under the basement membrane, and are enclosed in the reticular tissue.

These structures are surrounded by the *basement membrane,*which is made up of a stratum of endothelial cells, and upon this is placed a layer of *columnar epithelium,* the characteristics of which have been described. The *retiform tissue* forms a net-work (Fig. 1060) in the meshes of which a number of leucocytes are found.

The intestinal glands (glandulæ intestinales [Lieberkühni]; crypts of Lieberkühn) (Fig. 1062) are found in considerable numbers over every part of the mucous membrane of the small intestine. They consist of minute tubular depressions of the mucous membrane, arranged perpendicularly to the surface, upon which they open by small circular apertures. They may be seen with the aid of a lens, their orifices appearing as minute dots scattered between the villi. Their walls are thin, consisting of a basement membrane lined by columnar epithelium, and covered on their exterior by capillary vessels.

The duodenal glands (glandulæ duodenales [Brunneri]; Brunner's glands) are limited to the duodenum (Fig. 1058), and are found in the submucous areolar tissue. They are largest and most numerous near the pylorus, forming an almost complete layer in the superior portion and upper half of the descending portions of the duodenum. They then begin to diminish in number, and practically disappear at the junction of the duodenum and jejunum. They are small compound acinotubular glands consisting of a number of alveoli lined by short columnar epithelium and opening by a single duct on the inner surface of the intestine.

The solitary lymphatic nodules (noduli lymphatici solitarii; solitary glands) are found scattered throughout the mucous membrane of the small intestine, but are most numerous in the lower part of the ileum. Their free surfaces are covered with rudimentary villi, except at the summits, and each gland is surrounded by the openings of the intestinal glands. Each consists of a dense interlacing retiform tissue closely packed with lymph-corpuscles, and permeated with an abundant capillary network. The interspaces of the retiform tissue are continuous with larger lymph spaces which surround the gland, through which they communicate with the lacteal system. They are situated partly in the submucous tissue, partly in the mucous membrane, where they form slight projections of its epithelial layer (see Fig. 1082).

The aggregated lymphatic nodules (noduli lymphatici aggregati; Peyer's patches; Peyer's glands; agminated follicles; tonsillæ intestinales) (Fig. 1063) form circular or oval patches, from twenty to thirty in number, and varying in length from 2 to 10 cm. They are largest and most numerous in the ileum. In the lower part of the jejunum they are small, circular, and few in number. They are occasionally seen in the duodenum. They are placed lengthwise in the intestine, and are situated in the portion of the tube most distant from the attachment of the mesentery. Each patch is formed of a group of solitary lymphatic nodules covered with mucous membrane, but the patches do not, as a rule, possess villi on their free surfaces. They are best marked in the young subject, become indistinct in middle age, and sometimes disappear altogether in advanced life. They are freely supplied with bloodvessels (Fig. 1064), which form an abundant plexus around each follicle and give off fine branches permeating the lymphoid tissue in the interior of the follicle. The lymphatic plexuses are especially abundant around these patches.

The large intestine extends from the end of the ileum to the anus. It is about 1.5 meters long, being one-fifth of the whole extent of the intestinal canal. Its caliber is largest at its commencement at the cecum, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anal canal. It differs from the small intestine in its greater caliber, its more fixed position, its sacculated form, and in possessing certain appendages to its external coat, the appendices epiploicæ. Further, its longitudinal muscular fibers do not form a continuous layer around the gut, but are arranged in three longitudinal bands or tæniæ. The large intestine, in its course, describes an arch which surrounds the convolutions of the small intestine. It commences in the right iliac region, in a dilated part, the cecum. It ascends through the right lumbar and hypochondriac regions to the under surface of the liver; it here takes a bend, the right colic flexure, to the left and passes transversely across the abdomen on the confines of the epigastric and umbilical regions, to the left hypochondriac region; it then bends again, the left colic flexure, and descends through the left lumbar and iliac regions to the pelvis, where it forms a bend called the sigmoid flexure; from this it is continued along the posterior wall of the pelvis to the anus. The large intestine is divided into the cecum, colon, rectum, and anal canal.

The Cecum (intestinum cæcum) (Fig. 1073), the commencement of the large intestine, is the large blind pouch situated below the colic valve. Its blind end is directed downward, and its open end upward, communicating directly with the colon, of which this blind pouch appears to be the beginning or head, and hence the old name of caput cæcum coli was applied to it. Its size is variously estimated by different authors, but on an average it may be said to be 6.25 cm. in length and 7.5 in breadth. It is situated in the right iliac fossa, above the lateral half of the inguinal ligament: it rests on the Iliacus and Psoas major, and usually lies in contact with the anterior abdominal wall, but the greater omentum and, if the cecum be empty, some coils of small intestine may lie in front of it. As a rule, it is entirely enveloped by peritoneum, but in a certain number of cases (5 per cent., Berry) the peritoneal covering is not complete, so that the upper part of the posterior surface is uncovered and connected to the iliac fascia by connective tissue. The cecum lies quite free in the abdominal cavity and enjoys a considerable amount of movement, so that it may become herniated down the right inguinal canal, and has occasionally been found in an inguinal hernia on the left side. The cecum varies in shape, but, according to Treves, in man it may be classified under one of four types. In early fetal life it is short, conical, and broad at the base, with its apex turned upward and medialward toward the ileocolic junction. It then resembles the cecum of some monkeys, e. g., mangabey monkey. As the fetus grows the cecum increases in length more than in breadth, so that it forms a longer tube than in the primitive form and without the broad base, but with the same inclination of the apex toward the ileocolic junction. This form is seen in other monkeys, e. g., the spider monkey. As development goes on, the lower part of the tube ceases to grow and the upper part becomes greatly increased, so that at birth there is a narrow tube, the vermiform process, hanging from a conical projection, the cecum. This is the infantile form, and as it persists throughout life in about 2 per cent. of cases, it is regarded by Treves as the first of his four types of human ceca. The cecum is conical and the appendix rises from its apex. The three longitudinal bands start from the appendix and are equidistant from each other. In the second type, the conical cecum has become quadrate by the growing out of a saccule on either side of the anterior longitudinal band. These saccules are of equal size, and the appendix arises from between them, instead of from the apex of a cone. This type is found in about 3 per cent. of cases. The third type is the normal type of man. Here the two saccules, which in the second type were uniform, have grown at unequal rates: the right with greater rapidity than the left. In consequence of this an apparently new apex has been formed by the growing downward of the right saccule, and the original apex, with the appendix attached, is pushed over to the left toward the ileocolic junction. The three longitudinal bands still start from the base of the vermiform process, but they are now no longer equidistant from each other, because the right saccule has grown between the anterior and posterolateral bands, pushing them over to the left. This type occurs in about 90 per cent. of cases. The fourth type is merely an exaggerated condition of the third; the right saccule is still larger, and at the same time the left saccule has become atrophied, so that the original apex of the cecum, with the vermiform process, is close to the ileocolic junction, and the anterior band courses medialward to the same situation. This type is present in about 4 per cent. of cases.

The Vermiform Process or Appendix (processus vermiformis) (Fig. 1073) is a long, narrow, worm-shaped tube, which starts from what was originally the apex of the cecum, and may pass in one of several directions: upward behind the cecum; to the left behind the ileum and mesentery; or downward into the lesser pelvis. It varies from 2 to 20 cm. in length, its average being about 8.3 cm. It is retained in position by a fold of peritoneum (mesenteriole), derived from the left leaf of the mesentery. This fold, in the majority of cases, is more or less triangular in shape, and as a rule extends along the entire length of the tube. Between its two layers and close to its free margin lies the appendicular artery (Fig. 1073). The canal of the vermiform process is small, extends throughout the whole length of the tube, and communicates with the cecum by an orifice which is placed below and behind the ileocecal opening. It is sometimes guarded by a semilunar valve formed by a fold of mucous membrane, but this is by no means constant.

Structure.—The coats of the vermiform process are the same as those of the intestine: serous, muscular, submucous, and mucous. The serous coat forms a complete investment for the tube, except along the narrow line of attachment of its mesenteriole in its proximal two-thirds. The longitudinal muscular fibers do not form three bands as in the greater part of the large intestine, but invest the whole organ, except at one or two points where both the longitudinal and circular fibers are deficient so that the peritoneal and submucous coats are contiguous over small areas.

The circular muscle fibers form a much thicker layer than the longitudinal fibers, and are separated from them by a small amount of connective tissue. The submucous coat is well marked, and contains a large number of masses of lymphoid tissue which cause the mucous membrane to bulge into the lumen and so render the latter of small size and irregular shape. The mucous membrane is lined by columnar epithelium and resembles that of the rest of the large intestine, but the intestinal glands are fewer in number (Fig. 1074).

The Colic Valve (valvula coli; ileocecal valve) (Fig. 1075).—The lower end of the ileum ends by opening into the medial and back part of the large intestine, at the point of junction of the cecum with the colon. The opening is guarded by a valve, consisting of two segments or lips, which project into the lumen of the large intestine. If the intestine has been inflated and dried, the lips are of a semilunar shape. The upper one, nearly horizontal in direction, is attached by its convex border to the line of junction of the ileum with the colon; the lower lip, which is longer and more concave, is attached to the line of junction of the ileum with the cecum. At the ends of the aperture the two segments of the valve coalesce, and are continued as narrow membranous ridges around the canal for a short distance, forming the frenula of the valve. The left or anterior end of the aperture is rounded; the right or posterior is narrow and pointed. In the fresh condition, or in specimens which have been hardened in situ, the lips project as thick cushion-like folds into the lumen of the large gut, while the opening between them may present the appearance of a slit or may be somewhat oval in shape.

Each lip of the valve is formed by a reduplication of the mucous membrane and of the circular muscular fibers of the intestine, the longitudinal fibers and peritoneum being continued uninterruptedly from the small to the large intestine.

The surfaces of the valve directed toward the ileum are covered with villi, and present the characteristic structure of the mucous membrane of the small intestine; while those turned toward the large intestine are destitute of villi, and marked with the orifices of the numerous tubular glands peculiar to the mucous membrane of the large intestine. These differences in structure continue as far as the free margins of the valve. It is generally maintained that this valve prevents reflux from the cecum into the ileum, but in all probability it acts as a sphincter around the end of the ileum and prevents the contents of the ileum from passing too quickly into the cecum.

The Colon is divided into four parts: the ascending, transverse, descending, and sigmoid.

The Ascending Colon (colon ascendens) is smaller in caliber than the cecum, with which it is continuous. It passes upward, from its commencement at the cecum, opposite the colic valve, to the under surface of the right lobe of the liver, on the right of the gall-bladder, where it is lodged in a shallow depression, the colic impression;here it bends abruptly forward and to the left, forming the right colic(hepatic) flexure (Fig. 1056). It is retained in contact with the posterior wall of the abdomen by the peritoneum, which covers its anterior surface and sides, its posterior surface being connected by loose areolar tissue with the Iliacus, Quadratus lumborum, aponeurotic origin of Transversus abdominis, and with the front of the lower and lateral part of the right kidney. Sometimes the peritoneum completely invests it, and forms a distinct but narrow mesocolon. (*169 It is in relation, in front, with the convolutions of the ileum and the abdominal parietes.

The Transverse Colon (colon transversum) the longest and most movable part of the colon, passes with a downward convexity from the right hypochondriac region across the abdomen, opposite the confines of the epigastric and umbilical zones, into the left hypochondriac region, where it curves sharply on itself beneath the lower end of the spleen, forming the left colic (splenic) flexure. In its course it describes an arch, the concavity of which is directed backward and a little upward; toward its splenic end there is often an abrupt U-shaped curve which may descend lower than the main curve. It is almost completely invested by peritoneum, and is connected to the inferior border of the pancreas by a large and wide duplicature of that membrane, the transverse mesocolon. It is in relation, by its upper surface, with the liver and gall-bladder, the greater curvature of the stomach, and the lower end of the spleen; by its under surface, with the small intestine; by its anterior surface, with the anterior layers of the greater omentum and the abdominal parietes; its posterior surface is in relation from right to left with the descending portion of the duodenum, the head of the pancreas, and some of the convolutions of the jejunum and ileum.

The left colic or splenic flexure (Fig. 1056) is situated at the junction of the transverse and descending parts of the colon, and is in relation with the lower end of the spleen and the tail of the pancreas; the flexure is so acute that the end of the transverse colon usually lies in contact with the front of the descending colon. It lies at a higher level than, and on a plane posterior to, the right colic flexure, and is attached to the diaphragm, opposite the tenth and eleventh ribs, by a peritoneal fold, named the phrenicocolic ligament, which assists in supporting the lower end of the spleen (see page 1158).

The Descending Colon (*170 (colon descendens) passes downward through the left hypochondriac and lumbar regions along the lateral border of the left kidney. At the lower end of the kidney it turns medialward toward the lateral border of the Psoas, and then descends, in the angle between Psoas and Quadratus lumborum, to the crest of the ilium, where it ends in the iliac colon. The peritoneum covers its anterior surface and sides, while its posterior surface is connected by areolar tissue with the lower and lateral part of the left kidney, the aponeurotic origin of the Transversus abdominis, and the Quadratus lumborum. It is smaller in caliber and more deeply placed than the ascending colon, and is more frequently covered with peritoneum on its posterior surface than the ascending colon (Treves). In front of it are some coils of small intestine.

The Iliac Colon is situated in the left iliac fossa, and is about 12 to 15 cm. long. It begins at the level of the iliac crest, where it is continuous with the descending colon, and ends in the sigmoid colon at the superior aperture of the lesser pelvis. It curves downward and medialward in front of the Iliacus and Psoas, and, as a rule, is covered by peritoneum on its sides and anterior surface only.

The Sigmoid Colon (colon sigmoideum; pelvic colon; sigmoid flexure) forms a loop which averages about 40 cm. in length, and normally lies within the pelvis, but on account of its freedom of movement it is liable to be displaced into the abdominal cavity. It begins at the superior aperture of the lesser pelvis, where it is continuous with the iliac colon, and passes transversely across the front of the sacrum to the right side of the pelvis; it then curves on itself and turns toward the left to reach the middle line at the level of the third piece of the sacrum, where it bends downward and ends in the rectum. It is completely surrounded by peritoneum, which forms a mesentery (sigmoid mesocolon), which diminishes in length from the center toward the ends of the loop, where it disappears, so that the loop is fixed at its junctions with the iliac colon and rectum, but enjoys a considerable range of movement in its central portion. Behind the sigmoid colon are the external iliac vessels, the left Piriformis, and left sacral plexus of nerves; in front, it is separated from the bladder in the male, and the uterus in the female, by some coils of the small intestine.

The Rectum (intestinum rectum) is continuous above with the sigmoid colon, while below it ends in the anal canal. From its origin at the level of the third sacral vertebra it passes downward, lying in the sacrococcygeal curve, and extends for about 2.5 cm. in front of, and a little below, the tip of the coccyx, as far as the apex of the prostate. It then bends sharply backward into the anal canal. It therefore presents two antero-posterior curves: an upper, with its convexity backward, and a lower, with its convexity forward. Two lateral curves are also described, one to the right opposite the junction of the third and fourth sacral vertebræ, and the other to the left, opposite the left sacrococcygeal articulation; they are, however, of little importance. The rectum is about 12 cm. long, and at its commencement its caliber is similar to that of the sigmoid colon, but near its termination it is dilated to form the rectal ampulla. The rectum has no sacculations comparable to those of the colon, but when the lower part of the rectum is contracted, its mucous membrane is thrown into a number of folds, which are longitudinal in direction and are effaced by the distension of the gut. Besides these there are certain permanent transverse folds, of a semilunar shape, known as Houston's valves (Fig. 1078). They are usually three in number; sometimes a fourth is found, and occasionally only two are present. One is situated near the commencement of the rectum, on the right side; a second extends inward from the left side of the tube, opposite the middle of the sacrum; a third, the largest and most constant, projects backward from the forepart of the rectum, opposite the fundus of the urinary bladder. When a fourth is present, it is situated nearly 2.5 cm. above the anus on the left and posterior wall of the tube. These folds are about 12 mm. in width, and contain some of the circular fibers of the gut. In the empty state of the intestine they overlap each other, as Houston remarks, so effectually as to require considerable maneuvering to conduct a bougie or the finger along the canal. Their use seems to be, "to support the weight of fecal matter, and prevent its urging toward the anus, where its presence always excites a sensation demanding its discharge.

The peritoneum is related to the upper two-thirds of the rectum, covering at first its front and sides, but lower down its front only; from the latter it is reflected on to the seminal vesicles in the male and the posterior vaginal wall in the female.

The level at which the peritoneum leaves the anterior wall of the rectum to be reflected on to the viscus in front of it is of considerable importance from a surgical point of view, in connection with the removal of the lower part of the rectum. It is higher in the male than in the female. In the former the height of the rectovesical excavation is about 7.5 cm., i. e., the height to which an ordinary index finger can reach from the anus. In the female the height of the rectouterine excavation is about 5.5 cm. from the anal orifice. The rectum is surrounded by a dense tube of fascia derived from the fascia endopelvina, but fused behind with the fascia covering the sacrum and coccyx. The facial tube is loosely attached to the rectal wall by areolar tissue in order to allow of distension of the viscus.

Relations of the Rectum.—The upper part of the rectum is in relation, behind, with the superior hemorrhoidal vessels, the left Piriformis, and left sacral plexus of nerves, which separate it from the pelvic surfaces of the sacral vertebræ; in its lower part it lies directly on the sacrum, coccyx, and Levatores ani, a dense fascia alone intervening; in front, it is separated above, in the male, from the fundus of the bladder; in the female, from the intestinal surface of the uterus and its appendages, by some convolutions of the small intestine, and frequently by the sigmoid colon; below, it is in relation in the male with the triangular portion of the fundus of the bladder, the vesiculæ seminales, and ductus deferentes, and more anteriorly with the posterior surface of the prostate; in the female, with the posterior wall of the vagina.

The **Anal Canal** (*pars analis recti*), or terminal portion of the large intestine, begins at the level of the apex of the prostate, is directed downward and backward, and ends at the anus. It forms an angle with the lower part of the rectum, and measures from 2.5 to 4 cm. in length. It has no peritoneal covering, but is invested by the Sphincter ani internus, supported by the Levatores ani, and surrounded at its termination by the Sphincter ani externus. In the empty condition it presents the appearance of an antero-posterior longitudinal slit. Behind it is a mass of muscular and fibrous tissue, the **anococcygeal body** (Symington); in front of it, in the male, but separated by connective tissue from it, are the membranous portion and bulb of the urethra, and the fascia of the urogenital diaphragm; and in the female it is separated from the lower end of the vagina by a mass of muscular and fibrous tissue, named the **perineal body.**

The lumen of the anal canal presents, in its upper half, a number of vertical folds, produced by an infolding of the mucous membrane and some of the muscular tissue. They are known as the **rectal columns** [*Morgagni*], and are separated from one another by furrows (**rectal sinuses**), which end below in small valve-like folds, termed **anal valves,** which join together the lower ends of the rectal columns.

Structure of the Colon.—The large intestine has four coats: **serous, muscular, areolar,** and **mucous.**

The **serous coat** (*tunica serosa*) is derived from the peritoneum, and invests the different portions of the large intestine to a variable extent. The cecum is completely covered by the serous membrane, except in about 5 per cent. of cases where the upper part of the posterior surface is uncovered. The ascending, descending, and iliac parts of the colon are usually covered only in front and at the sides; a variable amount of the posterior surface is uncovered. (*172 The transverse colon is almost completely invested, the parts corresponding to the attachment of the greater omentum and transverse mesocolon being alone excepted. The sigmoid colon is entirely surrounded. The rectum is covered above on its anterior surface and sides; below, on its anterior aspect only; the anal canal is entirely devoid of any serous covering. In the course of the colon the peritoneal coat is thrown into a number of small pouches filled with fat, called **appendices epiploicæ.** They are most numerous on the transverse colon.

The **muscular coat** (*tunica muscularis*) consists of an external longitudinal, and an internal circular, layer of non-striped muscular fibers:

The *longitudinal fibers* do not form a continuous layer over the whole surface of the large intestine. In the cecum and colon they are especially collected into three flat longitudinal bands (*tænæi coli*), each of about 12 mm. in width; one, the posterior, is placed along the attached border of the intestine; the anterior, the largest, corresponds along the arch of the colon to the attachment of the greater omentum, but is in front in the ascending, descending, and iliac parts of the colon, and in the sigmoid colon; the third, or lateral band, is found on the medial side of the ascending and descending parts of the colon, and on the under aspect of the transverse colon. These bands are shorter than the other coats of the intestine, and serve to produce the sacculi which are characteristic of the cecum and colon; accordingly, when they are dissected off, the tube can be lengthened, and its sacculated character disappears. In the sigmoid colon the longitudinal fibers become more scattered; and around the rectum they spread out and form a layer, which completely encircles this portion of the gut, but is thicker on the anterior and posterior surfaces, where it forms two bands, than on the lateral surfaces. In addition, two bands of plain muscular tissue arise from the second and third coccygeal vertebræ, and pass downward and forward to blend with the longitudinal muscular fibers on the posterior wall of the anal canal. These are known as the **Rectococcygeal muscles.**

The circular fibers form a thin layer over the cecum and colon, being especially accumulated in the intervals between the sacculi; in the rectum they form a thick layer, and in the anal canal they become numerous, and constitute the Sphincter ani internus.

The areolar coat (tela submucosa; submucous coat) connects the muscular and mucous layers closely together.

The mucous membrane (tunica mucosa) in the cecum and colon, is pale, smooth, destitute of villi, and raised into numerous crescentic folds which correspond to the intervals between the sacculi. In the rectum it is thicker, of a darker color, more vascular, and connected loosely to the muscular coat, as in the esophagus.

As in the small intestine, the mucous membrane consists of a muscular layer, the muscularis mucosæ; a quantity of retiform tissue in which the vessels ramify; a basement membrane and epithelium which is of the columnar variety, and resembles the epithelium found in the small intestine. The mucous membrane of the large intestine presents for examination glands and solitary lymphatic nodules.

The glands of the great intestine are minute tubular prolongations of the mucous membrane arranged perpendicularly, side by side, over its entire surface; they are longer, more numerous, and placed in much closer apposition than those of the small intestine; and they open by minute rounded orifices upon the surface, giving it a cribriform appearance. Each gland is lined by short columnar epithelium and contains numerous goblet cells.

The solitary lymphatic nodules (noduli lymphatic solitarii) of the large intestine are most abundant in the cecum and vermiform process, but are irregularly scattered also over the rest of the intestine. They are similar to those of the small intestine.

Control questions:

1. Topography of the stomach.
2. The structure of the stomach.
3. Ligaments and function of the stomach.
4. Rentgenography of stomach.
5. The structure and function of the duodenum.
6. The structure and functions of the jejunum and ileum.
7. The structure and function of the colon.

Criterion for evaluation

№	Performance	Evaluation	Level of students' knowledge.
1	86-100	Excellent "5"	-able to make independent decisions and conclusion -has creative thinking -can independently think -can apply interactive games more actively -solves situational problems with a full justified answer -understands the meaning of the question and answered with confidence -has a full understanding
2	71-85,9	Good "4"	-may apply in practice interactive games more actively -solves situational problems,but completely unable to explain -understands the meaning of the question and answered with confidence

			-has a full understanding
3	56-70,9	Satisfactory "3"	-solves situational problems ,but can't justify the answer -knows can answer -on certain issues has an idea
4	0-55	Unsatisfactory "2"	-has no representation on this topic -doesn't know the subject

Equipments of the lesson:
-Dummies and tablets with an overview of the abdominal organs.
-Museum preparations.
-Radiographs of the stomach, intestine and colon.
-Colored slides
-Presentation of lectures.
-Tables, charts, tablets, Atlas, textbook

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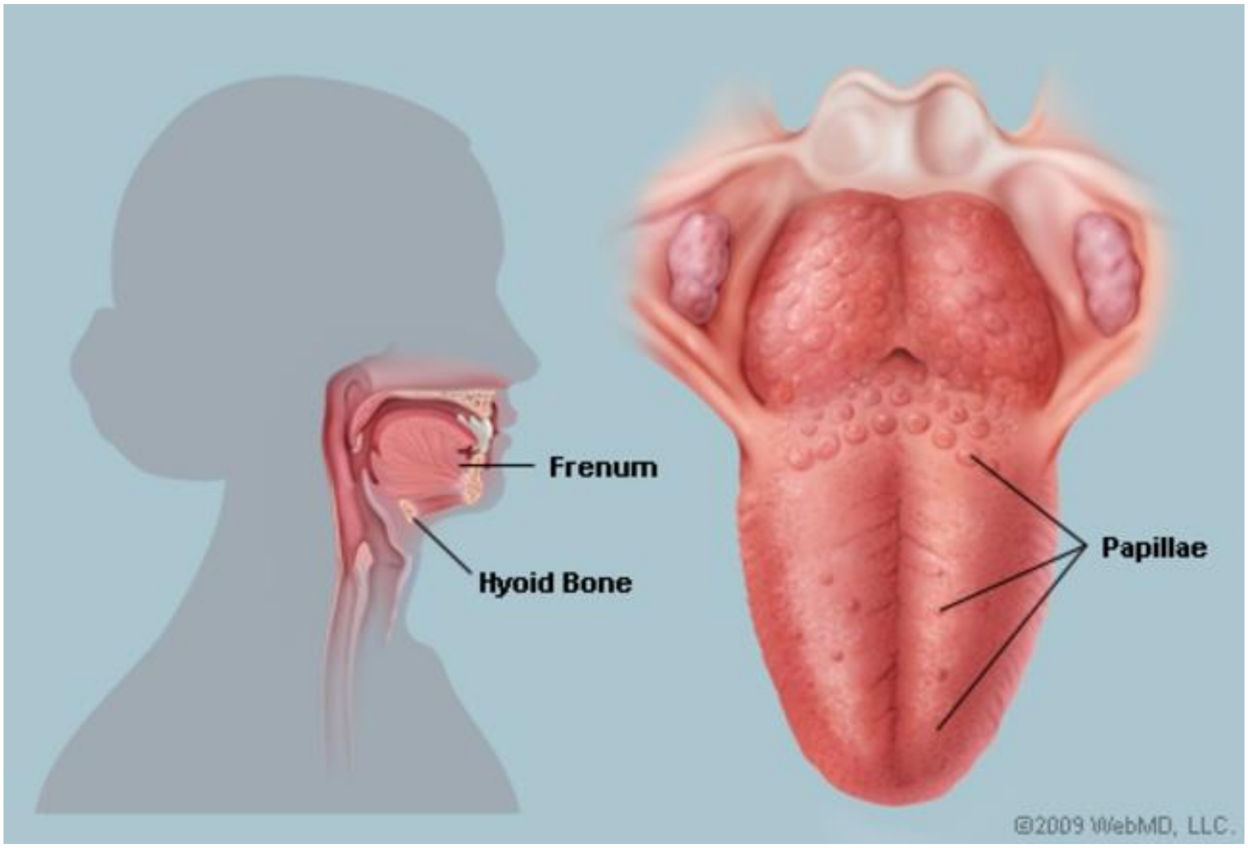
The tongue is a muscular organ in the mouth. The tongue is covered with moist, pink tissue called mucosa. Tiny bumps called papillae give the tongue its rough texture. Thousands of taste buds cover the surfaces of the papillae. Taste buds are collections of nerve-like cells that connect to nerves running into the brain.

The tongue is anchored to the mouth by webs of tough tissue and mucosa. The tether holding down the front of the tongue is called the frenum. In the back of the mouth, the tongue is anchored into the hyoid bone. The tongue is vital for chewing and swallowing food, as well as for speech.

The four common tastes are sweet, sour, bitter, and salty. A fifth taste, called umami, results from tasting glutamate (present in MSG). The tongue has many nerves that help detect and transmit taste signals to the brain. Because of this, all parts of the tongue can detect these four common tastes; the commonly described “taste map” of the tongue doesn’t really exist.



Tongue Conditions

- Thrush (candidiasis): *Candida albicans* (a yeast) grows over the surface of the mouth and tongue. Thrush can occur in almost anyone, but it occurs more often in people taking steroids or with suppressed immune systems, the very young, and the elderly.
- Oral cancer: A growth or ulcer appears on the tongue and grows steadily. Oral cancer is more common in people who smoke and/or drink alcohol heavily.
- Macroglossia (big tongue): This can be broken down into various categories based on the cause. These include congenital, inflammatory, traumatic, cancerous, and metabolic causes. Thyroid disease, lymphangiomas, and congenital abnormalities are among some of the causes of an enlarged tongue.
- Geographic tongue: Ridges and colored spots migrate over the surface of the tongue, periodically changing its appearance. Geographic tongue is a harmless condition.
- Burning mouth/burning tongue syndrome: a relatively common problem. The tongue feels burned or scalded, or strange tastes or sensations develop. Apparently harmless, burning mouth syndrome may be caused by a mild nerve problem.

- Atrophic glossitis (bald tongue): The tongue loses its bumpy texture, becoming smooth. Sometimes this is due to anemia or a B vitamin deficiency.
- Canker sores (aphthous ulcers): Small, painful ulcers appear periodically on the tongue or mouth. A relatively common condition, the cause of canker sores is unknown; they are unrelated to the cold sores caused by herpes viruses. Canker sores are not contagious.
- Oral leukoplakia: White patches appear on the tongue that can't be scraped off. Leukoplakia may be benign, or it can progress to oral cancer.
- Hairy tongue: Papillae can overgrow the surface of the tongue, giving it a white or black appearance. Scraping off the papillae corrects this harmless condition.
- Herpes stomatitis: The herpes virus can uncommonly cause cold sores on the tongue. Herpes virus cold sores are usually on the lip.
- Lichen planus: A harmless condition that can affect the skin or the mouth. The cause is unknown; however, it is believed to be caused by the immune system attacking the skin and lining of the mouth.

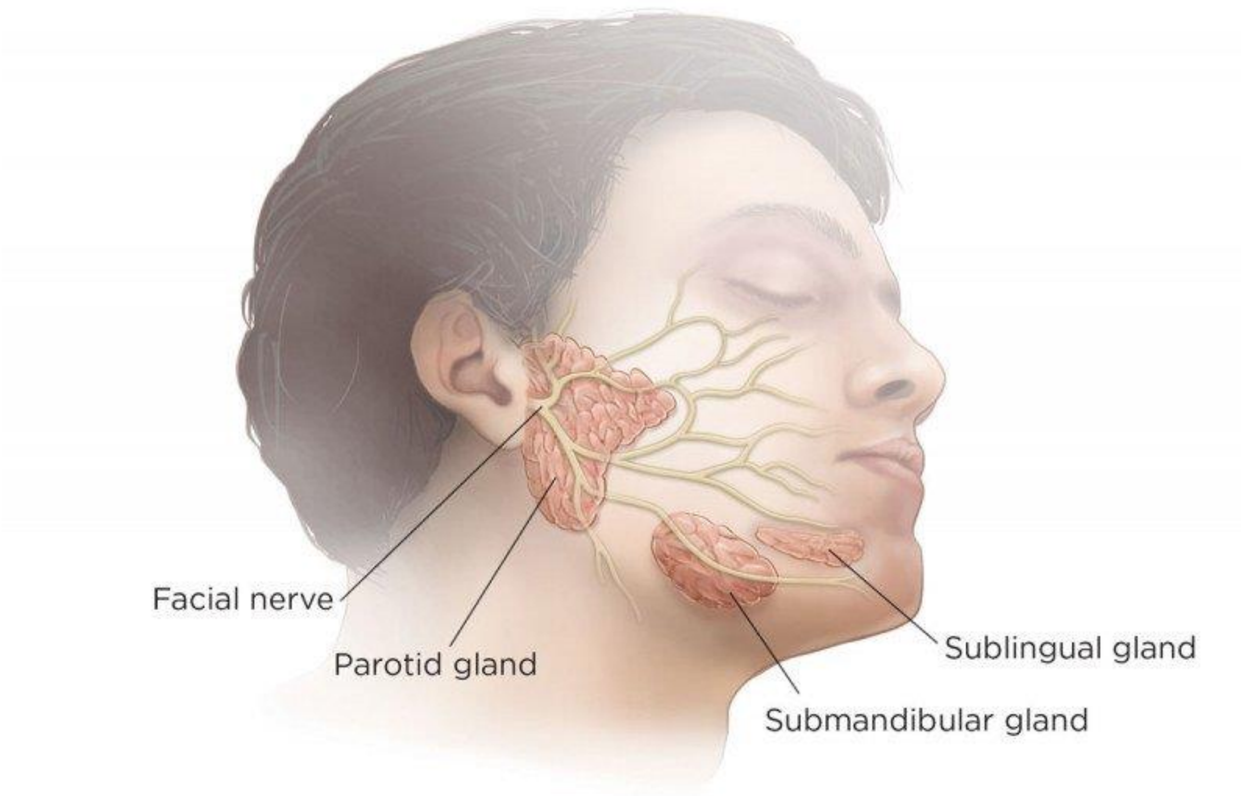
Tongue Tests

- Biopsy: A small sample of tissue is taken from a suspicious-looking area on the tongue. This is most often done to check for oral cancer.
- Flavor discrimination test: Four solutions of different amounts of sweetener are used to evaluate taste and smell.

Tongue Treatments

- Steroid gel: Applying a prescription steroid gel like Lidex hastens the resolution of canker sores.
- Silver nitrate: Doctors can apply this chemical to a canker sore, speeding healing and relieving pain.
- Viscous lidocaine: Applied to the tongue, lidocaine gel provides immediate, though temporary, pain relief.
- Antifungal medicines: Antifungal drugs can eliminate *Candida albicans*, the thrush-causing fungus. Swish-and-spit mouthwash and pills are both effective.
- Tongue scraping: Simply scraping the tongue can usually remove the overgrown papillae causing black or white hairy tongue.
- B vitamins: A B vitamin supplement can correct a vitamin deficiency, if present.
- Tongue surgery: Surgery may be required to remove oral cancer or leukoplakia.

Salivary Glands Anatomy



The major salivary glands (shown above) are the largest and most important salivary glands. They produce most of the saliva in your mouth.

If you have been diagnosed with salivary gland cancer, knowing a little bit about the salivary glands will help you talk to your doctor about surgery or other aspects of your care.

The salivary glands make saliva and empty it into your mouth through openings called ducts. Saliva helps with swallowing and chewing. It can also help prevent infections from developing in your mouth or throat.

There are two types of salivary glands:

1. the major salivary glands
2. the minor salivary glands

Major Salivary Glands

The major salivary glands are the largest and most important salivary glands. They produce most of the saliva in your mouth.

There are three pairs of major salivary glands: the parotid glands, the submandibular glands, and the sublingual glands.

Parotid Glands

The parotid glands are the largest salivary glands. They are located just in front of the ears. The saliva produced in these glands is secreted into the mouth from a duct near your upper second molar.

Each parotid gland has two parts, or lobes: the superficial lobe and the deep lobe. Between the two lobes is the **facial nerve**. The facial nerve is important because it controls your ability to close your eyes, raise your eyebrows, and smile.

Other critical structures near the parotid glands include the **external carotid artery**, which is a major supplier of blood to the head and neck region, and the **retromandibular vein**, a branch of the jugular vein.

Surgery to treat a parotid gland tumor is called a parotidectomy. It requires great precision because the surgeon has to locate and operate around these important structures.

Submandibular Glands

About the size of a walnut, the submandibular glands are located below the jaw. The saliva produced in these glands is secreted into the mouth from under the tongue.

Like the parotid glands, the submandibular glands have two parts called the superficial lobe and the deep lobe. Nearby structures include:

- the **marginal mandibular nerve**, which helps you smile
- the **platysma muscle**, which helps you move your lower lip
- the **lingual nerve**, which allows sensation in your tongue
- the **hypoglossal nerve**, which allows movement in the part of your tongue that helps with speech and swallowing

During treatment, we protect all of these important structures to avoid causing damage.

Sublingual Glands

The sublingual glands are the smallest of the major salivary glands. These almond-shaped structures are located under the floor of the mouth and below either side of the tongue.

Tumors starting in these glands are particularly rare.

Minor Salivary Glands

There are hundreds of minor salivary glands throughout the mouth and the aerodigestive tract. Unlike the major salivary glands, these glands are too small to be seen without a microscope. Most are found in the lining of the lips, the tongue, and the roof of the mouth, as well as inside the cheeks, nose, sinuses, and larynx (voice box).

Minor salivary gland tumors are extremely rare. However, they are more likely to be cancerous than benign. Cancers of the minor salivary glands most often begin in the roof of the mouth.

The **palate** (also known as the 'roof of the mouth'), forms a division between the nasal and oral cavities. It is separated into two distinct parts:

- **Hard palate** – comprised of bone.
  - It is immobile.
- **Soft palate** – comprised of muscle fibres covered by a mucous membrane.
  - It can be elevated to close the pharyngeal isthmus during swallowing – this prevents the food bolus from entering the nasopharynx.

In this article, we will look at the **anatomy of the palate**; its structure, function and neurovascular supply.

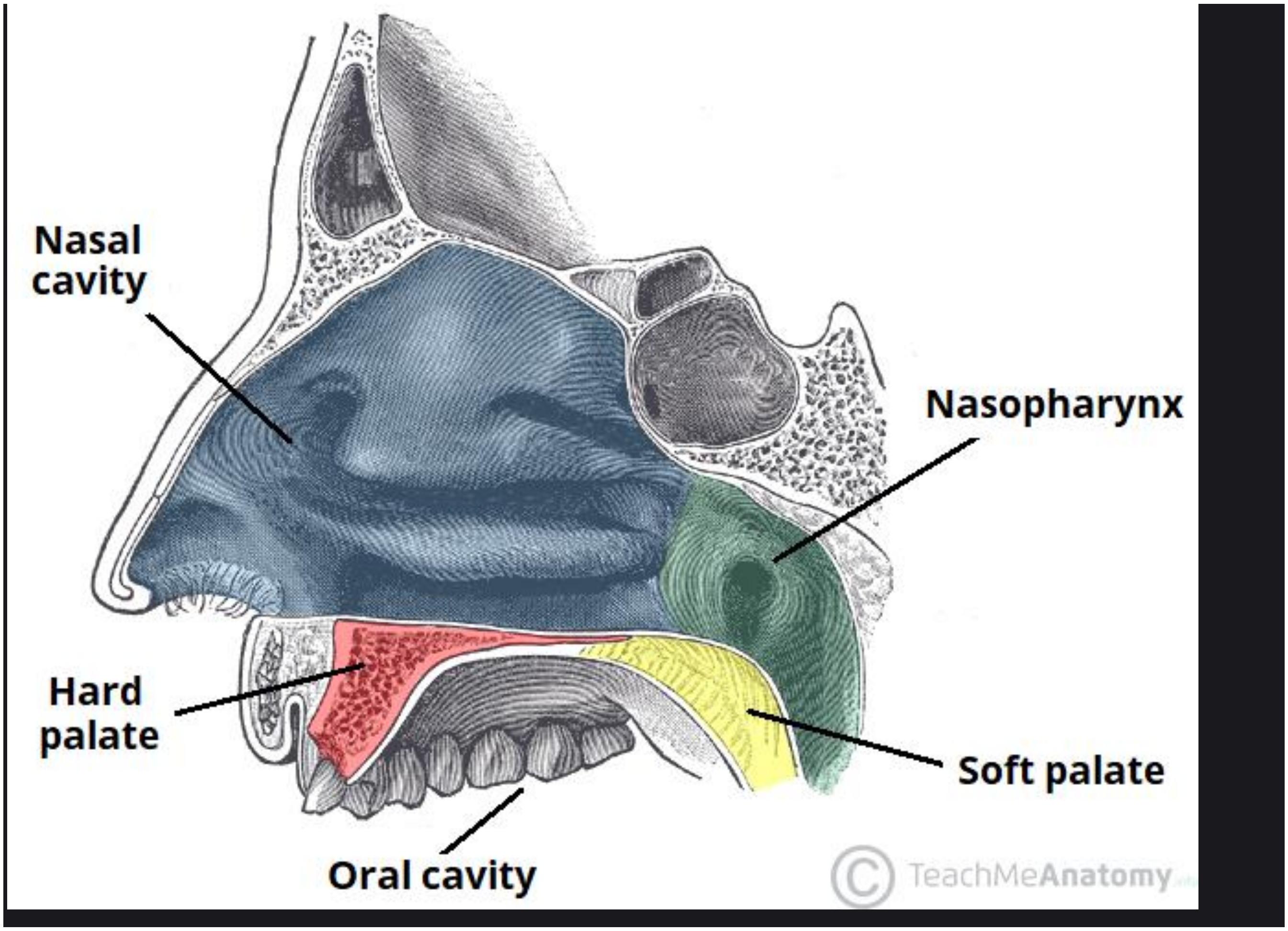
- **Structure**
- The palate divides the nasal cavity and the oral cavity, with the hard palate positioned anteriorly and the soft palate posteriorly.
- It forms both the roof of the mouth and the floor of the nasal cavity. Reflecting this, the superior and inferior palatal surfaces have different mucosae:
- Superior aspect of palate (nasal cavity) – respiratory epithelium.
- Inferiorly aspect of palate (oral cavity) – oral mucosa, populated by secretory salivary glands.
- **Hard Palate**

The **hard palate** forms the anterior aspect of the palate.

The underlying bony structure is composed of (i) palatine processes of the maxilla; and (ii) horizontal plates of the palatine bones.

There are three main foramina/canals in the hard palate:

- **Incisive canal** – located in the anterior midline, transmits the nasopalatine nerve.
- **Greater palatine foramen** – located medial to the third molar tooth, transmits the greater palatine nerve and vessels
- **Lesser palatine foramina** – located in the pyramidal process of the palatine bone, transmits the lesser palatine nerve.

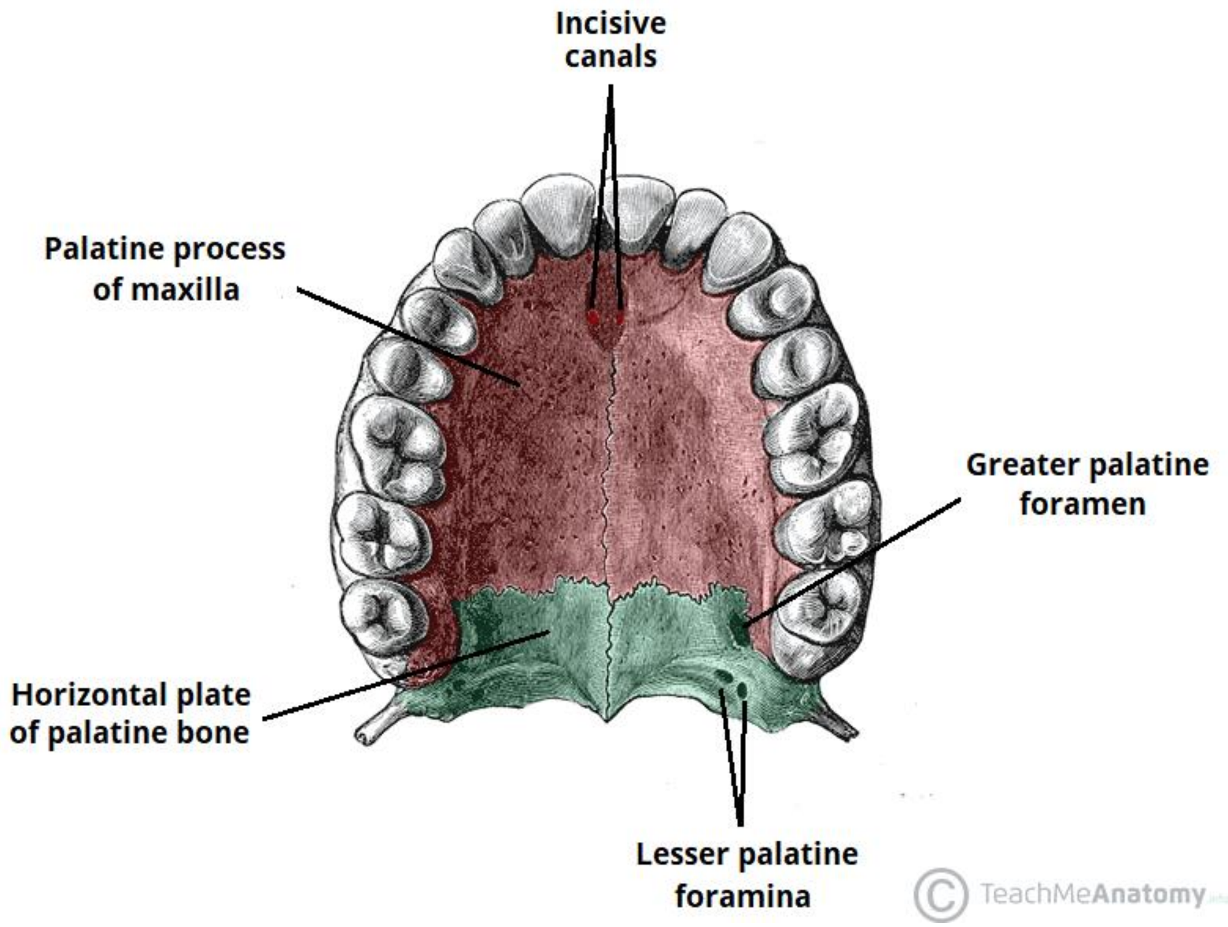


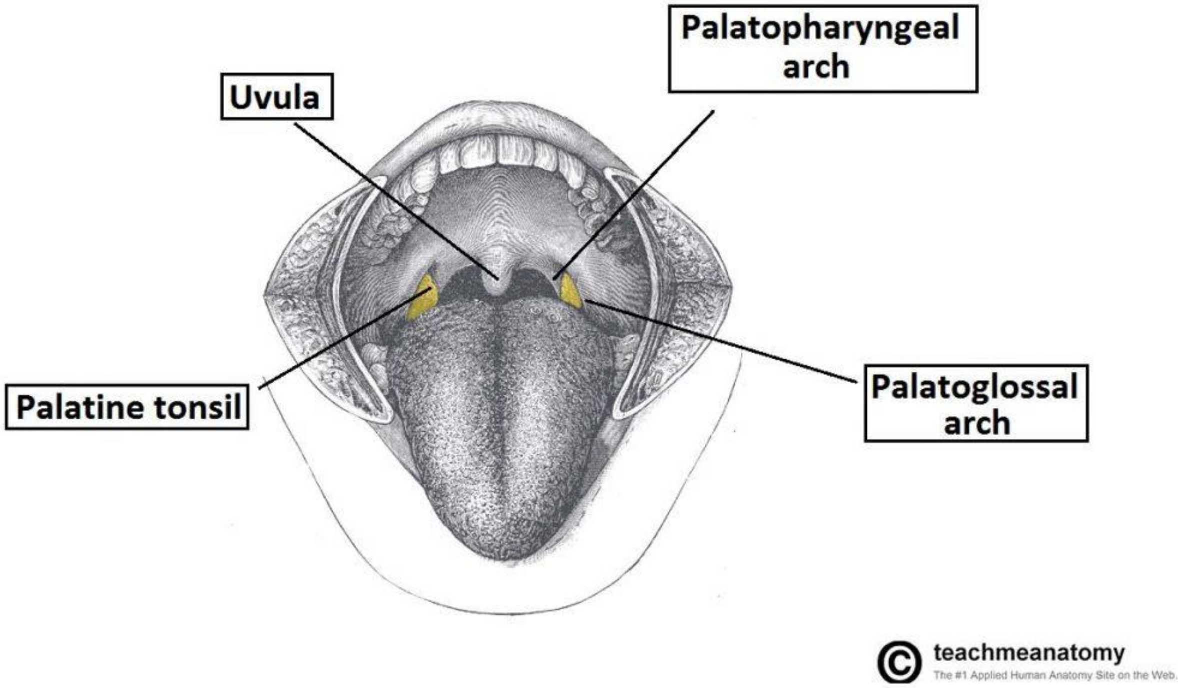
Soft Palate

The **soft palate** is located posteriorly. It is mobile, and comprised of muscle fibres covered by a mucous membrane.

Anteriorly, it is continuous with the hard palate and with the palatine aponeurosis. The posterior border of the soft palate is free (i.e. not connected to any structure), and has a central process that hangs from the midline – the **uvula**.

The soft palate also forms the roof of the **fauces**; an area connecting the oral cavity and the pharynx. Two arches bind the palate to the tongue and pharynx; the **palatoglossal arches** anteriorly and the **palatopharyngeal arches** posteriorly. Between these two arches lie the palatine tonsils, which reside in the tonsillar fossae of the oropharynx.





Muscles of the Soft Palate

There are five muscles which give the actions of the soft palate.

They are all innervated by the **pharyngeal branch** of the **vagus nerve (CN X)** – apart from Tensor veli palatini – which is innervated by the medial pterygoid nerve (a branch of CN V3).

Tensor Veli Palatini

Attachments: Originates from the medial pterygoid plate of the sphenoid and inserts into the palatine aponeurosis.

Function: Tenses the soft palate.

Levator Veli Palatini

Attachments: Arises from the petrous temporal bone and the eustachian tube, before inserting into the palatine aponeurosis.

Function: Elevation of the soft palate.

Palatoglossus

Attachments: Originates from the palatine aponeurosis, and travels anteriorly, laterally and inferiorly to insert into the side of the tongue.

Function: Pulls the soft palate towards the tongue.

Palatopharyngeus

Attachments: Arises from the palatine aponeurosis and the hard palate, and inserts into the upper border of the thyroid cartilage.

Function: Tenses soft palate and draws the pharynx anteriorly on swallowing.

Musculus Uvulae

Attachments: Arises from the posterior nasal spine and the palatine aponeurosis, and inserts into the mucous membrane of the uvula.

Function: Shortens the uvula.

Vasculature

The palate receives arterial supply primarily from the **greater palatine arteries**, which run anteriorly from the greater palatine foramen.

In addition, the anastomosis between the lesser palatine artery and ascending palatine artery provide collateral supply to the palate.

Venous drainage is into the **pterygoid venous plexus**.

Innervation

Sensory innervation of the palate is derived from the **maxillary branch** of the trigeminal nerve (CN V). The greater palatine nerve innervates most of the glandular structures of the hard palate.

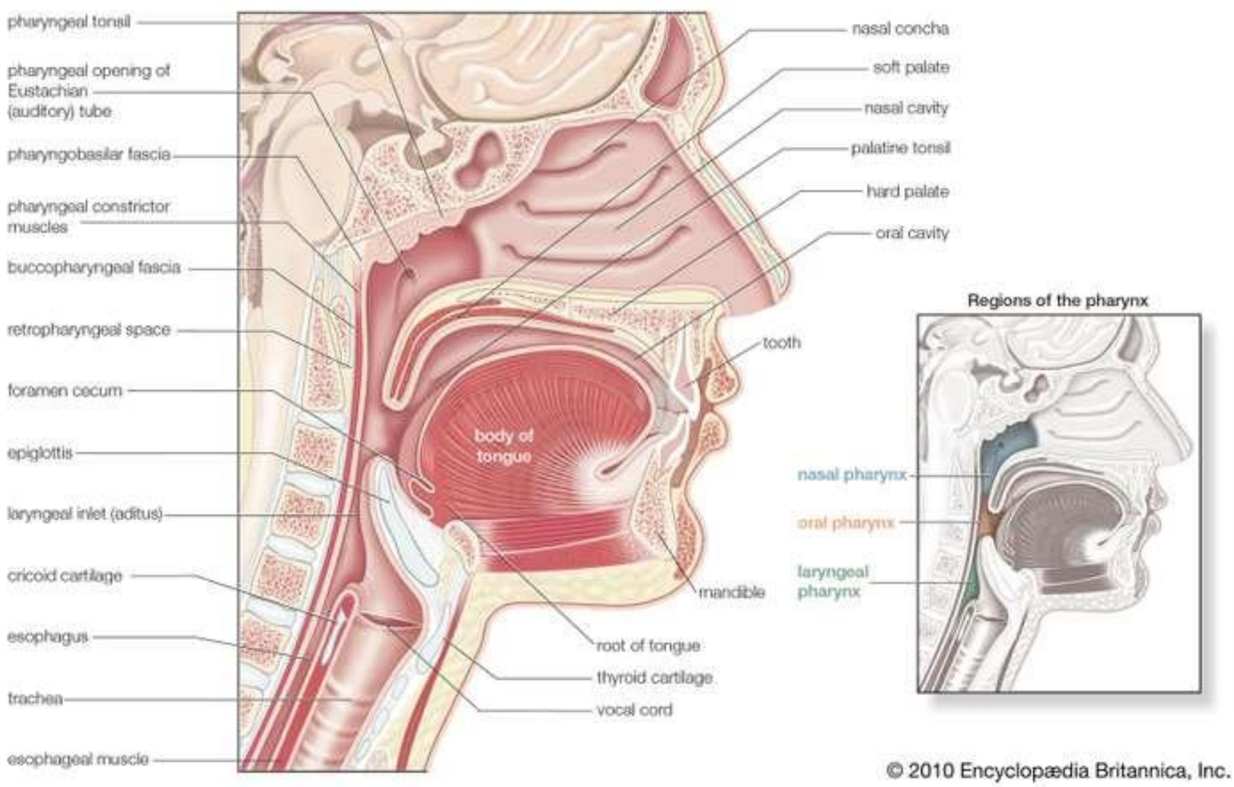
The **nasopalatine nerve** innervates the mucous membrane of the anterior hard palate and the lesser palatine nerves innervate the soft palate.

Pharynx, (Greek: "throat") cone-shaped passageway leading from the oral and nasal cavities in the head to the esophagus and larynx. The pharynx chamber serves both respiratory and digestive functions. Thick fibres of muscle and connective tissue attach the pharynx to the base of the skull and surrounding structures. Both circular and longitudinal muscles occur in the walls of the pharynx; the circular muscles form constrictions that help push food to the esophagus and prevent air from being swallowed, while the longitudinal fibres lift the walls of the pharynx during swallowing.

The pharynx consists of three main divisions. The anterior portion is the nasal pharynx, the back section of the nasal cavity. The nasal pharynx connects to the second region, the oral pharynx, by means of a passage called an isthmus. The oral pharynx begins at the back of the mouth cavity and continues down the throat to the epiglottis, a flap of tissue that covers the air passage to the lungs and that channels food to the esophagus. Triangular-shaped recesses in the walls of this region house the palatine tonsils, two masses of lymphatic tissue prone to infection. The isthmus connecting the oral and nasal regions is extremely beneficial in humans. It allows them to breathe through either the nose or the mouth and, when medically necessary, allows food to be passed to the esophagus by nasal tubes. The third region is the laryngeal pharynx, which begins at the epiglottis and leads down to the esophagus. Its function is to regulate the passage of air to the lungs and food to the esophagus.

Two small tubes (eustachian tubes) connect the middle ears to the pharynx and allow air pressure on the eardrum to be equalized. Head colds sometimes inflame the tubes, causing earaches and hearing difficulties. Other medical afflictions associated with the pharynx include tonsillitis, cancer, and various types of throat paralyses caused by polio, diphtheria, rabies, or nervous-system injuries.

The term *pharynx* may also be used to describe a differentiated portion of the invertebrate alimentary canal. In some invertebrate species, the structure is thick and muscular. It is occasionally eversible (rotated or turned outward) and may have multiple functions—for example, being both suctorial and peristaltic in nature.

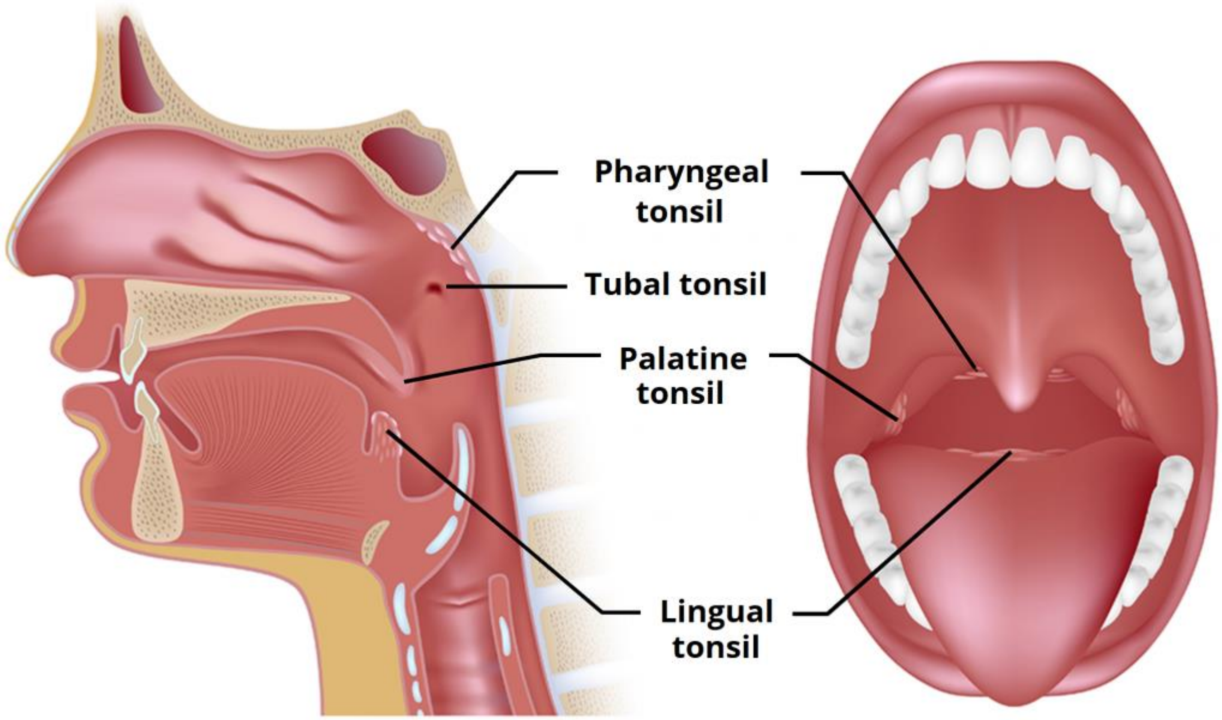


The tonsils are collections of lymphatic tissue located within the pharynx. They collectively form a ringed arrangement, known as Waldeyer's ring:

- Pharyngeal tonsil
- Tubal tonsils (x2)
- Palatine tonsils (x2)
- Lingual tonsil

The tonsils are classified as mucosa-associated lymphoid tissue (MALT), and therefore contain T cells, B cells and macrophages. They have an important role in fighting infection – the first line of defence against pathogens entering through the nasopharynx or oropharynx.

In this article, we shall look at the anatomy of the tonsils – their location, blood supply and any clinical correlations.



Lingual Tonsil

The lingual tonsil refers to numerous lymphoid nodules located within the submucosa of the posterior third of the tongue.

This tonsil is responsible for the irregular appearance of the posterior tongue surface. and forms the inferior part of Waldeyer's ring.

Like the rest of the tongue, the lingual tonsil is covered by a stratified non-keratinised squamous epithelium.

Blood Supply and Innervation

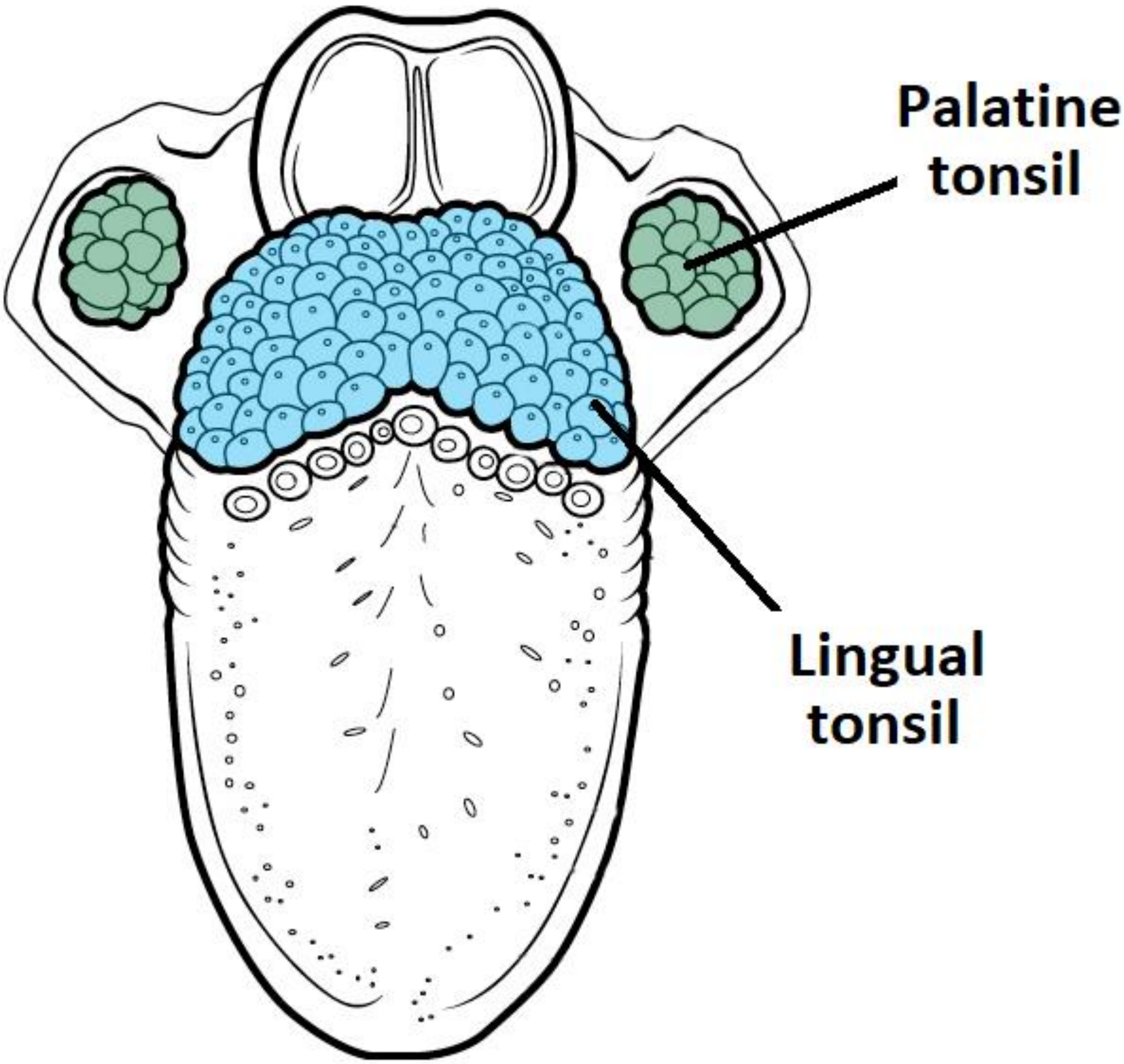
Arterial supply to the lingual tonsil via largely via the lingual artery, with contributions from the tonsillar branch of the facial artery and the ascending pharyngeal artery.

The dorsal lingual branch of the lingual vein performs the venous drainage.

Innervation is from the glossopharyngeal nerve.

Lymphatic Drainage

Lymphatic fluid from the lingual tonsil drains into the jugulodigastric and deep cervical lymph nodes.



Pharyngeal Tonsil

The pharyngeal tonsil refers to a collection of lymphoid tissue within the mucosa of the roof of the nasopharynx. When enlarged, the pharyngeal tonsil is also known as the adenoids.

It is located in the midline of the nasopharynx, and forms the superior aspect of Waldeyer's ring.

The epithelial covering of the pharyngeal tonsil is ciliated pseudostratified epithelium.

Blood Supply and Innervation

The pharyngeal tonsil receives arterial supply from several vessels:

- Ascending palatine artery
- Ascending pharyngeal artery (external carotid)

- Pharyngeal branch of the maxillary artery
- Artery of the pterygoid canal
- Basisphenoid artery
- Tonsillar branch of the facial artery

Venous drainage is via numerous small veins which pierce the superior constrictor muscle to empty into the pharyngeal plexus.
The pharyngeal tonsil receives nerve fibres from the vagus and glossopharyngeal nerves via the pharyngeal plexus, which drains into the internal jugular vein.

Lymphatic Drainage

Lymphatic fluid from the pharyngeal tonsil drains into the retropharyngeal nodes (which empty into the deep cervical chain), and directly into deep cervical nodes within the parapharyngeal space.

Tubal Tonsils

The tubal tonsils refer to lymphoid tissue around the opening of the Eustachian tube in the lateral wall of the nasopharynx. They form the lateral aspect of the Waldeyer's ring.

The epithelial covering of the tubal tonsils is ciliated pseudostratified epithelium.

Blood Supply and Innervation

The neurovascular supply is similar to other structures in the nasopharynx. Arterial supply is chiefly via the ascending pharyngeal artery and venous drainage is to the pharyngeal plexus.

Innervation is via the maxillary and glossopharyngeal nerves.

Lymphatic Drainage

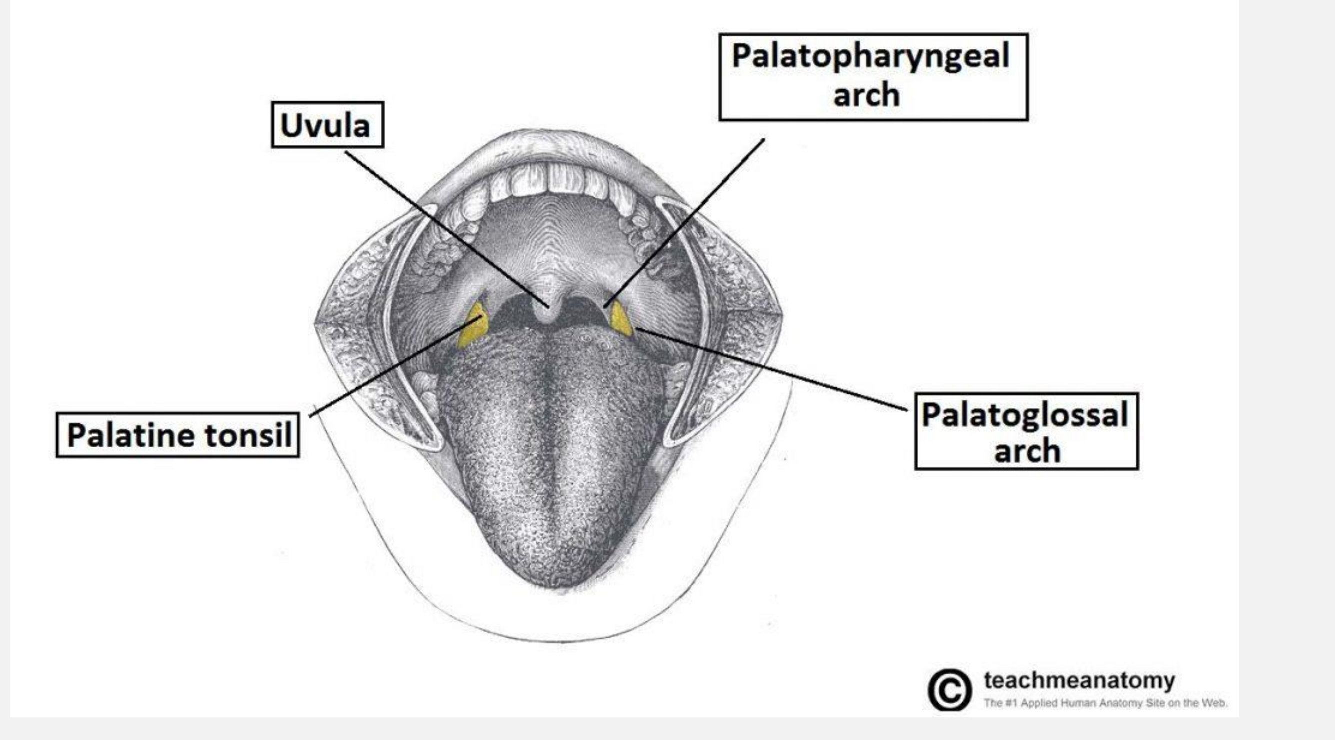
The retropharyngeal and the deep cervical lymph nodes drain the tubal tonsils.

Palatine Tonsils

The palatine tonsils are commonly referred to as 'the tonsils'.
They are located within the tonsillar bed of the lateral oropharynx wall – between the palatoglossal arch (anteriorly) and palatopharyngeal arch (posteriorly). They form the lateral part of the Waldeyer's ring.

Each tonsil has free medial surface which projects into the pharynx. The lateral surface is covered by a fibrous capsule, and is separated from the superior constrictor of the tonsillar bed by loose areolar connective tissue.

They are covered by a stratified non-keratinised squamous epithelium.



Blood Supply and Innervation

The arterial supply to the tonsil is via the tonsillar branch of the facial artery. It pierces the superior constrictor muscle to reach the palatine tonsil.

The venous drainage is via the external palatine vein (drains into the facial vein), and numerous smaller vessels which drain into the pharyngeal plexus.

The palatine tonsils receive innervation from the maxillary nerve and glossopharyngeal nerve.

Lymphatic Drainage

The palatine tonsils drain into the jugulodigastric and upper deep cervical lymph nodes.

The **stomach** is the most dilated part of the digestive tube, and is situated between the end of the esophagus and the beginning of the small intestine. It lies in the epigastric, umbilical, and left hypochondriac regions of the abdomen, and occupies a recess bounded by the upper abdominal viscera, and completed in front and on the left side by the anterior abdominal wall and the diaphragm.

The **shape and position** of the stomach are so greatly modified by changes within itself and in the surrounding viscera that no one form can be described as typical. The chief modifications are determined by (1) the amount of the stomach contents, (2) the stage which the digestive process has reached, (3) the degree of development of the gastric musculature, and (4) the condition of the adjacent intestines. It is, however, possible by comparing a series of stomachs to determine certain markings more or less common to all.

The stomach presents two **openings,** two **borders** or **curvatures,**and two **surfaces.**

Openings.—The opening by which the esophagus communicates with the stomach is known as the **cardiac orifice,** and is situated on the left of the middle line at the level of the tenth thoracic vertebra. The short abdominal portion of the esophagus (*antrum cardiacum*) is conical in shape and curved sharply to the left, the base of the cone being continuous with the cardiac orifice of the stomach. The right margin of the esophagus is continuous with the lesser curvature of the stomach, while the left margin joins the greater curvature at an acute angle, termed the **incisura cardiaca.**

The **pyloric orifice** communicates with the duodenum, and its position is usually indicated on the surface of the stomach by a circular groove, the **duodenopyloric constriction.** This orifice lies to the right of the middle line at the level of the upper border of the first lumbar vertebra.

Curvatures.—The **lesser curvature** (*curvatura ventriculi minor*), extending between the cardiac and pyloric orifices, forms the right or posterior border of the stomach. It descends as a continuation of the right margin of the esophagus in front of the fibers of the right crus of the diaphragm, and then, turning to the right, it crosses the first lumbar vertebra and ends at the pylorus. Nearer its pyloric than its cardiac end is a well-marked notch, the **incisura angularis,** which varies somewhat in position with the state of distension of the viscus; it serves to separate the stomach into a right and a left portion. The lesser curvature gives attachment to the two layers of the hepatogastric ligament, and between these two layers are the left gastric artery and the right gastric branch of the hepatic artery.

The **greater curvature** (*curvatura ventriculi major*) is directed mainly forward, and is four or five times as long as the lesser curvature. Starting from the cardiac orifice at the incisura cardiaca, it forms an arch backward, upward, and to the left; the highest point of the convexity is on a level with the sixth left costal cartilage. From this level it may be followed downward and forward, with a slight convexity to the left as low as the cartilage of the ninth rib; it then turns to the right, to the end of the pylorus. Directly opposite the incisura angularis of the lesser curvature the greater curvature presents a dilatation, which is the left extremity of the **pyloric part;**this dilatation is limited on the right by a slight groove, the **sulcus intermedius,** which is about 2.5 cm, from the duodenopyloric constriction. The portion between the sulcus intermedius and the duodenopyloric constriction is termed the **pyloric antrum.** At its commencement the greater curvature is covered by peritoneum continuous with that covering the front of the organ. The left part of the curvature gives attachment to the gastrolienal ligament, while to its anterior portion are attached the two layers of the greater omentum, separated from each other by the gastroepiploic vessels.

Surfaces.—When the stomach is in the contracted condition, its surfaces are directed upward and downward respectively, but when the viscus is distended they are directed forward, and backward. They may therefore be described as anterosuperior and postero-inferior.

Antero-superior Surface.—The left half of this surface is in contact with the diaphragm, which separates it from the base of the left lung, the pericardium, and the seventh, eighth, and ninth ribs, and intercostal spaces of the left side. The right half is in relation with the left and quadrate lobes of the liver and with the anterior abdominal wall. When the stomach is empty, the transverse colon may lie on the front part of this surface. The whole surface is covered by peritoneum.

The **Postero-inferior Surface** is in relation with the diaphragm, the spleen, the left suprarenal gland, the upper part of the front of the left kidney, the anterior surface of the pancreas, the left colic flexure, and the upper layer of the transverse mesocolon. These structures form a shallow bed, the **stomach bed,** on which the viscus rests. The transverse mesocolon separates the stomach from the duodenojejunal flexure and small intestine. The postero-inferior surface is covered by peritoneum, except over a small area close to the cardiac orifice; this area is limited by the lines of attachment of the **gastrophrenic ligament,** and lies in apposition with the diaphragm, and frequently with the upper portion of the left suprarenal gland.

Component Parts of the Stomach.—A plane passing through the incisura angularis on the lesser curvature and the left limit of the opposed dilatation on the greater curvature divides the stomach into a left portion or **body** and a right or **pyloric portion.** The left portion of the body is known as the **fundus,** and is marked off from the remainder of the body by a plane passing horizontally through the cardiac orifice. The pyloric portion is divided by a plane through the sulcus intermedius at right angles to the long axis of this portion; the part to the right of this plane is the **pyloric antrum**

If the stomach be examined during the process of digestion it will be found divided by a muscular constriction into a large dilated left portion, and a narrow contracted tubular right portion. The constriction is in the body of the stomach, and does not follow any of the anatomical landmarks; indeed, it shifts gradually toward the left as digestion progresses, *i. e.,* more of the body is gradually absorbed into the tubular part.

Position of the Stomach.—The position of the stomach varies with the posture, with the amount of the stomach contents and with the condition of the intestines on which it rests. In the erect posture the empty stomach is somewhat J-shaped; the part above the cardiac orifice is usually distended with gas; the pylorus descends to the level of the second lumbar vertebra and the most dependent part of the stomach is at the level of the umbilicus. Variation in the amount of its contents affects mainly the cardiac portion, the pyloric portion remaining in a more or less contracted condition during the process of digestion. As the stomach fills it tends to expand forward and downward in the direction of least resistance, but when this is interfered with by a distended condition of the colon or intestines the fundus presses upward on the liver and diaphragm and gives rise to the feelings of oppression and palpitation complained of in such cases. His (*166 and Cunningham (*167 have shown by hardening the viscera *in situ* that the contracted stomach has a sickle shape, the fundus looking directly backward. The surfaces are directed upward and downward, the upper surface having, however, a gradual downward slope to the right. The greater curvature is in front and at a slightly higher level than the lesser.

The position of the full stomach depends, as already indicated, on the state of the intestines; when these are empty the fundus expands vertically and also forward, the pylorus is displaced toward the right and the whole organ assumes an oblique position, so that its surfaces are directed more forward and backward. The lowest part of the stomach is at the pyloric vestibule, which reaches to the region of the umbilicus. Where the intestines interfere with the downward expansion of the fundus the stomach retains the horizontal position which is characteristic of the contracted viscus.

Examination of the stomach during life by *x*-rays has confirmed these findings, and has demonstrated that, in the erect posture, the full stomach usually presents a hook-like appearance, the long axis of the clinical fundus being directed downward, medialward, and forward toward the umbilicus, while the pyloric portion curves upward to the duodenopyloric junction.

Interior of the Stomach.—When examined after death, the stomach is usually fixed at some temporary stage of the digestive process. A common form is that shown in Fig. 1050. If the viscus be laid open by a section through the plane of its two curvatures, it is seen to consist of two segments: (*a*) a large globular portion on the left and (*b*) a narrow tubular part on the right. These correspond to the clinical subdivisions of fundus and pyloric portions already described, and are separated by a constriction which indents the body and greater curvature, but does not involve the lesser curvature. To the left of the cardiac orifice is the incisura cardiaca: the projection of this notch into the cavity of the stomach increases as the organ distends, and has been supposed to act as a valve preventing regurgitation into the esophagus. In the pyloric portion are seen: (*a*) the elevation corresponding to the incisura angularis, and (*b*) the circular projection from the duodenopyloric constriction which forms the pyloric valve; the separation of the pyloric antrum from the rest of the pyloric part is scarcely indicated.

The pyloric valve (valvula pylori) is formed by a reduplication of the mucous membrane of the stomach, covering a muscular ring composed of a thickened portion of the circular layer of the muscular coat. Some of the deeper longitudinal fibers turn in and interlace with the circular fibers of the valve.

Structure.—The wall of the stomach consists of four coats: serous, muscular, areolar, and mucous, together with vessels and nerves.

The serous coat (tunica serosa) is derived from the peritoneum, and covers the entire surface of the organ, excepting along the greater and lesser curvatures at the points of attachment of the greater and lesser omenta; here the two layers of peritoneum leave a small triangular space, along which the nutrient vessels and nerves pass. On the posterior surface of the stomach, close to the cardiac orifice, there is also a small area uncovered by peritoneum, where the organ is in contact with the under surface of the diaphragm.

The muscular coat (tunica muscularis) (Figs. 1051, 1052) is situated immediately beneath the serous covering, with which it is closely connected. It consists of three sets of smooth muscle fibers: longitudinal, circular and oblique.

The longitudinal fibers (stratum longitudinale) are the most superficial, and are arranged in two sets. The first set consists of fibers continuous with the longitudinal fibers of the esophagus; they radiate in a stellate manner from the cardiac orifice and are practically all lost before the pyloric portion is reached. The second set commences on the body of the stomach and passes to the right, its fibers becoming more thickly distributed as they approach the pylorus. Some of the more superficial fibers of this set pass on to the duodenum, but the deeper fibers dip inward and interlace with the circular fibers of the pyloric valve.

The circular fibers (stratum circulare) form a uniform layer over the whole extent of the stomach beneath the longitudinal fibers. At the pylorus they are most abundant, and are aggregated into a circular ring, which projects into the lumen, and forms, with the fold of mucous membrane covering its surface, the pyloric valve. They are continuous with the circular fibers of the esophagus, but are sharply marked off from the circular fibers of the duodenum.

The oblique fibers (fibræ obliquæ) internal to the circular layer, are limited chiefly to the cardiac end of the stomach, where they are disposed as a thick uniform layer, covering both surfaces, some passing obliquely from left to right, others from right to left, around the cardiac end.

The areolar or submucous coat (tela submucosa) consists of a loose, areolar tissue, connecting the mucous and muscular layers.

The mucous membrane (tunica mucosa) is thick and its surface is smooth, soft, and velvety. In the fresh state it is of a pinkish tinge at the pyloric end, and of a red or reddish-brown color over the rest of its surface. In infancy it is of a brighter hue, the vascular redness being more marked. It is thin at the cardiac extremity, but thicker toward the pylorus. During the contracted state of the organ it is thrown into numerous plaits or rugæ, which, for the most part, have a longitudinal direction, and are most marked toward the pyloric end of the stomach, and along the greater curvature (Fig. 1050). These folds are entirely obliterated when the organ becomes distended.

Structure of the Mucous Membrane.—When examined with a lens, the inner surface of the mucous membrane presents a peculiar honeycomb appearance from being covered with small shallow depressions or alveoli, of a polygonal or hexagonal form, which vary from 0.12 to 0.25 mm. in diameter. These are the ducts of the gastric glands, and at the bottom of each may be seen one or more minute orifices, the openings of the gland tubes. The surface of the mucous membrane is covered by a single layer of columnar epithelium with occasional goblet cells. This epithelium commences very abruptly at the cardiac orifice, where there is a sudden transition from the stratified epithelium of the esophagus. The epithelial lining of the gland ducts is of the same character and is continuous with the general epithelial lining of the stomach (Fig. 1055).

The Gastric Glands.—The gastric glands are of three kinds: (a) pyloric, (b) cardiac, and (c) fundus or oxyntic glands. They are tubular in character, and are formed of a delicate basement membrane, consisting of flattened transparent endothelial cells lined by epithelium. The pyloric glands (Fig. 1054) are found in the pyloric portion of the stomach. They consist of two or three short closed tubes opening into a common duct or mouth. These tubes are wavy, and are about one-half the length of the duct. The duct is lined by columnar cells, continuous with the epithelium lining the surface of the mucous membrane of the stomach, the tubes by shorter and more cubical cell which are finely granular. The cardiac glands (Fig. 1053), few in number, occur close to the cardiac orifice. They are of two kinds: (1) simple tubular glands resembling those of the pyloric end of the stomach, but with short ducts; (2) compound racemose glands resembling the duodenal glands. The fundus glands (Fig. 1055) are found in the body and fundus of the stomach; they are simple tubes, two or more of which open into a single duct. The duct, however, in these glands is shorter than in the pyloric variety, sometimes not amounting to more than one-sixth of the whole length of the gland; it is lined throughout by columnar epithelium. The gland tubes are straight and parallel to each other. At the point where they open into the duct, which is termed the neck, the epithelium alters, and consists of short columnar or polyhedral, granular cells, which almost fill the tube, so that the lumen becomes suddenly constricted and is continued down as a very fine channel. They are known as the chief or central cells of the glands. Between these cells and the basement membrane, larger oval cells, which stain deeply with eosin, are found; these cells are studded throughout the tube at intervals, giving it a beaded or varicose appearance. These are known as the parietal or oxyntic cells, and they are connected with the lumen by fine channels which run into their substance. Between the glands the mucous membrane consists of a connective-tissue frame-work, with lymphoid tissue. In places, this later tissue, especially in early life, is collected into little masses, which to a certain extent resemble the solitary nodules of the intestine, and are termed the lenticular glands of the stomach. They are not, however, so distinctly circumscribed as the solitary nodules. Beneath the mucous membrane, and between it and the submucous coat, is a thin stratum of involuntary muscular fiber (muscularis mucosæ), which in some parts consists only of a single longitudinal layer; in others of two layers, an inner circular and an outer longitudinal.

The small intestine is a convoluted tube, extending from the pylorus to the colic valve, where it ends in the large intestine. It is about 7 meters long, (*168 and gradually diminishes in size from its commencement to its termination. It is contained in the central and lower part of the abdominal cavity, and is surrounded above and at the sides by the large intestine; a portion of it extends below the superior aperture of the pelvis and lies in front of the rectum. It is in relation, in front, with the greater omentum and abdominal parietes, and is connected to the vertebral column by a fold of peritoneum, the mesentery. The small intestine is divisible into three portions: the duodenum, the jejunum, and the ileum.

The Duodenum (Fig. 1056) has received its name from being about equal in length to the breadth of twelve fingers (25 cm.). It is the shortest, the widest, and the most fixed part of the small intestine, and has no mesentery, being only partially covered by peritoneum. Its course presents a remarkable curve, somewhat of the shape of an imperfect circle, so that its termination is not far removed from its starting-point.

In the adult the course of the duodenum is as follows: commencing at the pylorus it passes backward, upward, and to the right, beneath the quadrate lobe of the liver to the neck of the gall-bladder, varying slightly in direction according to the degree of distension of the stomach: it then takes a sharp curve and descends along the right margin of the head of the pancreas, for a variable distance, generally to the level of the upper border of the body of the fourth lumbar vertebra. It now takes a second bend, and passes from right to left across the vertebral column, having a slight inclination upward; and on the left side of the vertebral column it ascends for about 2.5 cm., and then ends opposite the second lumbar vertebra in the jejunum. As it unites with the jejunum it turns abruptly forward, forming the duodendojejunal flexure. From the above description it will be seen that the duodenum may be divided into four portions: superior, descending, horizontal, and ascending.

Relations.—The superior portion (pars superior; first portion) is about 5 cm. long. Beginning at the pylorus, it ends at the neck of the gall-bladder. It is the most movable of the four portions. It is almost completely covered by peritoneum, but a small part of its posterior surface near the neck of the gall-bladder and the inferior vena cava is uncovered; the upper border of its first half has the hepatoduodenal ligament attached to it, while to the lower border of the same segment the greater omentum is connected. It is in such close relation with the gall-bladder that it is usually found to be stained by bile after death, especially on its anterior surface. It is in relation above and in front with the quadrate lobe of the liver and the gall-bladder; behind with the gastroduodenal artery, the common bile duct, and the portal vein; and below and behind with the head and neck of the pancreas.

The descending portion (pars descendens; second portion) is from 7 to 10 cm. long, and extends from the neck of the gall-bladder, on a level with the first lumbar vertebra, along the right side of the vertebral column as low as the upper border of the body of the fourth lumbar vertebra. It is crossed in its middle third by the transverse colon, the posterior surface of which is uncovered by peritoneum and is connected to the duodenum by a small quantity of connective tissue. The supra- and infracolic portions are covered in front by peritoneum, the infracolic part by the right leaf of the mesentery. Posteriorly the descending portion of the duodenum is not covered by peritoneum. The descending portion is in relation, in front, from above downward, with the duodenal impression on the right lobe of the liver, the transverse colon, and the small intestine; behind, it has a variable relation to the front of the right kidney in the neighborhood of the hilum, and is connected to it by loose areolar tissue; the renal vessels, the inferior vena cava, and the Psoas below, are also behind it. At its medial side is the head of the pancreas, and the common bile duct; to its lateral side is the right colic flexure. The common bile duct and the pancreatic duct together perforate the medial side of this portion of the intestine obliquely (Figs. 1057 and 1100), some 7 to 10 cm. below the pylorus; the accessory pancreatic duct sometimes pierces it about 2 cm. above and slightly in front of these.

The horizontal portion (pars horizontalis; third or preaortic or transverse portion) is from 5 to 7.5 cm. long. It begins at the right side of the upper border of the fourth lumbar vertebra and passes from right to left, with a slight inclination upward, in front of the great vessels and crura of the diaphragm, and ends in the ascending portion in front of the abdominal aorta. It is crossed by the superior mesenteric vessels and the mesentery. Its front surface is covered by peritoneum, except near the middle line, where it is crossed by the superior mesenteric vessels. Its posterior surface is uncovered by peritoneum, except toward its left extremity, where the posterior layer of the mesentery may sometimes be found covering it to a variable extent. This surface rests upon the right crus of the diaphragm, the inferior vena cava, and the aorta. The upper surface is in relation with the head of the pancreas.

The ascending portion (pars ascendens; fourth portion) of the duodenum is about 2.5 cm long. It ascends on the left side of the aorta, as far as the level of the upper border of the second lumbar vertebra, where it turns abruptly forward to become the jejunum, forming the duodenojejunal flexure. It lies in front of the left Psoas major and left renal vessels, and is covered in front, and partly at the sides, by peritoneum continuous with the left portion of the mesentery.

The superior part of the duodenum, as stated above, is somewhat movable, but the rest is practically fixed, and is bound down to neighboring viscera and the posterior abdominal wall by the peritoneum. In addition to this, the ascending part of the duodenum and the duodenojejunal flexure are fixed by a structure to which the name of Musculus suspensorius duodeni has been given. This structure commences in the connective tissue around the celiac artery and left crus of the diaphragm, and passes downward to be inserted into the superior border of the duodenojejunal curve and a part of the ascending duodenum, and from this it is continued into the mesentery. It possesses, according to Treitz, plain muscular fibers mixed with the fibrous tissue of which it is principally made up. It is of little importance as a muscle, but acts as a suspensory ligament.

Jejunum and Ileum.—The remainder of the small intestine from the end of the duodenum is named jejunum and ileum; the former term being given to the upper two-fifths and the latter to the lower three-fifths. There is no morphological line of distinction between the two, and the division is arbitrary; but at the same time the character of the intestine gradually undergoes a change from the commencement of the jejunum to the end of the ileum, so that a portion of the bowel taken from these two situations would present characteristic and marked differences. These are briefly as follows:

The Jejunum (intestinum jejunum) is wider, its diameter being about 4 cm., and is thicker, more vascular, and of a deeper color than the ileum, so that a given length weighs more. The circular folds (valvulæ conniventes) of its mucous membrane are large and thickly set, and its villi are larger than in the ileum. The aggregated lymph nodules are almost absent in the upper part of the jejunum, and in the lower part are less frequently found than in the ileum, and are smaller and tend to assume a circular form. By grasping the jejunum between the finger and thumb the circular folds can be felt through the walls of the gut; these being absent in the lower part of the ileum, it is possible in this way to distinguish the upper from the lower part of the small intestine.

The **Ileum** (*intestinum ileum*) is narrow, its diameter being 3.75 cm., and its coats thinner and less vascular than those of the jejunum. It possesses but few circular folds, and they are small and disappear entirely toward its lower end, but aggregated lymph nodules (Peyer's patches) are larger and more numerous. The jejunum for the most part occupies the umbilical and left iliac regions, while the ileum occupies chiefly the umbilical, hypogastric, right iliac, and pelvic regions. The terminal part of the ileum usually lies in the pelvis, from which it ascends over the right Psoas and right iliac vessels; it ends in the right iliac fossa by opening into the medial side of the commencement of the large intestine. The jejunum and ileum are attached to the posterior abdominal wall by an extensive fold of peritoneum, the **mesentery,** which allows the freest motion, so that each coil can accommodate itself to changes in form and position. The mesentery is fan-shaped; its posterior border or root, about 15 cm. long, is attached to the posterior abdominal wall from the left side of the body of the second lumbar vertebra to the right sacroiliac articulation, crossing successively the horizontal part of the duodenum, the aorta, the inferior vena cava, the ureter, and right Psoas muscle (Fig. 1040). Its breadth between its vertebral and intestinal borders averages about 20 cm., and is greater in the middle than at its upper and lower ends. According to Lockwood it tends to increase in breadth as age advances. Between the two layers of which it is composed are contained bloodvessels, nerves, lacteals, and lymph glands, together with a variable amount of fat.

Meckel's Diverticulum (*diverticulum ilei*).—This consists of a pouch which projects from the lower part of the ileum in about 2 per cent. of subjects. Its average position is about 1 meter above the colic valve, and its average length about 5 cm. Its caliber is generally similar to that of the ileum, and its blind extremity may be free or may be connected with the abdominal wall or with some other portion of the intestine by a fibrous band. It represents the remains of the proximal part of the vitelline duct, the duct of communication between the yolk-sac and the primitive digestive tube in early fetal life.

Structure.—The wall of the small intestine (Fig. 1058) is composed of four coats: **serous, muscular, areolar,** and **mucous.**

The **serous coat** (*tunica serosa*) is derived from the peritoneum. The superior portion of the duodenum is almost completely surrounded by this membrane near its pyloric end, but is only covered in front at the other extremity; the descending portion is covered by it in front, except where it is carried off by the transverse colon; and the inferior portion lies behind the peritoneum which passes over it without being closely incorporated with the other coats of this part of the intestine, and is separated from it in and near the middle line by the superior mesenteric vessels. The rest of the small intestine is surrounded by the peritoneum, excepting along its attached or mesenteric border; here a space is left for the vessels and nerves to pass to the gut.

The **muscular coat** (*tunica muscularis*) consists of two layers of unstriped fibers: an external, longitudinal, and an internal, circular layer. The *longitudinal fibers* are thinly scattered over the surface of the intestine, and are more distinct along its free border. The *circular fibers* form a thick, uniform layer, and are composed of plain muscle cells of considerable length. The muscular coat is thicker at the upper than at the lower part of the small intestine.

The **areolar** or **submucous coat** (*tela submucosa*) connects together the mucous and muscular layers. It consists of loose, filamentous areolar tissue containing bloodvessels, lymphatics, and nerves. It is the strongest layer of the intestine.

The **mucous membrane** (*tunica mucosa*) is thick and highly vascular at the upper part of the small intestine, but somewhat paler and thinner below. It consists of the following structures: next the areolar or submucous coat is a double layer of unstriped muscular fibers, outer longitudinal and inner circular, the **muscularis mucosæ**internal to this is a quantity of retiform tissue, enclosing in its meshes lymph corpuscles, and in this the bloodvessels and nerves ramify; lastly, a basement membrane, supporting a single layer of epithelial cells, which throughout the intestine are columnar in character. The cells are granular in appearance, and each possesses a clear oval nucleus. At their superficial or unattached ends they present a distinct layer of highly refracting material, marked by vertical striæ, the **striated border.**

The **circular folds** (*plicæ circulares* [*Kerkringi*]; *valvulæ conniventes; valves of Kerkring*) are large valvular flaps projecting into the lumen of the bowel. They are composed of reduplications of the mucous membrane, the two layers of the fold being bound together by submucous tissue; unlike the folds in the stomach, they are permanent, and are not obliterated when the intestine is distended. The majority extend transversely around the cylinder of the intestine for about one-half or two-thirds of its circumference, but some form complete circles, and others have a spiral direction; the latter usually extend a little more than once around the bowel, but occasionally two or three times. The larger folds are about 8 mm. in depth at their broadest part; but the greater number are of smaller size. The larger and smaller folds alternate with each other. They are not found at the commencement of the duodenum, but begin to appear about 2.5 or 5 cm. beyond the pylorus. In the lower part of the descending portion, below the point where the bile and pancreatic ducts enter the intestine, they are very large and closely approximated. In the horizontal and ascending portions of the duodenum and upper half of the jejunum they are large and numerous, but from this point, down to the middle of the ileum, they diminish considerably in size. In the lower part of the ileum they almost entirely disappear; hence the comparative thinness of this portion of the intestine, as compared with the duodenum and jejunum. The circular folds retard the passage of the food along the intestines, and afford an increased surface for absorption.

The **intestinal villi** (*villi intestinales*) are highly vascular processes, projecting from the mucous membrane of the small intestine throughout its whole extent, and giving to its surface a velvety appearance. They are largest and most numerous in the duodenum and jejunum, and become fewer and smaller in the ileum.

Structure of the villi (Figs. 1059, 1060).—The essential parts of a villus are: the lacteal vessel, the bloodvessels, the epithelium, the basement membrane, and the muscular tissue of the mucosa, all being supported and held together by retiform lymphoid tissue.

The *lacteals* are in some cases double, and in some animals multiple, but usually there is a single vessel. Situated in the axis of the villus, each commences by dilated cecal extremities near to, but not quite at, the summit of the villus. The walls are composed of a single layer of endothelial cells.

The *muscular fibers* are derived from the muscularis mucosæ, and are arranged in longitudinal bundless around the lacteal vessel, extending from the base to the summit of the villus, and giving off, laterally, individual muscle cells, which are enclosed by the reticulum, and by it are attached to the basement-membrane and to the lacteal.

The *bloodvessels* (Fig. 1061) form a plexus under the basement membrane, and are enclosed in the reticular tissue.

These structures are surrounded by the *basement membrane*,which is made up of a stratum of endothelial cells, and upon this is placed a layer of *columnar epithelium*, the characteristics of which have been described. The *retiform tissue* forms a net-work (Fig. 1060) in the meshes of which a number of leucocytes are found.

The intestinal glands (glandulæ intestinales [Lieberkühni]; crypts of Lieberkühn) (Fig. 1062) are found in considerable numbers over every part of the mucous membrane of the small intestine. They consist of minute tubular depressions of the mucous membrane, arranged perpendicularly to the surface, upon which they open by small circular apertures. They may be seen with the aid of a lens, their orifices appearing as minute dots scattered between the villi. Their walls are thin, consisting of a basement membrane lined by columnar epithelium, and covered on their exterior by capillary vessels.

The duodenal glands (glandulæ duodenales [Brunneri]; Brunner's glands) are limited to the duodenum (Fig. 1058), and are found in the submucous areolar tissue. They are largest and most numerous near the pylorus, forming an almost complete layer in the superior portion and upper half of the descending portions of the duodenum. They then begin to diminish in number, and practically disappear at the junction of the duodenum and jejunum. They are small compound acinotubular glands consisting of a number of alveoli lined by short columnar epithelium and opening by a single duct on the inner surface of the intestine.

The solitary lymphatic nodules (noduli lymphatici solitarii; solitary glands) are found scattered throughout the mucous membrane of the small intestine, but are most numerous in the lower part of the ileum. Their free surfaces are covered with rudimentary villi, except at the summits, and each gland is surrounded by the openings of the intestinal glands. Each consists of a dense interlacing retiform tissue closely packed with lymph-corpuscles, and permeated with an abundant capillary network. The interspaces of the retiform tissue are continuous with larger lymph spaces which surround the gland, through which they communicate with the lacteal system. They are situated partly in the submucous tissue, partly in the mucous membrane, where they form slight projections of its epithelial layer (see Fig. 1082).

The aggregated lymphatic nodules (noduli lymphatici aggregati; Peyer's patches; Peyer's glands; agminated follicles; tonsillæ intestinales) (Fig. 1063) form circular or oval patches, from twenty to thirty in number, and varying in length from 2 to 10 cm. They are largest and most numerous in the ileum. In the lower part of the jejunum they are small, circular, and few in number. They are occasionally seen in the duodenum. They are placed lengthwise in the intestine, and are situated in the portion of the tube most distant from the attachment of the mesentery. Each patch is formed of a group of solitary lymphatic nodules covered with mucous membrane, but the patches do not, as a rule, possess villi on their free surfaces. They are best marked in the young subject, become indistinct in middle age, and sometimes disappear altogether in advanced life. They are freely supplied with bloodvessels (Fig. 1064), which form an abundant plexus around each follicle and give off fine branches permeating the lymphoid tissue in the interior of the follicle. The lymphatic plexuses are especially abundant around these patches.

The large intestine extends from the end of the ileum to the anus. It is about 1.5 meters long, being one-fifth of the whole extent of the intestinal canal. Its caliber is largest at its commencement at the cecum, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anal canal. It differs from the small intestine in its greater caliber, its more fixed position, its sacculated form, and in possessing certain appendages to its external coat, the appendices epiploicæ. Further, its longitudinal muscular fibers do not form a continuous layer around the gut, but are arranged in three longitudinal bands or tæniæ. The large intestine, in its course, describes an arch which surrounds the convolutions of the small intestine. It commences in the right iliac region, in a dilated part, the cecum. It ascends through the right lumbar and hypochondriac regions to the under surface of the liver; it here takes a bend, the right colic flexure, to the left and passes transversely across the abdomen on the confines of the epigastric and umbilical regions, to the left hypochondriac region; it then bends again, the left colic flexure, and descends through the left lumbar and iliac regions to the pelvis, where it forms a bend called the sigmoid flexure; from this it is continued along the posterior wall of the pelvis to the anus. The large intestine is divided into the cecum, colon, rectum, and anal canal.

The Cecum (intestinum cæcum) (Fig. 1073), the commencement of the large intestine, is the large blind pouch situated below the colic valve. Its blind end is directed downward, and its open end upward, communicating directly with the colon, of which this blind pouch appears to be the beginning or head, and hence the old name of caput cæcum coli was applied to it. Its size is variously estimated by different authors, but on an average it may be said to be 6.25 cm. in length and 7.5 in breadth. It is situated in the right iliac fossa, above the lateral half of the inguinal ligament: it rests on the Iliacus and Psoas major, and usually lies in contact with the anterior abdominal wall, but the greater omentum and, if the cecum be empty, some coils of small intestine may lie in front of it. As a rule, it is entirely enveloped by peritoneum, but in a certain number of cases (5 per cent., Berry) the peritoneal covering is not complete, so that the upper part of the posterior surface is uncovered and connected to the iliac fascia by connective tissue. The cecum lies quite free in the abdominal cavity and enjoys a considerable amount of movement, so that it may become herniated down the right inguinal canal, and has occasionally been found in an inguinal hernia on the left side. The cecum varies in shape, but, according to Treves, in man it may be classified under one of four types. In early fetal life it is short, conical, and broad at the base, with its apex turned upward and medialward toward the ileocolic junction. It then resembles the cecum of some monkeys, e. g., mangabey monkey. As the fetus grows the cecum increases in length more than in breadth, so that it forms a longer tube than in the primitive form and without the broad base, but with the same inclination of the apex toward the ileocolic junction. This form is seen in other monkeys, e. g., the spider monkey. As development goes on, the lower part of the tube ceases to grow and the upper part becomes greatly increased, so that at birth there is a narrow tube, the vermiform process, hanging from a conical projection, the cecum. This is the infantile form, and as it persists throughout life in about 2 per cent. of cases, it is regarded by Treves as the first of his four types of human ceca. The cecum is conical and the appendix rises from its apex. The three longitudinal bands start from the appendix and are equidistant from each other. In the second type, the conical cecum has become quadrate by the growing out of a saccule on either side of the anterior longitudinal band. These saccules are of equal size, and the appendix arises from between them, instead of from the apex of a cone. This type is found in about 3 per cent. of cases. The third type is the normal type of man. Here the two saccules, which in the second type were uniform, have grown at unequal rates: the right with greater rapidity than the left. In consequence of this an apparently new apex has been formed by the growing downward of the right saccule, and the original apex, with the appendix attached, is pushed over to the left toward the ileocolic junction. The three longitudinal bands still start from the base of the vermiform process, but they are now no longer equidistant from each other, because the right saccule has grown between the anterior and posterolateral bands, pushing them over to the left. This type occurs in about 90 per cent. of cases. The fourth type is merely an exaggerated condition of the third; the right saccule is still larger, and at the same time the left saccule has become atrophied, so that the original apex of the cecum, with the vermiform process, is close to the ileocolic junction, and the anterior band courses medialward to the same situation. This type is present in about 4 per cent. of cases.

The Vermiform Process or Appendix (processus vermiformis) (Fig. 1073) is a long, narrow, worm-shaped tube, which starts from what was originally the apex of the cecum, and may pass in one of several directions: upward behind the cecum; to the left behind the ileum and mesentery; or downward into the lesser pelvis. It varies from 2 to 20 cm. in length, its average being about 8.3 cm. It is retained in position by a fold of peritoneum (mesenteriole), derived from the left leaf of the mesentery. This fold, in the majority of cases, is more or less triangular in shape, and as a rule extends along the entire length of the tube. Between its two layers and close to its free margin lies the appendicular artery (Fig. 1073). The canal of the vermiform process is small, extends throughout the whole length of the tube, and communicates with the cecum by an orifice which is placed below and behind the ileocecal opening. It is sometimes guarded by a semilunar valve formed by a fold of mucous membrane, but this is by no means constant.

Structure.—The coats of the vermiform process are the same as those of the intestine: serous, muscular, submucous, and mucous. The serous coat forms a complete investment for the tube, except along the narrow line of attachment of its mesenteriole in its proximal two-thirds. The longitudinal muscular fibers do not form three bands as in the greater part of the large intestine, but invest the whole organ, except at one or two points where both the longitudinal and circular fibers are deficient so that the peritoneal and submucous coats are contiguous over small areas.

The circular muscle fibers form a much thicker layer than the longitudinal fibers, and are separated from them by a small amount of connective tissue. The submucous coat is well marked, and contains a large number of masses of lymphoid tissue which cause the mucous membrane to bulge into the lumen and so render the latter of small size and irregular shape. The mucous membrane is lined by columnar epithelium and resembles that of the rest of the large intestine, but the intestinal glands are fewer in number (Fig. 1074).

The Colic Valve (valvula coli; ileocecal valve) (Fig. 1075).—The lower end of the ileum ends by opening into the medial and back part of the large intestine, at the point of junction of the cecum with the colon. The opening is guarded by a valve, consisting of two segments or lips, which project into the lumen of the large intestine. If the intestine has been inflated and dried, the lips are of a semilunar shape. The upper one, nearly horizontal in direction, is attached by its convex border to the line of junction of the ileum with the colon; the lower lip, which is longer and more concave, is attached to the line of junction of the ileum with the cecum. At the ends of the aperture the two segments of the valve coalesce, and are continued as narrow membranous ridges around the canal for a short distance, forming the frenula of the valve. The left or anterior end of the aperture is rounded; the right or posterior is narrow and pointed. In the fresh condition, or in specimens which have been hardened in situ, the lips project as thick cushion-like folds into the lumen of the large gut, while the opening between them may present the appearance of a slit or may be somewhat oval in shape.

Each lip of the valve is formed by a reduplication of the mucous membrane and of the circular muscular fibers of the intestine, the longitudinal fibers and peritoneum being continued uninterruptedly from the small to the large intestine.

The surfaces of the valve directed toward the ileum are covered with villi, and present the characteristic structure of the mucous membrane of the small intestine; while those turned toward the large intestine are destitute of villi, and marked with the orifices of the numerous tubular glands peculiar to the mucous membrane of the large intestine. These differences in structure continue as far as the free margins of the valve. It is generally maintained that this valve prevents reflux from the cecum into the ileum, but in all probability it acts as a sphincter around the end of the ileum and prevents the contents of the ileum from passing too quickly into the cecum.

The Colon is divided into four parts: the ascending, transverse, descending, and sigmoid.

The Ascending Colon (colon ascendens) is smaller in caliber than the cecum, with which it is continuous. It passes upward, from its commencement at the cecum, opposite the colic valve, to the under surface of the right lobe of the liver, on the right of the gall-bladder, where it is lodged in a shallow depression, the colic impression;here it bends abruptly forward and to the left, forming the right colic(hepatic) flexure (Fig. 1056). It is retained in contact with the posterior wall of the abdomen by the peritoneum, which covers its anterior surface and sides, its posterior surface being connected by loose areolar tissue with the Iliacus, Quadratus lumborum, aponeurotic origin of Transversus abdominis, and with the front of the lower and lateral part of the right kidney. Sometimes the peritoneum completely invests it, and forms a distinct but narrow mesocolon. (*169 It is in relation, in front, with the convolutions of the ileum and the abdominal parietes.

The Transverse Colon (colon transversum) the longest and most movable part of the colon, passes with a downward convexity from the right hypochondriac region across the abdomen, opposite the confines of the epigastric and umbilical zones, into the left hypochondriac region, where it curves sharply on itself beneath the lower end of the spleen, forming the left colic (splenic) flexure. In its course it describes an arch, the concavity of which is directed backward and a little upward; toward its splenic end there is often an abrupt U-shaped curve which may descend lower than the main curve. It is almost completely invested by peritoneum, and is connected to the inferior border of the pancreas by a large and wide duplicature of that membrane, the transverse mesocolon. It is in relation, by its upper surface, with the liver and gall-bladder, the greater curvature of the stomach, and the lower end of the spleen; by its under surface, with the small intestine; by its anterior surface, with the anterior layers of the greater omentum and the abdominal parietes; its posterior surface is in relation from right to left with the descending portion of the duodenum, the head of the pancreas, and some of the convolutions of the jejunum and ileum.

The left colic or splenic flexure (Fig. 1056) is situated at the junction of the transverse and descending parts of the colon, and is in relation with the lower end of the spleen and the tail of the pancreas; the flexure is so acute that the end of the transverse colon usually lies in contact with the front of the descending colon. It lies at a higher level than, and on a plane posterior to, the right colic flexure, and is attached to the diaphragm, opposite the tenth and eleventh ribs, by a peritoneal fold, named the phrenicocolic ligament, which assists in supporting the lower end of the spleen (see page 1158).

The Descending Colon (*170 (colon descendens) passes downward through the left hypochondriac and lumbar regions along the lateral border of the left kidney. At the lower end of the kidney it turns medialward toward the lateral border of the Psoas, and then descends, in the angle between Psoas and Quadratus lumborum, to the crest of the ilium, where it ends in the iliac colon. The peritoneum covers its anterior surface and sides, while its posterior surface is connected by areolar tissue with the lower and lateral part of the left kidney, the aponeurotic origin of the Transversus abdominis, and the Quadratus lumborum. It is smaller in caliber and more deeply placed than the ascending colon, and is more frequently covered with peritoneum on its posterior surface than the ascending colon (Treves). In front of it are some coils of small intestine.

The Iliac Colon is situated in the left iliac fossa, and is about 12 to 15 cm. long. It begins at the level of the iliac crest, where it is continuous with the descending colon, and ends in the sigmoid colon at the superior aperture of the lesser pelvis. It curves downward and medialward in front of the Iliacus and Psoas, and, as a rule, is covered by peritoneum on its sides and anterior surface only.

The Sigmoid Colon (colon sigmoideum; pelvic colon; sigmoid flexure) forms a loop which averages about 40 cm. in length, and normally lies within the pelvis, but on account of its freedom of movement it is liable to be displaced into the abdominal cavity. It begins at the superior aperture of the lesser pelvis, where it is continuous with the iliac colon, and passes transversely across the front of the sacrum to the right side of the pelvis; it then curves on itself and turns toward the left to reach the middle line at the level of the third piece of the sacrum, where it bends downward and ends in the rectum. It is completely surrounded by peritoneum, which forms a mesentery (sigmoid mesocolon), which diminishes in length from the center toward the ends of the loop, where it disappears, so that the loop is fixed at its junctions with the iliac colon and rectum, but enjoys a considerable range of movement in its central portion. Behind the sigmoid colon are the external iliac vessels, the left Piriformis, and left sacral plexus of nerves; in front, it is separated from the bladder in the male, and the uterus in the female, by some coils of the small intestine.

The Rectum (intestinum rectum) is continuous above with the sigmoid colon, while below it ends in the anal canal. From its origin at the level of the third sacral vertebra it passes downward, lying in the sacrococcygeal curve, and extends for about 2.5 cm. in front of, and a little below, the tip of the coccyx, as far as the apex of the prostate. It then bends sharply backward into the anal canal. It therefore presents two antero-posterior curves: an upper, with its convexity backward, and a lower, with its convexity forward. Two lateral curves are also described, one to the right opposite the junction of the third and fourth sacral vertebræ, and the other to the left, opposite the left sacrococcygeal articulation; they are, however, of little importance. The rectum is about 12 cm. long, and at its commencement its caliber is similar to that of the sigmoid colon, but near its termination it is dilated to form the rectal ampulla. The rectum has no sacculations comparable to those of the colon, but when the lower part of the rectum is contracted, its mucous membrane is thrown into a number of folds, which are longitudinal in direction and are effaced by the distension of the gut. Besides these there are certain permanent transverse folds, of a semilunar shape, known as Houston’s valves (Fig. 1078). They are usually three in number; sometimes a fourth is found, and occasionally only two are present. One is situated near the commencement of the rectum, on the right side; a second extends inward from the left side of the tube, opposite the middle of the sacrum; a third, the largest and most constant, projects backward from the forepart of the rectum, opposite the fundus of the urinary bladder. When a fourth is present, it is situated nearly 2.5 cm. above the anus on the left and posterior wall of the tube. These folds are about 12 mm. in width, and contain some of the circular fibers of the gut. In the empty state of the intestine they overlap each other, as Houston remarks, so effectually as to require considerable maneuvering to conduct a bougie or the finger along the canal. Their use seems to be, "to support the weight of fecal matter, and prevent its urging toward the anus, where its presence always excites a sensation demanding its discharge.

The peritoneum is related to the upper two-thirds of the rectum, covering at first its front and sides, but lower down its front only; from the latter it is reflected on to the seminal vesicles in the male and the posterior vaginal wall in the female.

The level at which the peritoneum leaves the anterior wall of the rectum to be reflected on to the viscus in front of it is of considerable importance from a surgical point of view, in connection with the removal of the lower part of the rectum. It is higher in the male than in the female. In the former the height of the rectovesical excavation is about 7.5 cm., i. e., the height to which an ordinary index finger can reach from the anus. In the female the height of the rectouterine excavation is about 5.5 cm. from the anal orifice. The rectum is surrounded by a dense tube of fascia derived from the fascia endopelvina, but fused behind with the fascia covering the sacrum and coccyx. The facial tube is loosely attached to the rectal wall by areolar tissue in order to allow of distension of the viscus.

Relations of the Rectum.—The upper part of the rectum is in relation, behind, with the superior hemorrhoidal vessels, the left Piriformis, and left sacral plexus of nerves, which separate it from the pelvic surfaces of the sacral vertebræ; in its lower part it lies directly on the sacrum, coccyx, and Levatores ani, a dense fascia alone intervening; in front, it is separated above, in the male, from the fundus of the bladder; in the female, from the intestinal surface of the uterus and its appendages, by some convolutions of the small intestine, and frequently by the sigmoid colon; below, it is in relation in the male with the triangular portion of the fundus of the bladder, the vesiculæ seminales, and ductus deferentes, and more anteriorly with the posterior surface of the prostate; in the female, with the posterior wall of the vagina.

The **Anal Canal** (*pars analis recti*), or terminal portion of the large intestine, begins at the level of the apex of the prostate, is directed downward and backward, and ends at the anus. It forms an angle with the lower part of the rectum, and measures from 2.5 to 4 cm. in length. It has no peritoneal covering, but is invested by the Sphincter ani internus, supported by the Levatores ani, and surrounded at its termination by the Sphincter ani externus. In the empty condition it presents the appearance of an antero-posterior longitudinal slit. Behind it is a mass of muscular and fibrous tissue, the **anococcygeal body** (Symington); in front of it, in the male, but separated by connective tissue from it, are the membranous portion and bulb of the urethra, and the fascia of the urogenital diaphragm; and in the female it is separated from the lower end of the vagina by a mass of muscular and fibrous tissue, named the **perineal body.**

The lumen of the anal canal presents, in its upper half, a number of vertical folds, produced by an infolding of the mucous membrane and some of the muscular tissue. They are known as the **rectal columns** [*Morgagni*], and are separated from one another by furrows (**rectal sinuses**), which end below in small valve-like folds, termed **anal valves,** which join together the lower ends of the rectal columns.

Structure of the Colon.—The large intestine has four coats: **serous, muscular, areolar,** and **mucous.**

The **serous coat** (*tunica serosa*) is derived from the peritoneum, and invests the different portions of the large intestine to a variable extent. The cecum is completely covered by the serous membrane, except in about 5 per cent. of cases where the upper part of the posterior surface is uncovered. The ascending, descending, and iliac parts of the colon are usually covered only in front and at the sides; a variable amount of the posterior surface is uncovered. (*172 The transverse colon is almost completely invested, the parts corresponding to the attachment of the greater omentum and transverse mesocolon being alone excepted. The sigmoid colon is entirely surrounded. The rectum is covered above on its anterior surface and sides; below, on its anterior aspect only; the anal canal is entirely devoid of any serous covering. In the course of the colon the peritoneal coat is thrown into a number of small pouches filled with fat, called **appendices epiploicæ.** They are most numerous on the transverse colon.

The **muscular coat** (*tunica muscularis*) consists of an external longitudinal, and an internal circular, layer of non-striped muscular fibers:

The *longitudinal fibers* do not form a continuous layer over the whole surface of the large intestine. In the cecum and colon they are especially collected into three flat longitudinal bands (*tænæi coli*), each of about 12 mm. in width; one, the posterior, is placed along the attached border of the intestine; the anterior, the largest, corresponds along the arch of the colon to the attachment of the greater omentum, but is in front in the ascending, descending, and iliac parts of the colon, and in the sigmoid colon; the third, or lateral band, is found on the medial side of the ascending and descending parts of the colon, and on the under aspect of the transverse colon. These bands are shorter than the other coats of the intestine, and serve to produce the sacculi which are characteristic of the cecum and colon; accordingly, when they are dissected off, the tube can be lengthened, and its sacculated character disappears. In the sigmoid colon the longitudinal fibers become more scattered; and around the rectum they spread out and form a layer, which completely encircles this portion of the gut, but is thicker on the anterior and posterior surfaces, where it forms two bands, than on the lateral surfaces. In addition, two bands of plain muscular tissue arise from the second and third coccygeal vertebræ, and pass downward and forward to blend with the longitudinal muscular fibers on the posterior wall of the anal canal. These are known as the **Rectococcygeal muscles.**

The circular fibers form a thin layer over the cecum and colon, being especially accumulated in the intervals between the sacculi; in the rectum they form a thick layer, and in the anal canal they become numerous, and constitute the Sphincter ani internus.

The areolar coat (tela submucosa; submucous coat) connects the muscular and mucous layers closely together.

The mucous membrane (tunica mucosa) in the cecum and colon, is pale, smooth, destitute of villi, and raised into numerous crescentic folds which correspond to the intervals between the sacculi. In the rectum it is thicker, of a darker color, more vascular, and connected loosely to the muscular coat, as in the esophagus.

As in the small intestine, the mucous membrane consists of a muscular layer, the muscularis mucosæ; a quantity of retiform tissue in which the vessels ramify; a basement membrane and epithelium which is of the columnar variety, and resembles the epithelium found in the small intestine. The mucous membrane of the large intestine presents for examination glands and solitary lymphatic nodules.

The glands of the great intestine are minute tubular prolongations of the mucous membrane arranged perpendicularly, side by side, over its entire surface; they are longer, more numerous, and placed in much closer apposition than those of the small intestine; and they open by minute rounded orifices upon the surface, giving it a cribriform appearance. Each gland is lined by short columnar epithelium and contains numerous goblet cells.

The solitary lymphatic nodules (noduli lymphatic solitarii) of the large intestine are most abundant in the cecum and vermiform process, but are irregularly scattered also over the rest of the intestine. They are similar to those of the small intestine.

Control questions:

1. Topography of the stomach.
2. The structure of the stomach.

3. Ligaments and function of the stomach.
4. Rentgenography of stomach.
5. The structure and function of the duodenum.
6. The structure and functions of the jejunum and ileum.
7. The structure and function of the colon.

Criterion for evaluation

№	**Performance**	**Evaluation**	**Level of students' knowledge.**
1	86-100	Excellent "5"	-able to make independent decisions and conclusion -has creative thinking -can independently think -can apply interactive games more actively -solves situational problems with a full justified answer -understands the meaning of the question and answered with confidence -has a full understanding
2	71-85,9	Good "4"	-may apply in practice interactive games more actively -solves situational problems,but completely unable to explain -understands the meaning of the question and answered with confidence -has a full understanding
3	56-70,9	Satisfactory "3"	-solves situational problems ,but can't justify the answer -knows can answer -on certain issues has an idea
4	0-55	Unsatisfactory "2"	-has no representation on this topic -doesn't know the subject

Equipments of the lesson:
-Dummies and tablets with an overview of the abdominal organs.
-Museum preparations.
-Radiographs of the stomach, intestine and colon.
-Colored slides
-Presentation of lectures.
-Tables, charts, tablets, Atlas, textbook

References:

1. Netter's Clinical Anatomy, John T. Hansen, PhD, USA 2014.
2. Human Anatomy, Kenneth S. Saladin, USA 2014
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4. Sagatov T.A. Mirsharapov U.M. Human anatomy - Toshkent 2011
5. Fayzulla Bahadirov "Human Anatomy" 2005 y
6. Akhmedov A.G., Rasulov Kh.A. "Human Anatomy, with the basic pediatric anatomy", Toshkent 2013 yil
7. Akhmedov A.G., Rasulov Kh.A. "Atlas of human anatomy", Toshkent 2014y.

The small intestine is a convoluted tube, extending from the pylorus to the colic valve, where it ends in the large intestine. It is about 7 meters long, (*168 and gradually diminishes in size from its commencement to its termination. It is contained in the central and lower part of the abdominal cavity, and is surrounded above and at the sides by the large intestine; a portion of it extends below the superior aperture of the pelvis and lies in front of the rectum. It is in relation, in front, with the greater omentum and abdominal parietes, and is connected to the vertebral column by a fold of peritoneum, the mesentery. The small intestine is divisible into three portions: the duodenum, the jejunum, and the ileum.

The Duodenum (Fig. 1056) has received its name from being about equal in length to the breadth of twelve fingers (25 cm.). It is the shortest, the widest, and the most fixed part of the small intestine, and has no mesentery, being only partially covered by peritoneum. Its course presents a remarkable curve, somewhat of the shape of an imperfect circle, so that its termination is not far removed from its starting-point.

In the adult the course of the duodenum is as follows: commencing at the pylorus it passes backward, upward, and to the right, beneath the quadrate lobe of the liver to the neck of the gall-bladder, varying slightly in direction according to the degree of distension of the stomach: it then takes a sharp curve and descends along the right margin of the head of the pancreas, for a variable distance, generally to the level of the upper border of the body of the fourth lumbar vertebra. It now takes a second bend, and passes from right to left across the vertebral column, having a slight inclination upward; and on the left side of the vertebral column it ascends for about 2.5 cm., and then ends opposite the second lumbar vertebra in the jejunum. As it unites with the jejunum it turns abruptly forward, forming the duodendojejunal flexure. From the above description it will be seen that the duodenum may be divided into four portions: superior, descending, horizontal, and ascending.

Relations.—The superior portion (pars superior; first portion) is about 5 cm. long. Beginning at the pylorus, it ends at the neck of the gall-bladder. It is the most movable of the four portions. It is almost completely covered by peritoneum, but a small part of its posterior surface near the neck of the gall-bladder and the inferior vena cava is uncovered; the upper border of its first half has the hepatoduodenal ligament attached to it, while to the lower border of the same segment the greater omentum is connected. It is in such close relation with the gall-bladder that it is usually found to be stained by bile after death, especially on its anterior surface. It is in relation above and in front with the quadrate lobe of the liver and the gall-bladder; behind with the gastroduodenal artery, the common bile duct, and the portal vein; and below and behind with the head and neck of the pancreas.

The descending portion (pars descendens; second portion) is from 7 to 10 cm. long, and extends from the neck of the gall-bladder, on a level with the first lumbar vertebra, along the right side of the vertebral column as low as the upper border of the body of the fourth lumbar vertebra. It is crossed in its middle third by the transverse colon, the posterior surface of which is uncovered by peritoneum and is connected to the duodenum by a small quantity of connective tissue. The supra- and infracolic portions are covered in front by peritoneum, the infracolic part by the right leaf of the mesentery. Posteriorly the descending portion of the duodenum is not covered by peritoneum. The descending portion is in relation, in front, from above downward, with the duodenal impression on the right lobe of the liver, the transverse colon, and the small intestine; behind, it has a variable relation to the front of the right kidney in the neighborhood of the hilum, and is connected to it by loose areolar tissue; the renal vessels, the inferior vena cava, and the Psoas below, are also behind it. At its medial side is the head of the pancreas, and the common bile duct; to its lateral side is the right colic flexure. The common bile duct and the pancreatic duct together perforate the medial side of this portion of the intestine obliquely (Figs. 1057 and 1100), some 7 to 10 cm. below the pylorus; the accessory pancreatic duct sometimes pierces it about 2 cm. above and slightly in front of these.

The horizontal portion (pars horizontalis; third or preaortic or transverse portion) is from 5 to 7.5 cm. long. It begins at the right side of the upper border of the fourth lumbar vertebra and passes from right to left, with a slight inclination upward, in front of the great vessels and crura of the diaphragm, and ends in the ascending portion in front of the abdominal aorta. It is crossed by the superior mesenteric vessels and the mesentery. Its front surface is covered by peritoneum, except near the middle line, where it is crossed by the superior mesenteric vessels. Its posterior surface is uncovered by peritoneum, except toward its left extremity, where the posterior layer of the mesentery may sometimes be found covering it to a variable extent. This surface rests upon the right crus of the diaphragm, the inferior vena cava, and the aorta. The upper surface is in relation with the head of the pancreas.

The ascending portion (pars ascendens; fourth portion) of the duodenum is about 2.5 cm long. It ascends on the left side of the aorta, as far as the level of the upper border of the second lumbar vertebra, where it turns abruptly forward to become the jejunum, forming the duodenojejunal flexure. It lies in front of the left Psoas major and left renal vessels, and is covered in front, and partly at the sides, by peritoneum continuous with the left portion of the mesentery.

The superior part of the duodenum, as stated above, is somewhat movable, but the rest is practically fixed, and is bound down to neighboring viscera and the posterior abdominal wall by the peritoneum. In addition to this, the ascending part of the duodenum and the duodenojejunal flexure are fixed by a structure to which the name of Musculus suspensorius duodeni has been given. This structure commences in the connective tissue around the celiac artery and left crus of the diaphragm, and passes downward to be inserted into the superior border of the duodenojejunal curve and a part of the ascending duodenum, and from this it is continued into the mesentery. It possesses, according to Treitz, plain muscular fibers mixed with the fibrous tissue of which it is principally made up. It is of little importance as a muscle, but acts as a suspensory ligament.

Jejunum and Ileum.—The remainder of the small intestine from the end of the duodenum is named jejunum and ileum; the former term being given to the upper two-fifths and the latter to the lower three-fifths. There is no morphological line of distinction between the two, and the division is arbitrary; but at the same time the character of the intestine gradually undergoes a change from the commencement of the jejunum to the end of the ileum, so that a portion of the bowel taken from these two situations would present characteristic and marked differences. These are briefly as follows:

The Jejunum (intestinum jejunum) is wider, its diameter being about 4 cm., and is thicker, more vascular, and of a deeper color than the ileum, so that a given length weighs more. The circular folds (valvulæ conniventes) of its mucous membrane are large and thickly set, and its villi are larger than in the ileum. The aggregated lymph nodules are almost absent in the upper part of the jejunum, and in the lower part are less frequently found than in the ileum, and are smaller and tend to assume a circular form. By grasping the jejunum between the finger and thumb the circular folds can be felt through the walls of the gut; these being absent in the lower part of the ileum, it is possible in this way to distinguish the upper from the lower part of the small intestine.

The **Ileum** (*intestinum ileum*) is narrow, its diameter being 3.75 cm., and its coats thinner and less vascular than those of the jejunum. It possesses but few circular folds, and they are small and disappear entirely toward its lower end, but aggregated lymph nodules (Peyer's patches) are larger and more numerous. The jejunum for the most part occupies the umbilical and left iliac regions, while the ileum occupies chiefly the umbilical, hypogastric, right iliac, and pelvic regions. The terminal part of the ileum usually lies in the pelvis, from which it ascends over the right Psoas and right iliac vessels; it ends in the right iliac fossa by opening into the medial side of the commencement of the large intestine. The jejunum and ileum are attached to the posterior abdominal wall by an extensive fold of peritoneum, the **mesentery,** which allows the freest motion, so that each coil can accommodate itself to changes in form and position. The mesentery is fan-shaped; its posterior border or root, about 15 cm. long, is attached to the posterior abdominal wall from the left side of the body of the second lumbar vertebra to the right sacroiliac articulation, crossing successively the horizontal part of the duodenum, the aorta, the inferior vena cava, the ureter, and right Psoas muscle (Fig. 1040). Its breadth between its vertebral and intestinal borders averages about 20 cm., and is greater in the middle than at its upper and lower ends. According to Lockwood it tends to increase in breadth as age advances. Between the two layers of which it is composed are contained bloodvessels, nerves, lacteals, and lymph glands, together with a variable amount of fat.

Meckel's Diverticulum (*diverticulum ilei*).—This consists of a pouch which projects from the lower part of the ileum in about 2 per cent. of subjects. Its average position is about 1 meter above the colic valve, and its average length about 5 cm. Its caliber is generally similar to that of the ileum, and its blind extremity may be free or may be connected with the abdominal wall or with some other portion of the intestine by a fibrous band. It represents the remains of the proximal part of the vitelline duct, the duct of communication between the yolk-sac and the primitive digestive tube in early fetal life.

Structure.—The wall of the small intestine (Fig. 1058) is composed of four coats: **serous, muscular, areolar,** and **mucous.**

The **serous coat** (*tunica serosa*) is derived from the peritoneum. The superior portion of the duodenum is almost completely surrounded by this membrane near its pyloric end, but is only covered in front at the other extremity; the descending portion is covered by it in front, except where it is carried off by the transverse colon; and the inferior portion lies behind the peritoneum which passes over it without being closely incorporated with the other coats of this part of the intestine, and is separated from it in and near the middle line by the superior mesenteric vessels. The rest of the small intestine is surrounded by the peritoneum, excepting along its attached or mesenteric border; here a space is left for the vessels and nerves to pass to the gut.

The **muscular coat** (*tunica muscularis*) consists of two layers of unstriped fibers: an external, longitudinal, and an internal, circular layer. The *longitudinal fibers* are thinly scattered over the surface of the intestine, and are more distinct along its free border. The *circular fibers* form a thick, uniform layer, and are composed of plain muscle cells of considerable length. The muscular coat is thicker at the upper than at the lower part of the small intestine.

The **areolar** or **submucous coat** (*tela submucosa*) connects together the mucous and muscular layers. It consists of loose, filamentous areolar tissue containing bloodvessels, lymphatics, and nerves. It is the strongest layer of the intestine.

The **mucous membrane** (*tunica mucosa*) is thick and highly vascular at the upper part of the small intestine, but somewhat paler and thinner below. It consists of the following structures: next the areolar or submucous coat is a double layer of unstriped muscular fibers, outer longitudinal and inner circular, the **muscularis mucosæ**internal to this is a quantity of retiform tissue, enclosing in its meshes lymph corpuscles, and in this the bloodvessels and nerves ramify; lastly, a basement membrane, supporting a single layer of epithelial cells, which throughout the intestine are columnar in character. The cells are granular in appearance, and each possesses a clear oval nucleus. At their superficial or unattached ends they present a distinct layer of highly refracting material, marked by vertical striæ, the **striated border.**

The **circular folds** (*plicæ circulares* [*Kerkringi*]; *valvulæ conniventes; valves of Kerkring*) are large valvular flaps projecting into the lumen of the bowel. They are composed of reduplications of the mucous membrane, the two layers of the fold being bound together by submucous tissue; unlike the folds in the stomach, they are permanent, and are not obliterated when the intestine is distended. The majority extend transversely around the cylinder of the intestine for about one-half or two-thirds of its circumference, but some form complete circles, and others have a spiral direction; the latter usually extend a little more than once around the bowel, but occasionally two or three times. The larger folds are about 8 mm. in depth at their broadest part; but the greater number are of smaller size. The larger and smaller folds alternate with each other. They are not found at the commencement of the duodenum, but begin to appear about 2.5 or 5 cm. beyond the pylorus. In the lower part of the descending portion, below the point where the bile and pancreatic ducts enter the intestine, they are very large and closely approximated. In the horizontal and ascending portions of the duodenum and upper half of the jejunum they are large and numerous, but from this point, down to the middle of the ileum, they diminish considerably in size. In the lower part of the ileum they almost entirely disappear; hence the comparative thinness of this portion of the intestine, as compared with the duodenum and jejunum. The circular folds retard the passage of the food along the intestines, and afford an increased surface for absorption.

The **intestinal villi** (*villi intestinales*) are highly vascular processes, projecting from the mucous membrane of the small intestine throughout its whole extent, and giving to its surface a velvety appearance. They are largest and most numerous in the duodenum and jejunum, and become fewer and smaller in the ileum.

Structure of the villi (Figs. 1059, 1060).—The essential parts of a villus are: the lacteal vessel, the bloodvessels, the epithelium, the basement membrane, and the muscular tissue of the mucosa, all being supported and held together by retiform lymphoid tissue.

The *lacteals* are in some cases double, and in some animals multiple, but usually there is a single vessel. Situated in the axis of the villus, each commences by dilated cecal extremities near to, but not quite at, the summit of the villus. The walls are composed of a single layer of endothelial cells.

The *muscular fibers* are derived from the muscularis mucosæ, and are arranged in longitudinal bundless around the lacteal vessel, extending from the base to the summit of the villus, and giving off, laterally, individual muscle cells, which are enclosed by the reticulum, and by it are attached to the basement-membrane and to the lacteal.

The *bloodvessels* (Fig. 1061) form a plexus under the basement membrane, and are enclosed in the reticular tissue.

These structures are surrounded by the *basement membrane*,which is made up of a stratum of endothelial cells, and upon this is placed a layer of *columnar epithelium*, the characteristics of which have been described. The *retiform tissue* forms a net-work (Fig. 1060) in the meshes of which a number of leucocytes are found.

The intestinal glands (glandulæ intestinales [Lieberkühni]; crypts of Lieberkühn) (Fig. 1062) are found in considerable numbers over every part of the mucous membrane of the small intestine. They consist of minute tubular depressions of the mucous membrane, arranged perpendicularly to the surface, upon which they open by small circular apertures. They may be seen with the aid of a lens, their orifices appearing as minute dots scattered between the villi. Their walls are thin, consisting of a basement membrane lined by columnar epithelium, and covered on their exterior by capillary vessels.

The duodenal glands (glandulæ duodenales [Brunneri]; Brunner's glands) are limited to the duodenum (Fig. 1058), and are found in the submucous areolar tissue. They are largest and most numerous near the pylorus, forming an almost complete layer in the superior portion and upper half of the descending portions of the duodenum. They then begin to diminish in number, and practically disappear at the junction of the duodenum and jejunum. They are small compound acinotubular glands consisting of a number of alveoli lined by short columnar epithelium and opening by a single duct on the inner surface of the intestine.

The solitary lymphatic nodules (noduli lymphatici solitarii; solitary glands) are found scattered throughout the mucous membrane of the small intestine, but are most numerous in the lower part of the ileum. Their free surfaces are covered with rudimentary villi, except at the summits, and each gland is surrounded by the openings of the intestinal glands. Each consists of a dense interlacing retiform tissue closely packed with lymph-corpuscles, and permeated with an abundant capillary network. The interspaces of the retiform tissue are continuous with larger lymph spaces which surround the gland, through which they communicate with the lacteal system. They are situated partly in the submucous tissue, partly in the mucous membrane, where they form slight projections of its epithelial layer (see Fig. 1082).

The aggregated lymphatic nodules (noduli lymphatici aggregati; Peyer's patches; Peyer's glands; agminated follicles; tonsillæ intestinales) (Fig. 1063) form circular or oval patches, from twenty to thirty in number, and varying in length from 2 to 10 cm. They are largest and most numerous in the ileum. In the lower part of the jejunum they are small, circular, and few in number. They are occasionally seen in the duodenum. They are placed lengthwise in the intestine, and are situated in the portion of the tube most distant from the attachment of the mesentery. Each patch is formed of a group of solitary lymphatic nodules covered with mucous membrane, but the patches do not, as a rule, possess villi on their free surfaces. They are best marked in the young subject, become indistinct in middle age, and sometimes disappear altogether in advanced life. They are freely supplied with bloodvessels (Fig. 1064), which form an abundant plexus around each follicle and give off fine branches permeating the lymphoid tissue in the interior of the follicle. The lymphatic plexuses are especially abundant around these patches.

The large intestine extends from the end of the ileum to the anus. It is about 1.5 meters long, being one-fifth of the whole extent of the intestinal canal. Its caliber is largest at its commencement at the cecum, and gradually diminishes as far as the rectum, where there is a dilatation of considerable size just above the anal canal. It differs from the small intestine in its greater caliber, its more fixed position, its sacculated form, and in possessing certain appendages to its external coat, the appendices epiploicæ. Further, its longitudinal muscular fibers do not form a continuous layer around the gut, but are arranged in three longitudinal bands or tæniæ. The large intestine, in its course, describes an arch which surrounds the convolutions of the small intestine. It commences in the right iliac region, in a dilated part, the cecum. It ascends through the right lumbar and hypochondriac regions to the under surface of the liver; it here takes a bend, the right colic flexure, to the left and passes transversely across the abdomen on the confines of the epigastric and umbilical regions, to the left hypochondriac region; it then bends again, the left colic flexure, and descends through the left lumbar and iliac regions to the pelvis, where it forms a bend called the sigmoid flexure; from this it is continued along the posterior wall of the pelvis to the anus. The large intestine is divided into the cecum, colon, rectum, and anal canal.

The Cecum (intestinum cæcum) (Fig. 1073), the commencement of the large intestine, is the large blind pouch situated below the colic valve. Its blind end is directed downward, and its open end upward, communicating directly with the colon, of which this blind pouch appears to be the beginning or head, and hence the old name of caput cæcum coli was applied to it. Its size is variously estimated by different authors, but on an average it may be said to be 6.25 cm. in length and 7.5 in breadth. It is situated in the right iliac fossa, above the lateral half of the inguinal ligament: it rests on the Iliacus and Psoas major, and usually lies in contact with the anterior abdominal wall, but the greater omentum and, if the cecum be empty, some coils of small intestine may lie in front of it. As a rule, it is entirely enveloped by peritoneum, but in a certain number of cases (5 per cent., Berry) the peritoneal covering is not complete, so that the upper part of the posterior surface is uncovered and connected to the iliac fascia by connective tissue. The cecum lies quite free in the abdominal cavity and enjoys a considerable amount of movement, so that it may become herniated down the right inguinal canal, and has occasionally been found in an inguinal hernia on the left side. The cecum varies in shape, but, according to Treves, in man it may be classified under one of four types. In early fetal life it is short, conical, and broad at the base, with its apex turned upward and medialward toward the ileocolic junction. It then resembles the cecum of some monkeys, e. g., mangabey monkey. As the fetus grows the cecum increases in length more than in breadth, so that it forms a longer tube than in the primitive form and without the broad base, but with the same inclination of the apex toward the ileocolic junction. This form is seen in other monkeys, e. g., the spider monkey. As development goes on, the lower part of the tube ceases to grow and the upper part becomes greatly increased, so that at birth there is a narrow tube, the vermiform process, hanging from a conical projection, the cecum. This is the infantile form, and as it persists throughout life in about 2 per cent. of cases, it is regarded by Treves as the first of his four types of human ceca. The cecum is conical and the appendix rises from its apex. The three longitudinal bands start from the appendix and are equidistant from each other. In the second type, the conical cecum has become quadrate by the growing out of a saccule on either side of the anterior longitudinal band. These saccules are of equal size, and the appendix arises from between them, instead of from the apex of a cone. This type is found in about 3 per cent. of cases. The third type is the normal type of man. Here the two saccules, which in the second type were uniform, have grown at unequal rates: the right with greater rapidity than the left. In consequence of this an apparently new apex has been formed by the growing downward of the right saccule, and the original apex, with the appendix attached, is pushed over to the left toward the ileocolic junction. The three longitudinal bands still start from the base of the vermiform process, but they are now no longer equidistant from each other, because the right saccule has grown between the anterior and posterolateral bands, pushing them over to the left. This type occurs in about 90 per cent. of cases. The fourth type is merely an exaggerated condition of the third; the right saccule is still larger, and at the same time the left saccule has become atrophied, so that the original apex of the cecum, with the vermiform process, is close to the ileocolic junction, and the anterior band courses medialward to the same situation. This type is present in about 4 per cent. of cases.

The Vermiform Process or Appendix (processus vermiformis) (Fig. 1073) is a long, narrow, worm-shaped tube, which starts from what was originally the apex of the cecum, and may pass in one of several directions: upward behind the cecum; to the left behind the ileum and mesentery; or downward into the lesser pelvis. It varies from 2 to 20 cm. in length, its average being about 8.3 cm. It is retained in position by a fold of peritoneum (mesenteriole), derived from the left leaf of the mesentery. This fold, in the majority of cases, is more or less triangular in shape, and as a rule extends along the entire length of the tube. Between its two layers and close to its free margin lies the appendicular artery (Fig. 1073). The canal of the vermiform process is small, extends throughout the whole length of the tube, and communicates with the cecum by an orifice which is placed below and behind the ileocecal opening. It is sometimes guarded by a semilunar valve formed by a fold of mucous membrane, but this is by no means constant.

Structure.—The coats of the vermiform process are the same as those of the intestine: serous, muscular, submucous, and mucous. The serous coat forms a complete investment for the tube, except along the narrow line of attachment of its mesenteriole in its proximal two-thirds. The longitudinal muscular fibers do not form three bands as in the greater part of the large intestine, but invest the whole organ, except at one or two points where both the longitudinal and circular fibers are deficient so that the peritoneal and submucous coats are contiguous over small areas.

The circular muscle fibers form a much thicker layer than the longitudinal fibers, and are separated from them by a small amount of connective tissue. The submucous coat is well marked, and contains a large number of masses of lymphoid tissue which cause the mucous membrane to bulge into the lumen and so render the latter of small size and irregular shape. The mucous membrane is lined by columnar epithelium and resembles that of the rest of the large intestine, but the intestinal glands are fewer in number (Fig. 1074).

The Colic Valve (valvula coli; ileocecal valve) (Fig. 1075).—The lower end of the ileum ends by opening into the medial and back part of the large intestine, at the point of junction of the cecum with the colon. The opening is guarded by a valve, consisting of two segments or lips, which project into the lumen of the large intestine. If the intestine has been inflated and dried, the lips are of a semilunar shape. The upper one, nearly horizontal in direction, is attached by its convex border to the line of junction of the ileum with the colon; the lower lip, which is longer and more concave, is attached to the line of junction of the ileum with the cecum. At the ends of the aperture the two segments of the valve coalesce, and are continued as narrow membranous ridges around the canal for a short distance, forming the frenula of the valve. The left or anterior end of the aperture is rounded; the right or posterior is narrow and pointed. In the fresh condition, or in specimens which have been hardened in situ, the lips project as thick cushion-like folds into the lumen of the large gut, while the opening between them may present the appearance of a slit or may be somewhat oval in shape.

Each lip of the valve is formed by a reduplication of the mucous membrane and of the circular muscular fibers of the intestine, the longitudinal fibers and peritoneum being continued uninterruptedly from the small to the large intestine.

The surfaces of the valve directed toward the ileum are covered with villi, and present the characteristic structure of the mucous membrane of the small intestine; while those turned toward the large intestine are destitute of villi, and marked with the orifices of the numerous tubular glands peculiar to the mucous membrane of the large intestine. These differences in structure continue as far as the free margins of the valve. It is generally maintained that this valve prevents reflux from the cecum into the ileum, but in all probability it acts as a sphincter around the end of the ileum and prevents the contents of the ileum from passing too quickly into the cecum.

The Colon is divided into four parts: the ascending, transverse, descending, and sigmoid.

The Ascending Colon (colon ascendens) is smaller in caliber than the cecum, with which it is continuous. It passes upward, from its commencement at the cecum, opposite the colic valve, to the under surface of the right lobe of the liver, on the right of the gall-bladder, where it is lodged in a shallow depression, the colic impression;here it bends abruptly forward and to the left, forming the right colic(hepatic) flexure (Fig. 1056). It is retained in contact with the posterior wall of the abdomen by the peritoneum, which covers its anterior surface and sides, its posterior surface being connected by loose areolar tissue with the Iliacus, Quadratus lumborum, aponeurotic origin of Transversus abdominis, and with the front of the lower and lateral part of the right kidney. Sometimes the peritoneum completely invests it, and forms a distinct but narrow mesocolon. (*169 It is in relation, in front, with the convolutions of the ileum and the abdominal parietes.

The Transverse Colon (colon transversum) the longest and most movable part of the colon, passes with a downward convexity from the right hypochondriac region across the abdomen, opposite the confines of the epigastric and umbilical zones, into the left hypochondriac region, where it curves sharply on itself beneath the lower end of the spleen, forming the left colic (splenic) flexure. In its course it describes an arch, the concavity of which is directed backward and a little upward; toward its splenic end there is often an abrupt U-shaped curve which may descend lower than the main curve. It is almost completely invested by peritoneum, and is connected to the inferior border of the pancreas by a large and wide duplicature of that membrane, the transverse mesocolon. It is in relation, by its upper surface, with the liver and gall-bladder, the greater curvature of the stomach, and the lower end of the spleen; by its under surface, with the small intestine; by its anterior surface, with the anterior layers of the greater omentum and the abdominal parietes; its posterior surface is in relation from right to left with the descending portion of the duodenum, the head of the pancreas, and some of the convolutions of the jejunum and ileum.

The left colic or splenic flexure (Fig. 1056) is situated at the junction of the transverse and descending parts of the colon, and is in relation with the lower end of the spleen and the tail of the pancreas; the flexure is so acute that the end of the transverse colon usually lies in contact with the front of the descending colon. It lies at a higher level than, and on a plane posterior to, the right colic flexure, and is attached to the diaphragm, opposite the tenth and eleventh ribs, by a peritoneal fold, named the phrenicocolic ligament, which assists in supporting the lower end of the spleen (see page 1158).

The Descending Colon (*170 (colon descendens) passes downward through the left hypochondriac and lumbar regions along the lateral border of the left kidney. At the lower end of the kidney it turns medialward toward the lateral border of the Psoas, and then descends, in the angle between Psoas and Quadratus lumborum, to the crest of the ilium, where it ends in the iliac colon. The peritoneum covers its anterior surface and sides, while its posterior surface is connected by areolar tissue with the lower and lateral part of the left kidney, the aponeurotic origin of the Transversus abdominis, and the Quadratus lumborum. It is smaller in caliber and more deeply placed than the ascending colon, and is more frequently covered with peritoneum on its posterior surface than the ascending colon (Treves). In front of it are some coils of small intestine.

The Iliac Colon is situated in the left iliac fossa, and is about 12 to 15 cm. long. It begins at the level of the iliac crest, where it is continuous with the descending colon, and ends in the sigmoid colon at the superior aperture of the lesser pelvis. It curves downward and medialward in front of the Iliacus and Psoas, and, as a rule, is covered by peritoneum on its sides and anterior surface only.

The Sigmoid Colon (colon sigmoideum; pelvic colon; sigmoid flexure) forms a loop which averages about 40 cm. in length, and normally lies within the pelvis, but on account of its freedom of movement it is liable to be displaced into the abdominal cavity. It begins at the superior aperture of the lesser pelvis, where it is continuous with the iliac colon, and passes transversely across the front of the sacrum to the right side of the pelvis; it then curves on itself and turns toward the left to reach the middle line at the level of the third piece of the sacrum, where it bends downward and ends in the rectum. It is completely surrounded by peritoneum, which forms a mesentery (sigmoid mesocolon), which diminishes in length from the center toward the ends of the loop, where it disappears, so that the loop is fixed at its junctions with the iliac colon and rectum, but enjoys a considerable range of movement in its central portion. Behind the sigmoid colon are the external iliac vessels, the left Piriformis, and left sacral plexus of nerves; in front, it is separated from the bladder in the male, and the uterus in the female, by some coils of the small intestine.

The Rectum (intestinum rectum) is continuous above with the sigmoid colon, while below it ends in the anal canal. From its origin at the level of the third sacral vertebra it passes downward, lying in the sacrococcygeal curve, and extends for about 2.5 cm. in front of, and a little below, the tip of the coccyx, as far as the apex of the prostate. It then bends sharply backward into the anal canal. It therefore presents two antero-posterior curves: an upper, with its convexity backward, and a lower, with its convexity forward. Two lateral curves are also described, one to the right opposite the junction of the third and fourth sacral vertebræ, and the other to the left, opposite the left sacrococcygeal articulation; they are, however, of little importance. The rectum is about 12 cm. long, and at its commencement its caliber is similar to that of the sigmoid colon, but near its termination it is dilated to form the rectal ampulla. The rectum has no sacculations comparable to those of the colon, but when the lower part of the rectum is contracted, its mucous membrane is thrown into a number of folds, which are longitudinal in direction and are effaced by the distension of the gut. Besides these there are certain permanent transverse folds, of a semilunar shape, known as Houston's valves (Fig. 1078). They are usually three in number; sometimes a fourth is found, and occasionally only two are present. One is situated near the commencement of the rectum, on the right side; a second extends inward from the left side of the tube, opposite the middle of the sacrum; a third, the largest and most constant, projects backward from the forepart of the rectum, opposite the fundus of the urinary bladder. When a fourth is present, it is situated nearly 2.5 cm. above the anus on the left and posterior wall of the tube. These folds are about 12 mm. in width, and contain some of the circular fibers of the gut. In the empty state of the intestine they overlap each other, as Houston remarks, so effectually as to require considerable maneuvering to conduct a bougie or the finger along the canal. Their use seems to be, "to support the weight of fecal matter, and prevent its urging toward the anus, where its presence always excites a sensation demanding its discharge.

The peritoneum is related to the upper two-thirds of the rectum, covering at first its front and sides, but lower down its front only; from the latter it is reflected on to the seminal vesicles in the male and the posterior vaginal wall in the female.

The level at which the peritoneum leaves the anterior wall of the rectum to be reflected on to the viscus in front of it is of considerable importance from a surgical point of view, in connection with the removal of the lower part of the rectum. It is higher in the male than in the female. In the former the height of the rectovesical excavation is about 7.5 cm., i. e., the height to which an ordinary index finger can reach from the anus. In the female the height of the rectouterine excavation is about 5.5 cm. from the anal orifice. The rectum is surrounded by a dense tube of fascia derived from the fascia endopelvina, but fused behind with the fascia covering the sacrum and coccyx. The facial tube is loosely attached to the rectal wall by areolar tissue in order to allow of distension of the viscus.

Relations of the Rectum.—The upper part of the rectum is in relation, behind, with the superior hemorrhoidal vessels, the left Piriformis, and left sacral plexus of nerves, which separate it from the pelvic surfaces of the sacral vertebræ; in its lower part it lies directly on the sacrum, coccyx, and Levatores ani, a dense fascia alone intervening; in front, it is separated above, in the male, from the fundus of the bladder; in the female, from the intestinal surface of the uterus and its appendages, by some convolutions of the small intestine, and frequently by the sigmoid colon; below, it is in relation in the male with the triangular portion of the fundus of the bladder, the vesiculæ seminales, and ductus deferentes, and more anteriorly with the posterior surface of the prostate; in the female, with the posterior wall of the vagina.

The **Anal Canal** (*pars analis recti*), or terminal portion of the large intestine, begins at the level of the apex of the prostate, is directed downward and backward, and ends at the anus. It forms an angle with the lower part of the rectum, and measures from 2.5 to 4 cm. in length. It has no peritoneal covering, but is invested by the Sphincter ani internus, supported by the Levatores ani, and surrounded at its termination by the Sphincter ani externus. In the empty condition it presents the appearance of an antero-posterior longitudinal slit. Behind it is a mass of muscular and fibrous tissue, the **anococcygeal body** (Symington); in front of it, in the male, but separated by connective tissue from it, are the membranous portion and bulb of the urethra, and the fascia of the urogenital diaphragm; and in the female it is separated from the lower end of the vagina by a mass of muscular and fibrous tissue, named the **perineal body.**

The lumen of the anal canal presents, in its upper half, a number of vertical folds, produced by an infolding of the mucous membrane and some of the muscular tissue. They are known as the **rectal columns** [*Morgagni*], and are separated from one another by furrows (**rectal sinuses**), which end below in small valve-like folds, termed **anal valves,** which join together the lower ends of the rectal columns.

Structure of the Colon.—The large intestine has four coats: **serous, muscular, areolar,** and **mucous.**

The **serous coat** (*tunica serosa*) is derived from the peritoneum, and invests the different portions of the large intestine to a variable extent. The cecum is completely covered by the serous membrane, except in about 5 per cent. of cases where the upper part of the posterior surface is uncovered. The ascending, descending, and iliac parts of the colon are usually covered only in front and at the sides; a variable amount of the posterior surface is uncovered. (*172 The transverse colon is almost completely invested, the parts corresponding to the attachment of the greater omentum and transverse mesocolon being alone excepted. The sigmoid colon is entirely surrounded. The rectum is covered above on its anterior surface and sides; below, on its anterior aspect only; the anal canal is entirely devoid of any serous covering. In the course of the colon the peritoneal coat is thrown into a number of small pouches filled with fat, called **appendices epiploicæ.** They are most numerous on the transverse colon.

The **muscular coat** (*tunica muscularis*) consists of an external longitudinal, and an internal circular, layer of non-striped muscular fibers:

The *longitudinal fibers* do not form a continuous layer over the whole surface of the large intestine. In the cecum and colon they are especially collected into three flat longitudinal bands (*tænæi coli*), each of about 12 mm. in width; one, the posterior, is placed along the attached border of the intestine; the anterior, the largest, corresponds along the arch of the colon to the attachment of the greater omentum, but is in front in the ascending, descending, and iliac parts of the colon, and in the sigmoid colon; the third, or lateral band, is found on the medial side of the ascending and descending parts of the colon, and on the under aspect of the transverse colon. These bands are shorter than the other coats of the intestine, and serve to produce the sacculi which are characteristic of the cecum and colon; accordingly, when they are dissected off, the tube can be lengthened, and its sacculated character disappears. In the sigmoid colon the longitudinal fibers become more scattered; and around the rectum they spread out and form a layer, which completely encircles this portion of the gut, but is thicker on the anterior and posterior surfaces, where it forms two bands, than on the lateral surfaces. In addition, two bands of plain muscular tissue arise from the second and third coccygeal vertebræ, and pass downward and forward to blend with the longitudinal muscular fibers on the posterior wall of the anal canal. These are known as the **Rectococcygeal muscles.**

The circular fibers form a thin layer over the cecum and colon, being especially accumulated in the intervals between the sacculi; in the rectum they form a thick layer, and in the anal canal they become numerous, and constitute the Sphincter ani internus.

The areolar coat (tela submucosa; submucous coat) connects the muscular and mucous layers closely together.

The mucous membrane (tunica mucosa) in the cecum and colon, is pale, smooth, destitute of villi, and raised into numerous crescentic folds which correspond to the intervals between the sacculi. In the rectum it is thicker, of a darker color, more vascular, and connected loosely to the muscular coat, as in the esophagus.

As in the small intestine, the mucous membrane consists of a muscular layer, the muscularis mucosæ; a quantity of retiform tissue in which the vessels ramify; a basement membrane and epithelium which is of the columnar variety, and resembles the epithelium found in the small intestine. The mucous membrane of the large intestine presents for examination glands and solitary lymphatic nodules.

The glands of the great intestine are minute tubular prolongations of the mucous membrane arranged perpendicularly, side by side, over its entire surface; they are longer, more numerous, and placed in much closer apposition than those of the small intestine; and they open by minute rounded orifices upon the surface, giving it a cribriform appearance. Each gland is lined by short columnar epithelium and contains numerous goblet cells.

The solitary lymphatic nodules (noduli lymphatic solitarii) of the large intestine are most abundant in the cecum and vermiform process, but are irregularly scattered also over the rest of the intestine. They are similar to those of the small intestine.

Control questions:

1. Topography of the stomach.
2. The structure of the stomach.
3. Ligaments and function of the stomach.
4. Rentgenography of stomach.
5. The structure and function of the duodenum.
6. The structure and functions of the jejunum and ileum.
7. The structure and function of the colon.

Criterion for evaluation

№	Performance	Evaluation	Level of students' knowledge.
1	86-100	Excellent "5"	-able to make independent decisions and conclusion -has creative thinking -can independently think -can apply interactive games more actively -solves situational problems with a full justified answer -understands the meaning of the question and answered with confidence -has a full understanding
2	71-85,9	Good "4"	-may apply in practice interactive games more actively -solves situational problems,but completely unable to

			explain -understands the meaning of the question and answered with confidence -has a full understanding
3	56-70,9	Satisfactory "3"	-solves situational problems ,but can't justify the answer -knows can answer -on certain issues has an idea
4	0-55	Unsatisfactory "2"	-has no representation on this topic -doesn't know the subject

Equipments of the lesson:
-Dummies and tablets with an overview of the abdominal organs.
-Museum preparations.
-Radiographs of the stomach, intestine and colon.
-Colored slides
-Presentation of lectures.
-Tables, charts, tablets, Atlas, textbook

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The **liver** is a peritoneal organ positioned in the right upper quadrant of the abdomen. It is the largest visceral structure in the abdominal cavity, and the largest gland in the human body.

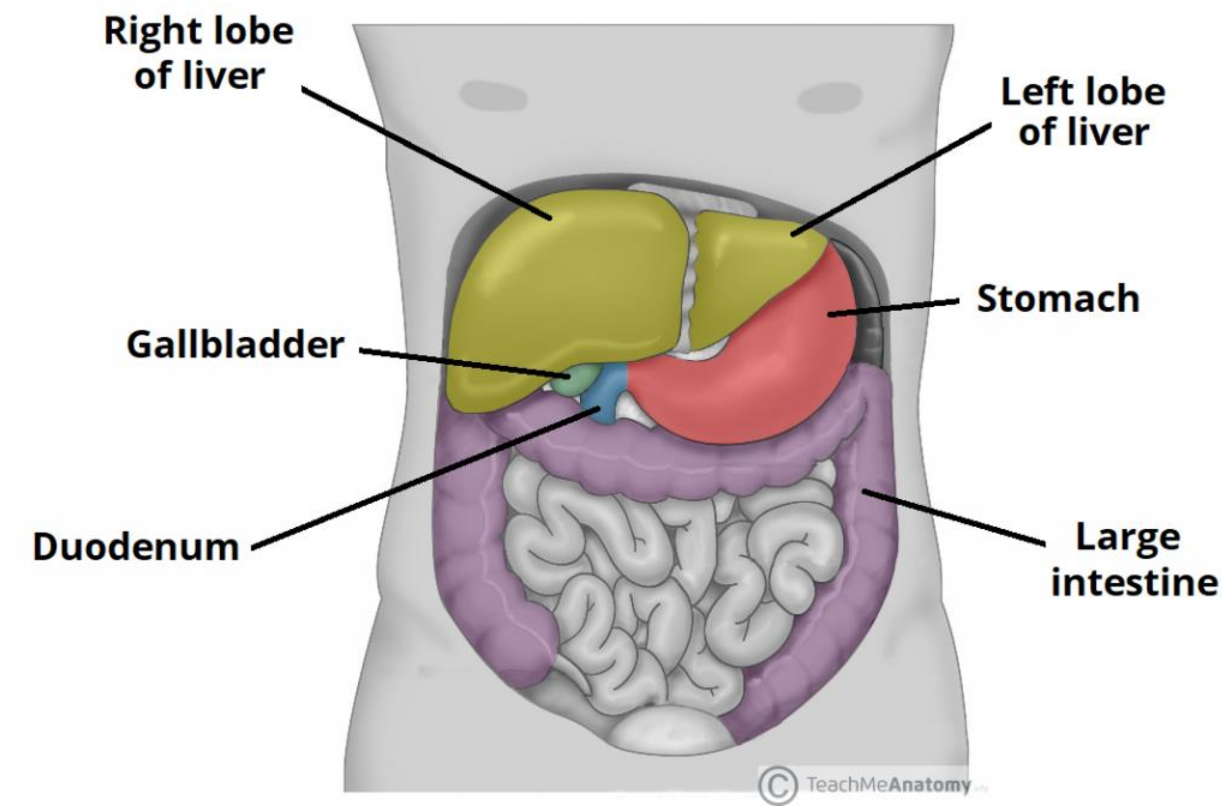
An accessory digestion gland, the liver performs a wide range of functions; including **synthesis of bile**, glycogen storage and clotting factor production.

In this article, we shall look at the anatomy of the **liver** – its position, structure, and neurovascular supply.

Anatomical Position

The liver is predominantly located in the right hypochondrium and epigastric areas, and extends into the left hypochondrium.

When discussing the anatomical position of the liver, it is useful to consider its external surfaces, associated ligaments, and the anatomical spaces (recesses) that surround it.



Liver Surfaces

The **external surfaces** of the liver are described by their location and adjacent structures. There are two liver surfaces – the diaphragmatic and visceral:

Diaphragmatic surface – the anterosuperior surface of the liver.

It is smooth and convex, fitting snugly beneath the curvature of the diaphragm.

The posterior aspect of the diaphragmatic surface is not covered by visceral peritoneum, and is in direct contact with the diaphragm itself (known as the 'bare area' of the liver).

Visceral surface – the posteroinferior surface of the liver.

With the exception of the fossa of the gallbladder and porta hepatis, it is covered with peritoneum.

It is moulded by the shape of the surrounding organs, making it irregular and flat.

It lies in contact with the right kidney, right adrenal gland, right colic flexure, transverse colon, first part of the duodenum, gallbladder, oesophagus and the stomach.

Ligaments of the Liver

There are various ligaments that attach the liver to the surrounding structures. These are formed by a double layer of peritoneum.

Falciform ligament – this sickle-shaped ligament attaches the anterior surface of the liver to the anterior abdominal wall and forms a natural anatomical division between the left and right lobs of the liver. The free edge of this ligament contains the ligamentum teres, a remnant of the umbilical vein.

Coronary ligament (anterior and posterior folds) – attaches the superior surface of the liver to the inferior surface of the diaphragm and demarcates the bare area of the liver The anterior and posterior folds unite to form the triangular ligaments on the right and left lobes of the liver.

Triangular ligaments (left and right):

The left triangular ligament is formed by the union of the anterior and posterior layers of the coronary ligament at the apex of the liver and attaches the left lobe of the liver to the diaphragm.

The right triangular ligament is formed in a similar fashion adjacent to the bare area and attaches the right lobe of the liver to the diaphragm.

Lesser omentum – Attaches the liver to the lesser curvature of the stomach and first part of the duodenum. It consists of the hepatoduodenal ligament (extends from the duodenum to the liver) and the hepatogastric ligament (extends from the stomach to the liver). The hepatoduodenal ligament surrounds the portal triad.

In addition to these supporting ligaments, the posterior surface of the liver is secured to the **inferior vena cava** by hepatic veins and fibrous tissue.

Hepatic Recesses

The **hepatic recesses** are anatomical spaces between the liver and surrounding structures. They are of clinical importance as infection may collect in these areas, forming an abscess.

Subphrenic spaces – located between the diaphragm and the anterior and superior aspects of the liver. They are divided into a right and left by the falciform ligament.

Subhepatic space – a subdivision of the supracolic compartment (above the transverse mesocolon), this peritoneal space is located between the inferior surface of the liver and the transverse colon.

Morison's pouch – a potential space between the visceral surface of the liver and the right kidney. This is the deepest part of the peritoneal cavity when supine (lying flat), therefore pathological abdominal fluid such as blood or ascites is most likely to collect in this region in a bedridden patient.

Anatomical Structure

The structure of the liver can be considered both macroscopically and microscopically.

Macroscopic

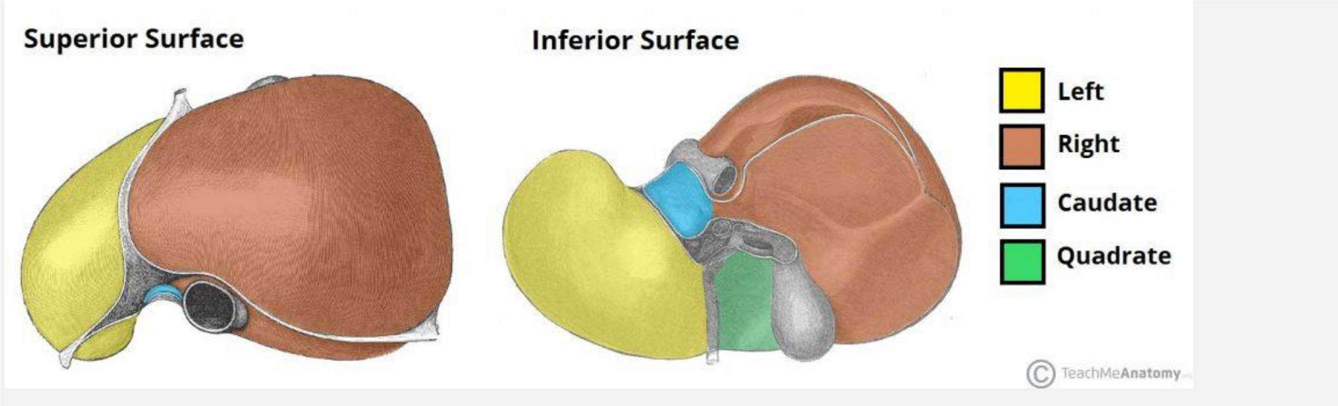
The liver is covered by a fibrous layer, known as **Glisson's capsule**.

It is divided into a right lobe and left lobe by the attachment of the **falciform ligament.** There are two further 'accessory' lobes that arise from the right lobe, and are located on the visceral surface of liver:

- **Caudate lobe** – located on the upper aspect of the visceral surface. It lies between the inferior vena cava and a fossa produced by the ligamentum venosum (a remnant of the fetal ductus venosus).

- **Quadrate lobe** – located on the lower aspect of the visceral surface. It lies between the gallbladder and a fossa produced by the ligamentum teres (a remnant of the fetal umbilical vein).

Separating the caudate and quadrate lobes is a deep, transverse fissure – known as the **porta hepatis**. It transmits all the vessels, nerves and ducts entering or leaving the liver with the exception of the hepatic veins.



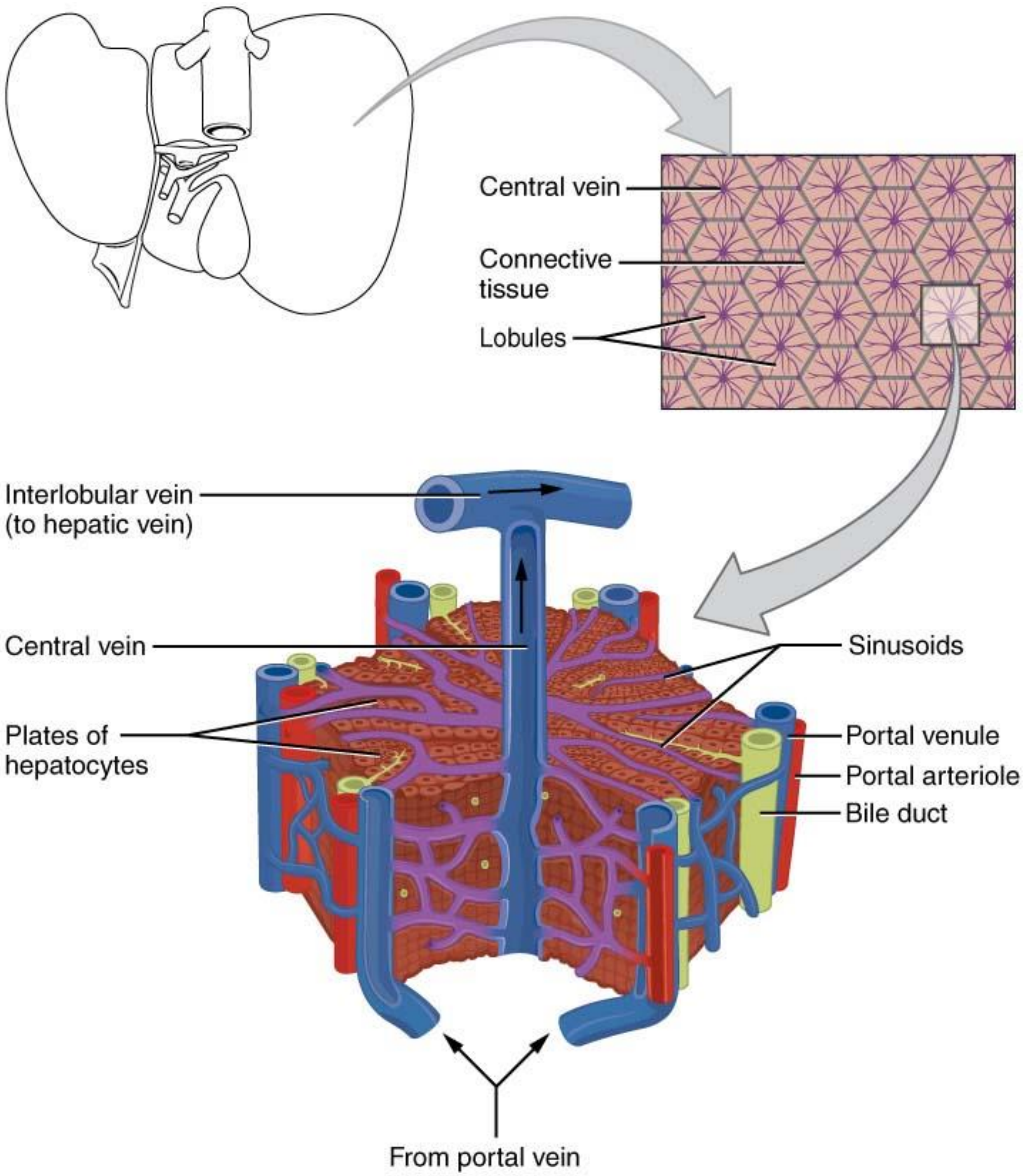
Microscopic

Microscopically, the cells of the liver (known as hepatocytes) are arranged into **lobules**. These are the structural units of the liver.

Each anatomical lobule is hexagonal-shaped and is drained by a **central vein**. At the periphery of the hexagon are three structures collectively known as the portal triad:

- **Arteriole** – a branch of the hepatic artery entering the liver.
- **Venule** – a branch of the hepatic portal vein entering the liver.
- **Bile duct** – branch of the bile duct leaving the liver.

The portal triad also contains **lymphatic vessels** and **vagus nerve** (parasympathetic) fibres.



Arterial Supply and Venous Drainage

The liver has a unique dual blood supply:

- **Hepatic artery proper (25%)** – supplies the non-parenchymal structures of the liver with arterial blood. It is derived from the coeliac trunk.

- **Hepatic portal vein (75%)** – supplies the liver with partially deoxygenated blood, carrying nutrients absorbed from the small intestine. This is the dominant blood supply to the liver parenchyma, and allows the liver to perform its gut-related functions, such as detoxification.

Venous drainage of the liver is achieved through hepatic veins. The central veins of the hepatic lobule form collecting veins which then combine to form multiple hepatic veins. These hepatic veins then open into the **inferior vena cava**.

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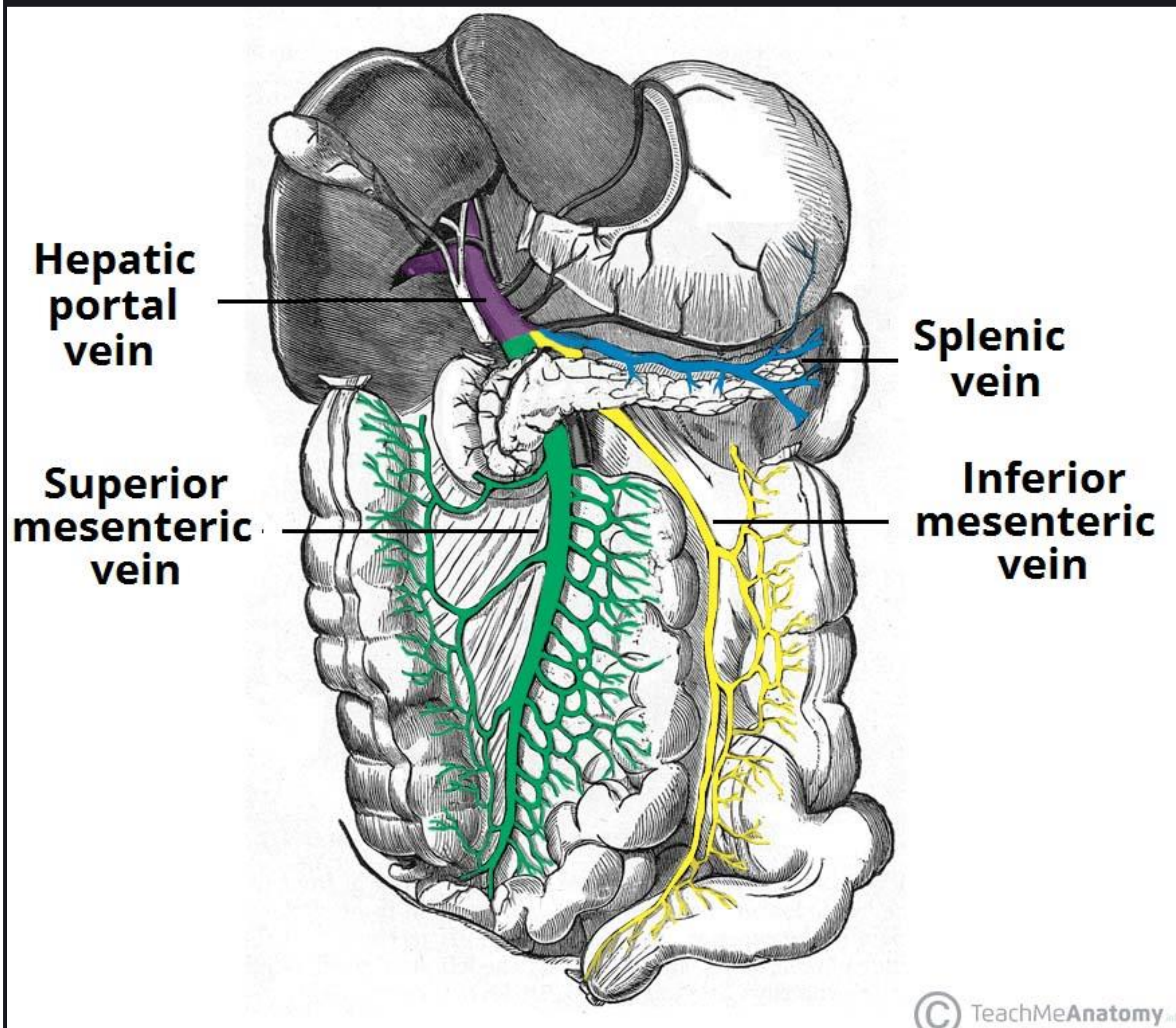


Nerve Supply

The parenchyma of the liver is innervated by the **hepatic plexus**, which contains sympathetic (coeliac plexus) and parasympathetic (vagus nerve) nerve fibres. These fibres enter the liver at the **porta hepatis** and follow the course of branches of the hepatic artery and portal vein.

Glisson's capsule, the fibrous covering of the liver, is innervated by branches of the **lower intercostal nerves**. Distension of the capsule results in a sharp, well localised pain.

Lymphatic Drainage

The lymphatic vessels of the anterior aspect of the liver drain into **hepatic lymph nodes**. These lie along the hepatic vessels and ducts in the lesser omentum, and empty in the colic lymph nodes which in turn, drain into the cisterna chyli.

Lymphatics from the posterior aspect of the liver however, drain into **phrenic** and **posterior mediastinal nodes** which join the right lymphatic and thoracic ducts.

All about the spleen

Although in medieval times, people thought that the spleen was the source of anger, hence the phrase "venting your spleen," it is nothing to do with anger or any other emotions for that matter.

The spleen sits in the upper left of the abdomen, protected by the rib cage. It is the largest organ of the lymphatic system — the circulation of the immune system. It recycles old red blood cells and stores platelets (components of the blood that help stop bleeding) and white blood cells.

Basic structure of the spleen

Although it varies in size between individuals, a spleen is typically around 3–5.5 inches long and weighs 5.3–7.1 ounces (oz). The spleen is a soft organ with a thin outer covering of tough connective tissue, called a capsule.

There is a handy rule to remember the rough dimensions of the spleen, called the 1x3x5x7x9x11 rule:

It measures approximately 1 inch by 3 inches by 5 inches, weighs around 7 oz, and is positioned between the 9th and 11th ribs.

Anything that relates to the spleen is referred to as splenic; the spleen receives blood through the splenic artery, and blood leaves the spleen through the splenic vein. Although the spleen is connected to the blood vessels of the stomach and pancreas, it is not involved in digestion.

The spleen contains two main regions of tissue called white pulp and red pulp.

Red pulp: Contains venous sinuses (cavities filled with blood), and splenic cords (connective tissues containing red blood cells and white blood cells).

White pulp: Mostly consists of immune cells (T cells and B cells).

Functions of the spleen

The spleen's primary job is to filter the blood. As blood flows into the spleen, it performs a quality control service, detecting any red blood cells that are old or damaged. Blood flows through a maze of passages in the spleen. Healthy cells flow straight through, but those considered to be unhealthy are broken down by large white blood cells called macrophages.

Once the red blood cells are broken down, the spleen stores useful leftover products, such as iron, which it eventually returns to the bone marrow, which makes hemoglobin (the iron-containing part of blood).

The spleen also stores blood — the blood vessels of the spleen can expand significantly. In humans, around 1 cup of blood is kept in the spleen, ready to be released if there is a significant loss of blood, after an accident, for instance. Interestingly, when a racehorse is at rest, up to half of its red blood cells are kept in the spleen.

The spleen also plays a role in the immune response by detecting pathogens (bacteria, for instance), and producing white blood cells in response.

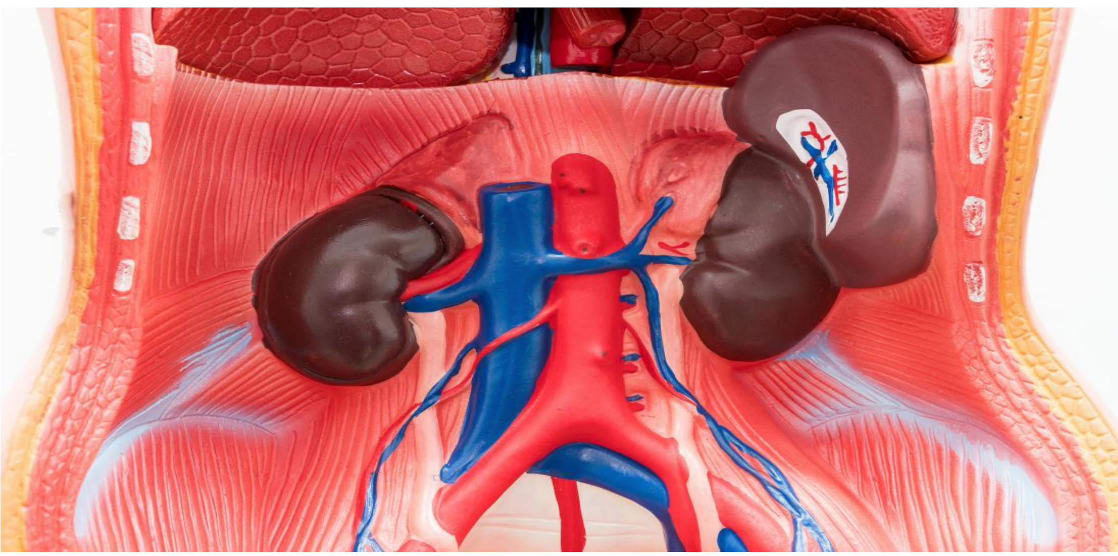
Around one-quarter of our lymphocytes (a type of white blood cell) are stored in the spleen at any one time.

The spleen clears out old platelets from the blood; it also acts as a reservoir for platelets.

As a fetus is developing, the spleen makes red blood cells, but after the fifth month of gestation, it stops.

The spleen also produces compounds called opsonins, such as properdin and tuftsin, that help the immune system.

Diseases affecting the spleen



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There are some conditions that can involve the spleen, these include:

Accessory spleen: An estimated 10–15 percent of people have an additional spleen. The second spleen is usually much smaller — around 1 centimeter (cm) in diameter. Generally, it causes no health problems.

Ruptured spleen: This can occur following an injury and cause life-threatening internal bleeding. Sometimes, the spleen will burst at the time of the injury; other times, it will burst days or weeks later. Certain diseases, such as malaria and infectious mononucleosis, make a ruptured spleen more likely because they cause the spleen to swell and the protective capsule to become thinner.

Enlarged spleen (splenomegaly): This can occur due to a variety of conditions, such as infectious mononucleosis (mono), blood cancers (such as leukemia), bacterial infections, and liver disease. Sometimes, the spleen is carrying out its regular work, but it is overactive (hypersplenism); it may, for instance, be destroying too many red blood cells or platelets.

Sickle cell disease: This is an inherited form of anemia; the condition is characterized by a dysfunctional type of hemoglobin. In this form of anemia, red blood cells are abnormally shaped (crescent-shaped) and block the flow of blood, causing damage to organs, including the spleen.

Thrombocytopenia: If the spleen becomes enlarged, it may store too many platelets, meaning that there are not enough in the rest of the body's circulatory system. Without platelets available to help blood clot, the primary symptom of thrombocytopenia is bleeding.

Spleen cancer: If cancer starts in the spleen, it is known as primary spleen cancer; if it spreads to the spleen from another site, it is called secondary. Both types of cancer are rare.

Splenic infarction: If the blood supply to the spleen is reduced, it is known as splenic infarction. This occurs if blood supply through the splenic artery is cut off by, for instance, a blood clot. This is often very painful, and treatment depends on the underlying cause.

Splenectomy: Can I live without my spleen?

Some people need to have their spleen surgically removed (splenectomy). Most commonly, this is due to a ruptured spleen, but it can also be because of an enlarged spleen, certain blood disorders, some cancers, infection, or noncancerous growths.

Although this modestly sized organ carries out a range of important tasks, it is possible to live without it. Other tissues, such as the lymph nodes and liver, can step in and carry out the spleen's tasks.

However, people who have had their spleen removed are more susceptible to infections.

As an aside, if a racehorse has its spleen removed, it will be significantly less athletic.

In a nutshell

The spleen is an important organ involved in cleaning out old blood cells and helping to mount the immune response. Although it is relatively small, it carries out a variety of roles. Despite this, if it is removed, a person can carry on without it.

The pancreas is an abdominal glandular organ with both **digestive** (exocrine) and **hormonal** (endocrine) functions.

In this article, we shall look at the anatomy of the pancreas – its structure, anatomical position and neurovascular supply.

Anatomical Position

The pancreas is an oblong-shaped organ positioned at the level of the transpyloric plane. With the exception of the tail of the pancreas, it is a retroperitoneal organ, located deep within the upper abdomen in the epigastrium and left hypochodrium regions.

Within the abdomen, the pancreas has direct anatomical relations to several structures

Organs:

Stomach – Separated from the pancreas by the lesser sac, the stomach and pylorus lie anterior and to the pancreas.

Duodenum – The "C" shaped duodenum curves around and outlines the head of the pancreas. The first part of the duodenum lies anteriorly whereas the second part of the duodenum including the ampulla of Vater lies laterally to the right of the pancreatic head

Transverse mesocolon – Attaches to the anterior surface of the pancreas

Common bile duct – Descends behind the head of the pancreas before opening into the second part of the duodenum alongside the major pancreatic duct through the major duodenal papilla

Spleen – located posteriorly and laterally. The lienorenal ligament is formed from peritoneum and connects the spleen to the tail of the pancreas.

Vessels

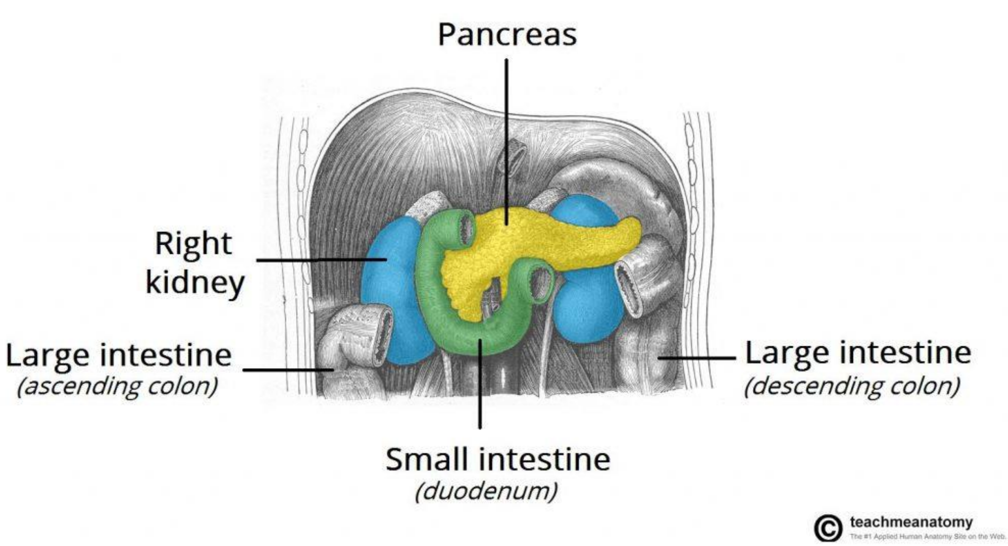
The pancreas lies near several major vessels and significant landmarks in vascular anatomy:

The aorta and inferior vena cava pass posteriorly to the head of the pancreas.

The superior mesenteric artery lies behind the neck of the pancreas and anterior to the uncinate process.

Posterior to the neck of the pancreas, the splenic and superior mesenteric veins unite to form the hepatic portal vein.

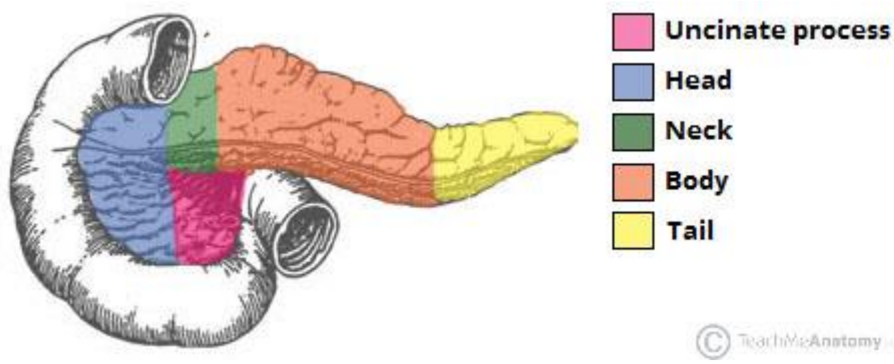
As it journeys from its origin at the celiac plexus to the splenic hilum, the splenic artery traverses the superior border of the pancreas.



Anatomical Structure

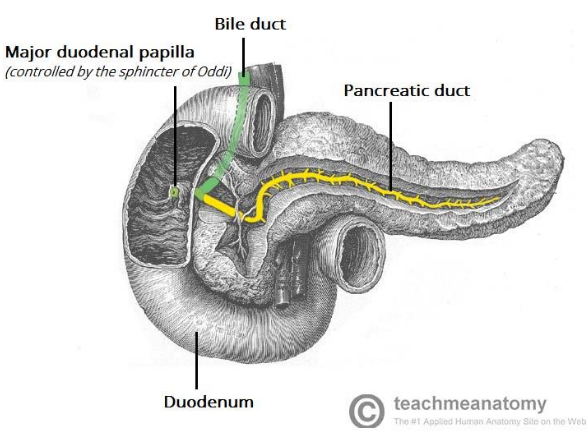
The pancreas is typically divided into five parts;

- **Head** – the widest part of the pancreas. It lies within the C-shaped curve created by the duodenum, and is connected to it by connective tissue.
- **Uncinate process** – a projection arising from the lower part of the head and extending medially to lie beneath the body of the pancreas. It lies posterior to the superior mesenteric vessels.
- **Neck** – located between the head and the body of the pancreas. It overlies the superior mesenteric vessels which form a groove in its posterior aspect.
- **Body** – centrally located, crossing the midline of the human body to lie behind the stomach and to the left of the superior mesenteric vessels.
- **Tail** – the left end of the pancreas that lies within close proximity to the hilum of the spleen. It is contained within the splenorenal ligament with the splenic vessels. This is the only part of the pancreas that is intraperitoneal.



The parts of the pancreas

The Duct System



The exocrine pancreas, secreting into the duodenum

The exocrine pancreas is classified as a lobulated, **serous gland** which produces digestive enzyme precursors. It is composed of approximately one million 'berry-like' clusters of cells called acini, connected by short intercalated ducts.

The intercalated ducts unite with those draining adjacent lobules and drain into a network of **intralobular collecting ducts**, which in turn drain into the main pancreatic duct.

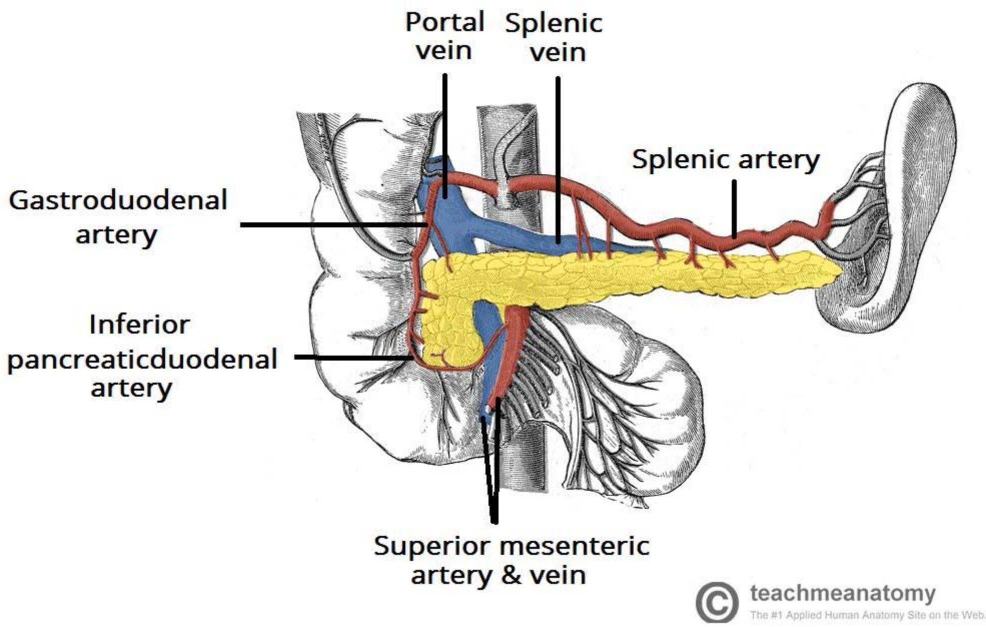
The pancreatic duct runs the length of the pancreas and unites with the common bile duct, forming the **hepatopancreatic ampulla of Vater**. This structure then opens into the duodenum via the major duodenal papilla.

Secretions into the duodenum are controlled by a muscular valve – the **sphincter of Oddi.** It surrounds the ampulla of Vater, acting as a valve.

Vasculature

The pancreas is supplied by the pancreatic branches of the splenic artery. The head is additionally supplied by the superior and inferior pancreaticoduodenal arteries which are branches of the gastroduodenal (from coeliac trunk) and superior mesenteric arteries, respectively.

Venous drainage of the head of the pancreas is into the superior mesenteric branches of the hepatic portal vein. The pancreatic veins draining the rest of the pancreas do so via the splenic vein.



The pancreas is drained by lymphatic vessels that follow the arterial supply. They empty into the **pancreaticosplenal nodes** and the pyloric nodes, which in turn drain into the superior mesenteric and coeliac lymph nodes.

On a scale from lesser omentum to mesentery, how difficult do anatomy students find the peritoneum? We guess that your answer comes out of all the hard-to-imagine pouches, layers and sacs.

So let's start with the basics; the Peritoneum is a serous membrane which lines the walls of the abdominal cavity and lies on abdominal and pelvic organs. Between its two layers – parietal and visceral – is the peritoneal cavity. The peritoneum functions to support and protect abdominopelvic organs.

Key facts about the peritoneum

Definition	Serous membrane lining viscera and abdominal cavity wall
Parts	Parietal peritoneum Visceral peritoneum Peritoneal cavity
Peritoneal formations	Mesentery: mesentery proper, transverse mesocolon, sigmoid mesocolon, mesoappendix Omenta: greater omentum, lesser omentum Peritoneal ligaments: hepatogastric, hepatoduodenal, gastrophrenic, gastrosplenic, splenorenal, gastrocolic ligament
Peritoneal divisions	Lesser sac (omental bursa) Greater sac (supracolic and infracolic compartments)
Function	Protection of the abdominopelvic organs Connect organs with each other Maintain the position of organs by suspending them with ligaments Prevent friction while organs move
Clinical relations	Ascites, peritonitis

This article will discuss the anatomy of the peritoneum, including key related topics; peritoneal cavity, omenta, mesentery, ligaments, and peritoneal relations.

Contents

Peritoneum

Parietal peritoneum (Peritoneum parietale)

The peritoneum consists of two layers:

- Parietal peritoneum – an outer layer which adheres to the anterior and posterior abdominal walls.
- Visceral peritoneum – an inner layer which lines the abdominal organs. It's made when parietal peritoneum reflects from the abdominal wall to the viscera.

Although in adults the peritoneum looks like it's scattered all over the place, there is a (embryo)logic reason behind it. During intrauterine development, the parietal peritoneum forms a closed sac occupying most of the abdominal cavity. At this time, abdominal organs are small and pressed against the posterior abdominal wall.

As organs develop and grow, they push into the peritoneum without entering the peritoneal cavity. The cavity squeezes through any available space that exists between the abdominal organs forming peritoneal folds and pouches. It is the same idea as pressing your hand into a balloon filled with water; the balloon changes shape around your hand but your hand doesn't go inside the balloon. Likewise, no organs lie within this potential space.

Peritoneal cavity

The peritoneal cavity is a potential space found between the parietal and visceral layers of the peritoneum. The cavity is filled with a small amount of serous peritoneal fluid secreted by the mesothelial cells which line the peritoneum. Peritoneal fluid enables the peritoneal layers to slide against each other with little friction while following the subtle movements of the abdominopelvic organs.

When the peritoneum folds while following the lining of the organs, it forms pouches (recesses) which can be filled with fluid if there is an ongoing inflammation of adjacent organs. Examples of such recesses are the inferior recess of the lesser sac formed by the folding of the greater omentum, and the recto-uterine pouch (of Douglas) found between the uterus and rectum in females.

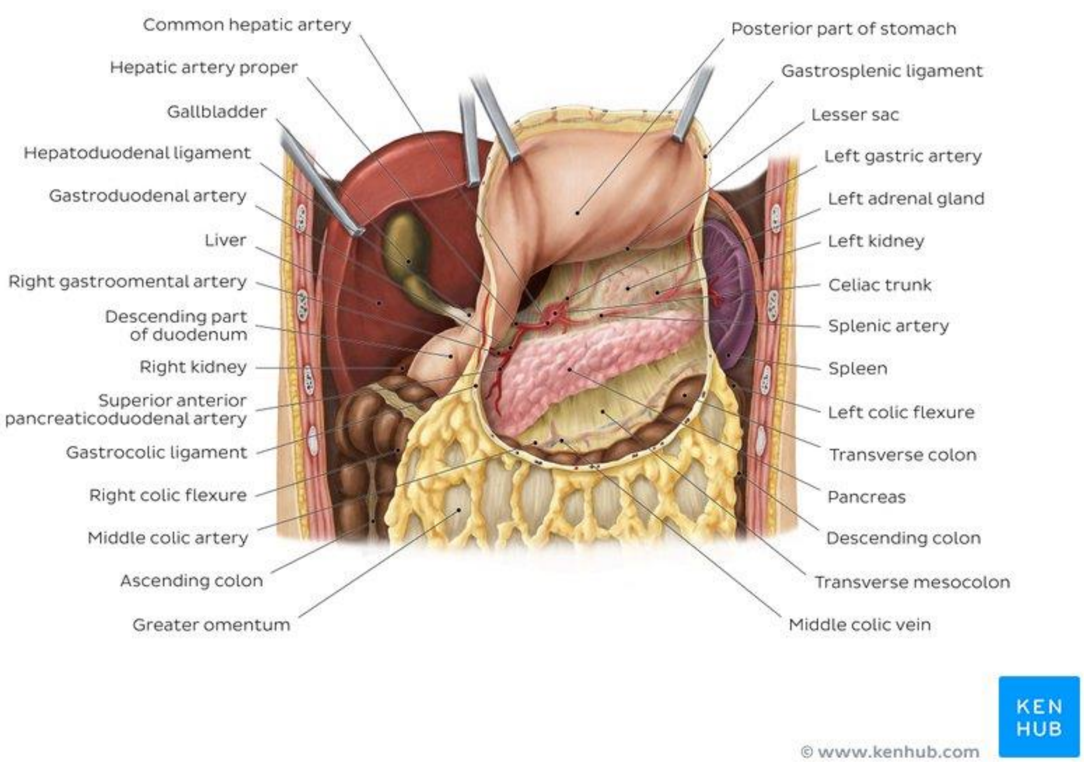
Learn more about the layers of the peritoneum and peritoneal cavity anatomy here:

Divisions

There are two divisions of the peritoneal cavity: lesser sac (omental bursa) and greater sac.

Lesser sac (omental bursa)

The omental bursa or lesser sac is found posterior to the stomach and liver, and anterior to the pancreas and duodenum. The function of the lesser sac is to provide space for unhindered movement of the stomach. It has an irregular shape with one superior and one inferior recess. The superior recess is bordered by the diaphragm and the coronary ligament of the liver, while the inferior recess is found between the folding layers of the greater omentum.



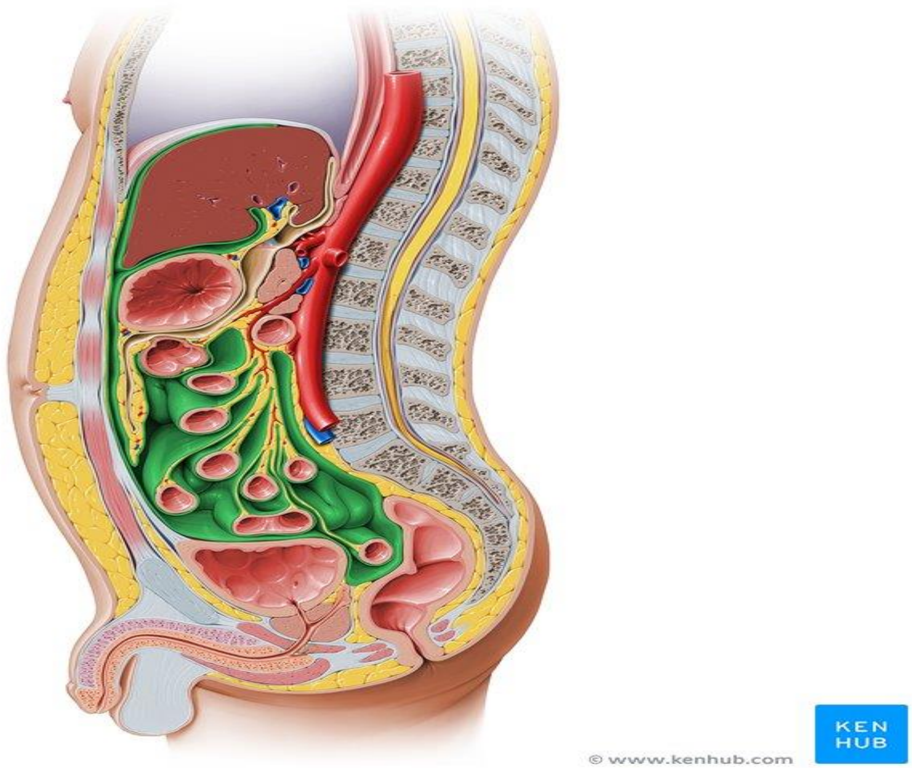
Lesser sac (diagram)

The lesser sac communicates with the greater sac via the epiploic foramen (omental foramen) found posterior to the free edge of the lesser omentum. This foramen has clear borders:

- Anterior – hepatoduodenal ligament
- Posterior – inferior vena cava and the right crus of the diaphragm
- Superior – caudate lobe of the liver
- Inferior – superior part of the duodenum

Learn more about the omental bursa with these resources.

Greater sac



Greater sac (medial view)

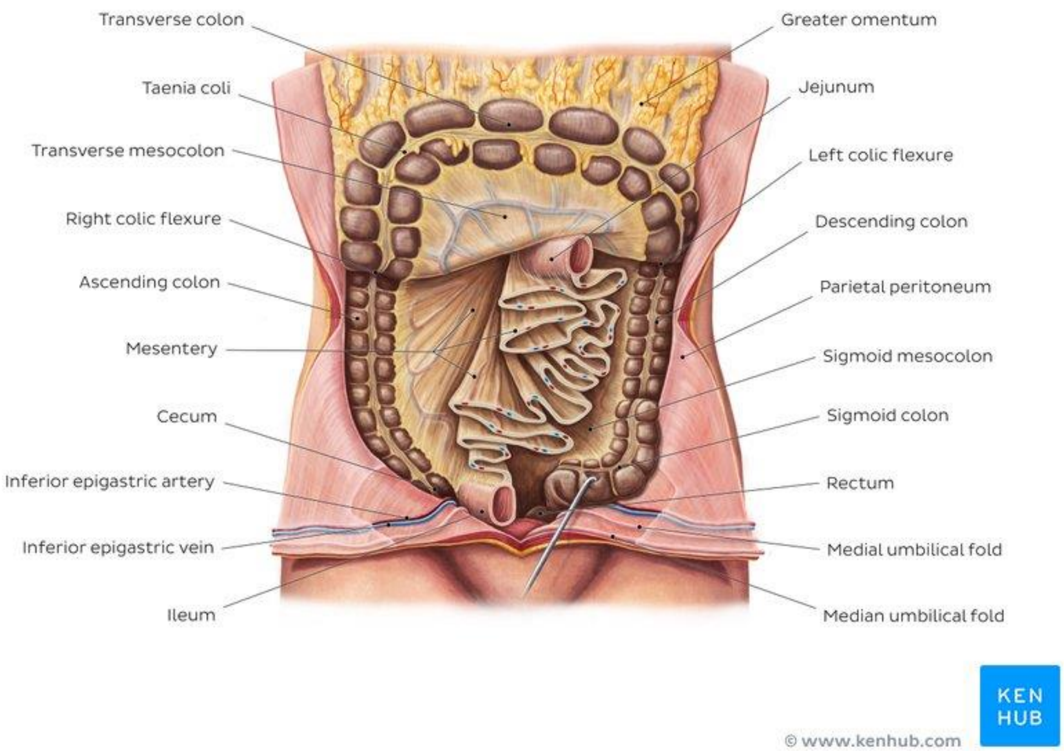
The greater sac extends from the diaphragm to the pelvic cavity. It is divided into the supracolic and infracolic compartments by the transverse mesocolon. The supracolic compartment is found anterior and superior to the transverse mesocolon, and contains the liver, stomach and spleen.

The infracolic compartment is posterior and inferior to the transverse mesocolon. Looking from the anterior aspect, it is divided by the root of the mesentery of the small intestine into the right and left infracolic spaces. The infracolic compartment contains the small intestine, ascending colon and descending colon.

Master the anatomy of the greater sac with these articles.

Mesentery

The mesentery is the folds of peritoneum that suspend organs from the posterior abdominal wall.



Mesentery (diagram)

The projection of an organ into the peritoneum creates a peritoneal fold which extends from the abdominal wall, wraps around that organ, and extends back to the abdominal wall. These double layers of peritoneum are the mesentery. Mesenteries carry neurovascular bundles through the fat between peritoneal layers to supply organs.

The mesentery of the small intestine is simply called the mesentery or mesentery proper, while the other parts of the digestive system have their mesenteries named more specifically: transverse mesocolon, sigmoid mesocolon, and mesoappendix. You'll notice the prefix "meso-" before the corresponding part of the intestines.

Omentum

Greater omentum (Omentum majus)

The omenta are two layers of peritoneum which have fused, and extend from the stomach and proximal duodenum to neighbouring organs. There are two subdivisions of the omentum depending on whether they extend from the greater or lesser curvature of the stomach.

The greater omentum hangs like a curtain covering the anterior surface of the small intestine. It hangs from the proximal duodenum and greater curvature of the stomach and then folds to attaches superiorly to the anterior surface of the transverse colon and its mesentery on the inferior edge. The lesser omentum extends superiorly from the lesser curvature of the stomach and proximal duodenum to the liver.

Peritoneal ligaments

Hepatogastric ligament (Ligamentum hepatogastricum)

Peritoneal ligaments are duplicatures of the peritoneum and can make up parts of the omenta. They have two main functions:

- To attach organs to the abdominal wall and/or to other abdominal organs and hold them in position
- To carry neurovascular structures which supply abdominal organs

Based on from which they originate, peritoneal ligaments are classified as splenic, gastric or hepatic ligaments.

Peritoneal ligaments

Splenic ligaments	Phrenicocolic ligament (sustentaculum lienis) Gastrosplenic ligament Splenorenal (lienorenal) ligament
Gastric ligaments	Gastrophrenic ligament Gastrocolic ligament
Hepatic ligaments	Falciform ligament Gastrohepatic ligament Hepatoduodenal ligament

Notable ligaments include the hepatogastric ligament and hepatoduodenal ligament which make up the lesser omentum. The hepatoduodenal ligament carries the portal triad – hepatic portal vein, hepatic artery proper, common bile duct. The gastrophrenic ligament, gastrosplenic ligament, gastrocolic ligament and splenorenal ligament form part of the greater omentum.

Want to learn more about the peritoneal ligaments? Check out this content we have prepared for you, including the quiz we specially designed for testing your knowledge.

Peritoneal relations

Intraperitoneal organ

Depending on how deep the abdominal organs dive into the peritoneum during development, they can be classified as:

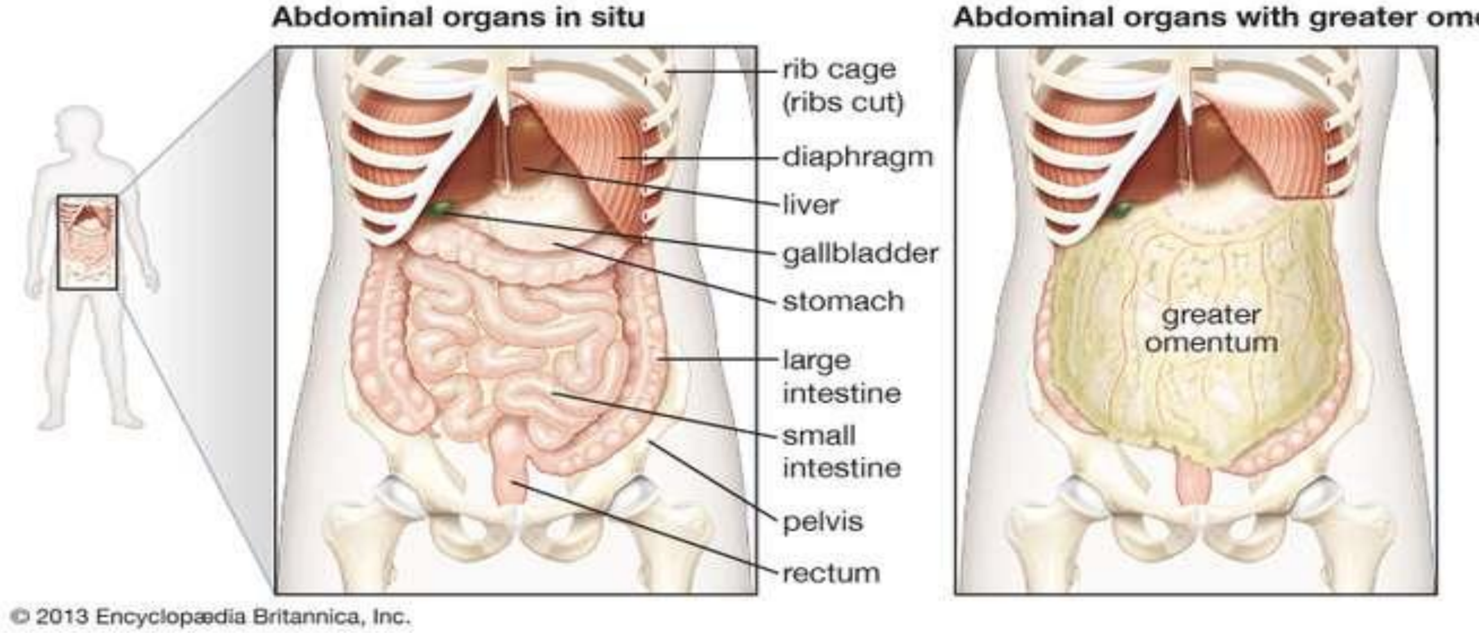
- Intraperitoneal organs
- Retroperitoneal organs (primarily and secondarily retroperitoneal)

Intraperitoneal organs are completely wrapped by visceral peritoneum. These organs are the liver, spleen, stomach, superior part of the duodenum, jejunum, ileum, transverse colon, sigmoid colon and superior part of the rectum.

Retroperitoneal organs are found posterior to the peritoneum in the retroperitoneal space with only their anterior wall covered by the parietal peritoneum. If they develop and remain outside the peritoneum, they are primarily retroperitoneal organs: kidney, adrenal glands and ureter. Other retroperitoneal organs develop inside the peritoneum, but then move beneath it: pancreas, distal duodenum, ascending and descending colons.

Master peritoneal relations with our study units. Also, take the chance to go further with clinical anatomy of the abdomen by reviewing our clinical case of necrotizing fasciitis of anterior abdominal wall.

Abdominal cavity, largest hollow space of the body. Its upper boundary is the diaphragm, a sheet of muscle and connective tissue that separates it from the chest cavity; its lower boundary is the upper plane of the pelvic cavity. Vertically it is enclosed by the vertebral column and the abdominal and other muscles. The abdominal cavity contains the greater part of the digestive tract, the liver and pancreas, the spleen, the kidneys, and the adrenal glands located above the kidneys.



The abdominal organs are supported and protected by the bones of the pelvis and ribcage and are covered by the greater omentum, a fold of peritoneum that consists mainly of fat.

The abdominal cavity is lined by the peritoneum, a membrane that covers not only the inside wall of the cavity (parietal peritoneum) but also every organ or structure contained in it (visceral peritoneum). The space between the visceral and parietal peritoneum, the peritoneal cavity, normally contains a small amount of serous fluid that permits free movement of the viscera, particularly of the gastrointestinal tract, inside the peritoneal cavity. The peritoneum, by connecting the visceral with the parietal portions, assists in the support and fixation of the abdominal organs. The diverse attachments of the peritoneum divide the abdominal cavity into several compartments.

Some of the viscera are attached to the abdominal walls by broad areas of the peritoneum, as is the pancreas. Others, such as the liver, are attached by folds of the peritoneum and ligaments, usually poorly supplied by blood vessels.

The peritoneal ligaments are actually rather strong peritoneal folds, usually connecting viscera to viscera or viscera to the abdominal wall; their name usually derives from the structures connected by them (e.g., the gastrocolic ligament, connecting the stomach and the colon; the splenocolic ligament, connecting the spleen and the colon) or from their shape (e.g., round ligament, triangular ligament).

The mesentery is a band of peritoneum that is attached to the wall of the abdomen and encloses the viscera. It extends from the pancreas, over the small intestine, and down over the colon and upper rectum. It helps to hold the organs in place and is richly supplied with vessels that carry blood to or from the organs it enfolds.

The omenta are folds of peritoneum enclosing nerves, blood vessels, lymph channels, and fatty and connective tissue. There are two omenta: the greater omentum hangs down from the transverse colon of the large intestine like an apron; the lesser omentum is much smaller and extends between the stomach and the liver.

Common afflictions of the abdominal cavity include the presence of fluid in the peritoneal cavity (ascites) and peritonitis, an inflammation of the peritoneum.

The respiratory system is a tube with many branches that end in millions of tiny air-filled sacs called alveoli. The airways have three main functions:

- To act as channels for gases moving to and from the lungs;
- To protect the lungs from the entry of any foreign matter;
- To control the heat and humidity of the gases.

The nose

The nose is the only part of the respiratory system that is visible externally and is the route for air entry into the respiratory system. Air is drawn in via the nostrils or external nares and enters the large nasal cavity, which is divided into two by the nasal septum. The nasal cavity is partitioned from the oral cavity directly below it by the palate.

Like the rest of the respiratory tract, the nose is lined with mucosal epithelium containing glands that secrete a thick, sticky mucus that helps to moisten the tract. Just below the surface of the epithelium is a rich network of blood vessels that warm the nasal cavities. Nosebleeds are fairly common because the blood vessels are so superficial.

The nerve endings responsible for smell (olfaction) are found in the nasal mucosa at the back of the nasal cavities. Any obstruction of the nasal passages and surrounding sinuses, for example caused by oedema of the tissues produced by the common cold, will affect these nerve endings. Typically the symptoms of an upper respiratory tract infection, or ‘head cold’ involve the airways above the trachea.

Four further cavities - the paranasal sinuses - surround and drain into the nasal cavity (Fig 2). Their mucosal lining is continuous with that of the nose and this means that sinus infections (sinusitis) are common during a cold when the nasal mucosa is inflamed. The hollow sinuses help lighten the skull and act as a resonating chamber for sounds, as well as helping to produce mucus for the respiratory tract.

Lacrimal ducts open into the nose and drain tears from the corner of each eye. This also helps to moisten the surface of the nasal cavity.

Three shell-like structures, the conchae or turbinates, protrude into each side of the nasal cavity and increase the surface area over which air flows on its way to the lungs (Fig 2). As air is drawn in, the turbinates cause it to swirl around within the nasal cavity and this is useful in a number of ways:

- It allows extra time for the incoming air to be warmed and humidified, and for outgoing air to be cooled and dehumidified. Breathing though the nose is much more effective at these functions than breathing through the mouth;
- The swirling action forces the air into frequent contact with the nasal mucosa and large foreign particles become trapped;
- The eddy currents that are created then carry olfactory stimuli to the olfactory receptors in the nose, allowing us to smell.

Warmed, humidified air passes from the nasal cavities through the internal nares into the pharynx, a structure shared by the respiratory and digestive systems.

The pharynx

This funnel-shaped tube is about 12.5cm long and has three sections - the nasopharynx, just behind the nasal cavities, the oropharynx behind the mouth and the lowest section, the laryngopharynx (Fig 1).

The pharynx acts as a passageway for food on its way to the stomach and for air en route to the lungs. The mucosal epithelium in the pharynx is thicker than elsewhere in the respiratory tract as it has to protect the tissues from any abrasive and chemical trauma caused by food.

Two eustachian or auditory tubes connect the middle ears with the nasopharynx and allow pressure in the middle and outer ear to equalise. The mucosal lining of the nasopharynx, eustachian tubes and middle ear is continuous and middle ear infections can occur when the nasopharynx is inflamed.

The oropharynx can be entered from the mouth as well as from the nasopharynx, while the lower portion, the laryngopharynx, divides into the oesophagus which carries food to the stomach and the larynx through which air passes to the lungs.

Tonsils are mounds of lymphatic tissue embedded in the pharynx - the adenoids or pharyngeal tonsils are found in the nasopharynx and the palatine tonsils in the oropharynx.

When the adenoids are swollen, it is difficult for air to pass from the nose to the throat and sufferers often breathe through their mouths. Although lymphatic tissue plays an important role in the body’s defence mechanisms, both sets of tonsils can be removed (tonsillectomy) if they become infected repeatedly. However, the operation has potentially serious complications.

Air is drawn through the pharynx into the larynx.

The larynx or voice box

The larynx is located immediately below the pharynx and is formed of pieces of cartilage bound together by ligaments. The largest of these, the thyroid cartilage, is often visible in the neck of adult males and is known as the Adam's apple.

Another leaf-shaped piece of cartilage, the epiglottis, partly covers the opening of the larynx and acts like a trapdoor, closing off the glottis during swallowing so that food and fluids cannot enter the trachea. If anything other than air enters the larynx, the cough reflex is triggered to try to expel the foreign matter (Marieb, 2006).

As well as being part of the airway, the larynx contains the highly elastic vocal cords or folds. These two short, fibrous bands are stretched across the inside of the larynx. The space between the two cords is known as the glottis.

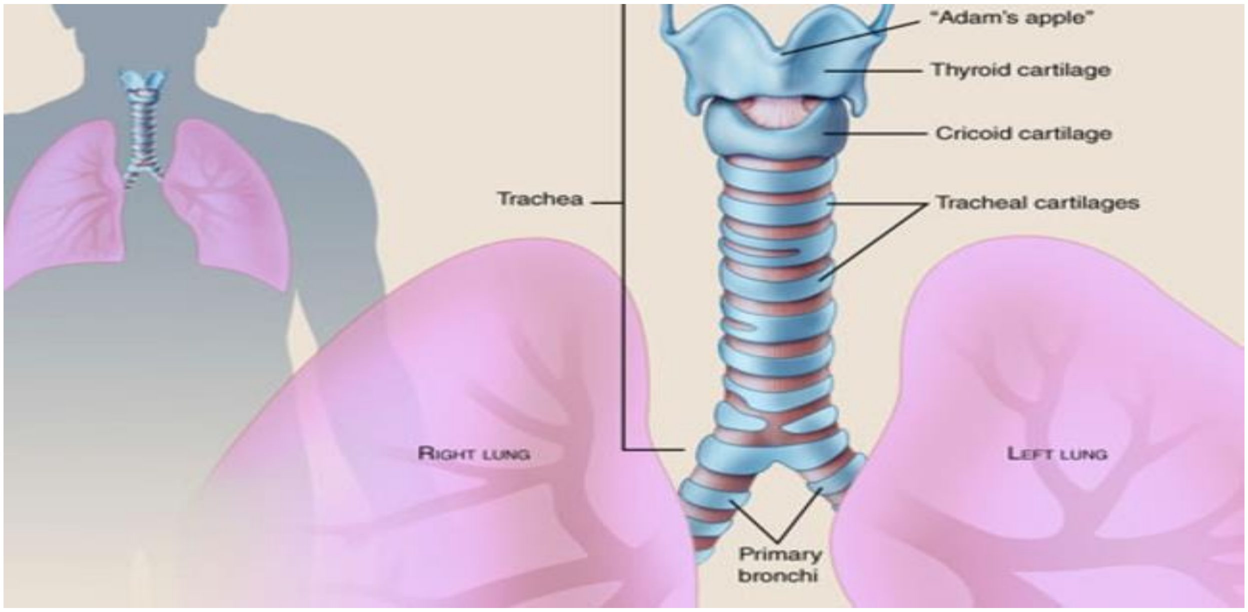
Exhaled air passing through the glottis makes the vocal cords vibrate, producing sound waves. Muscles attach the vocal cords to the larynx and can stretch the vocal cords so that they become taut or allow them to relax. When the vocal cords are taut, the voice is high-pitched; when relaxed, it is low-pitched.

The resultant sound is amplified and resonates in the pharynx, the oral and nasal cavities, and the paranasal sinuses.

At its lower end, the larynx joins the trachea.

The **trachea** is a cartilaginous tubular structure of the middle respiratory tract and is more commonly known as the windpipe. It connects the inferior margin of the larynx with the lower respiratory tract or the lungs.

This article will highlight the main anatomical features of the larynx as well as some of its common pathological transformations.



Anatomy

The trachea is a hollow cylinder that extends approximately nine to fifteen centimeters from the sixth cervical vertebra where it continues from the larynx to the point at which it bifurcates into the two major bronchi at the level of the fourth to the seventh (other references fourth to five) thoracic vertebrae. In diameter it spans approximately twenty five millimeters and only widens at it lower margin where it divides.

It descends into the thoracic cavity just anterior to the esophagus and bifurcates in the superior mediastinum with a slight deviation to the right, creating the right and left main bronchus. Above this however, it should be noted that the trachea is a median structure, meaning that it runs unpaired down the midline of the somatic axis.

Anteriorly, the aortic arch also descends before turning to the left side of the trachea, just above the left main bronchus. Other adjacent structures include the brachiocephalic trunk and the left common carotid artery.

It is comprised of approximately fifteen to twenty hyaline cartilages which are C-shaped. These cartilages provide structural rigidity to the trachea and its internal longitudinal elastic fibers enable it to stretch and shift inferiorly during inspiration. At the tracheobronchial bifurcation, there is an anatomical landmark known as the carina, which is a superior pointing ridge on the inner surface.

The trachea is supplied by the inferior thyroid arteries and innervated by both sympathetic and parasympathetic fibers. Pain sensation is governed by the sensory fibers of the vagus nerve (CN X).

h. A lung is an individual organ composed of tubular structures and alveolibound together by fibrous connective tissue (FCT). In the human, there are two lungs--right and left. Each lung is supplied by a primary or mainstem bronchus leading off of the trachea. The right lung is larger in volume than the left lung. The left lung must leave room for the heart. The right lung is divided into three pulmonary lobes (upper, middle, and lower) and 10 bronchopulmonary segments (2 + 3 + 5). The left lung is divided into two pulmonary lobes (upper and lower) and eight bronchopulmonary segments (4 + 4). A pulmonary lobe is a major subdivision of a lung marked by fissures (deep folds). Each lobe is further partitioned into bronchopulmonary segments. Each lobe is supplied by a secondary or lobar bronchus. Each segment is supplied by a tertiary or segmental bronchus, a branch of the lobar bronchus.

i. **Pleural Cavities**. See Lesson 3 to review a description of pleural cavities. ThatLesson indicates that each serous cavity has inner and outer membranes. In the case of the lungs, the inner membrane is known as the visceral pleura which very closely covers the surface of the lungs. The outer membrane is known as the parietal pleura, forming the outer wall of the cavity. The pleural cavities are the potential spaces between the inner and outer membranes. The pleural cavities allow the lungs to move freely with a minimum of friction during the expansion and contraction of breathing.

BREATHING AND BREATHING MECHANISMS IN HUMANS

INTRODUCTION

a. Boyle's law tells us that as the volume (V) of a gas-filled container increases, the pressure (P) inside decreases; as the volume (V) of a closed container decreases, the pressure (P) inside increases. When two connected spaces of air have different pressures, the air moves from the space with greater pressure to the one with lesser pressure. In regard to breathing, we can consider the air pressure around the human body to be constant. The pressure inside the lungs may be greater or less than the pressure outside the body. Thus, a greater internal pressure causes air to flow out; a greater external pressure causes air to flow in.

b. We can compare the human trunk to a hollow cylinder. This cylinder is divided into upper and lower cavities by the diaphragm. The upper is the thoracic cavity and is essentially gas-filled. The lower is the abdominopelvic cavity and is essentially water-filled.

COSTAL (THORACIC) BREATHING

a. **Inhalation**. Muscles attached to the thoracic cage raise the rib cage. A typical rib might be compared to a bucket handle, attached at one end to the sternum (breastbone) and at the other end to the vertebral column. The "bucket handle" is lifted by the overall movement upward and outward of the rib cage. These movements increase the thoracic diameters from right to left (transverse) and from front to back (A-P). Thus, the intrathoracic volume increases. Recalling Boyle's law, the increase in volume leads to a decrease in pressure. The air pressure outside the body then forces air into the lungs and inflates them.

b. **Exhalation**. The rib cage movements and pressure relationships are reversed for exhalation. Thus, intrathoracic volume decreases. The intrathoracic pressure increases and forces air outside the body.

DIAPHRAGMATIC (ABDOMINAL) BREATHING

The diaphragm is a thin, but strong, dome-shaped muscular membrane that separates the abdominal and thoracic cavities. The abdominal wall is elastic in nature. The abdominal cavity is filled with soft, watery tissues.

a. **Inhalation**. As the diaphragm contracts, the dome flattens and the diaphragm descends. This increases the depth (vertical diameter) of the thoracic cavity and thus increases its volume. This decreases air pressure within the thoracic cavity. The greater air pressure outside the body then forces air into the lungs.

b. **Exhalation**. As the diaphragm relaxes, the elastic abdominal wall forces the diaphragm back up by pushing the watery tissues of the abdomen against the underside of the relaxed diaphragm. The dome extends upward. The process of inhalation is thus reversed.

A pleura is a serous membrane that folds back on itself to form a two-layered membranous pleural sac. The outer layer is called the parietal pleura and attaches to the chest wall. The inner layer is called the visceral pleura and covers the lungs, blood vessels, nerves, and bronchi. There is no anatomical connection between the right and left pleural cavities. With the addition of pleural fluid, the lung pleura allows for easy movement of the lungs and inflation during breathing.

The mediastinum is a central compartment in the thoracic cavity between the pleural sacs of the lungs. It is divided into two major parts, the superior and inferior portions. The inferior portion is then further divided into the anterior, middle, and posterior portion. Each region of the mediastinum contains specific groups of structures.

- Superior mediastinum: Organs: thymus, trachea, esophagus; Arteries: aortic arch, brachiocephalic trunk, left common carotid artery, left subclavian artery; Veins and lymphatics: superior vena cava, brachiocephalic vein, thoracic duct; Nerves: vagus nerve, left recurrent laryngeal nerve, cardiac nerve, phrenic nerve
- Anterior mediastinum: Organs: thymus; Arteries: small arterial branches; Veins and lymphatics: small branches; Nerves: none
- Middle mediastinum: Organs: heart, pericardium; Arteries: ascending aorta, pulmonary trunk, pericardiacophrenic arteries; Veins and lymphatics: superior vena cava, azygos vein, pulmonary vein, pericardiacophrenic vein; Nerve: phrenic
- Posterior mediastinum: Organs: esophagus; Arteries: thoracic aorta; Veins and lymphatics: Azygos vein, hemiazygos vein, thoracic duct; Nerve: vagus nerve

Structure and Function

The pleural cavity is a space between the visceral and parietal pleura. The space contains a tiny amount of serous fluid which has two key functions.

The serous fluid continuously lubricates the pleural surface and makes it easy for them to slide over each other during lung inflation and deflation. The serous fluid also generates surface tension, which pulls the visceral and parietal pleura adjacent to each other. This function will allow the thoracic cavity to expand during inspiration.

NB; when air enters the pleural space, the surface tension will disappear, and the resulting condition is known as a pneumothorax.

Pleural Recesses

Located posterior and anterior, there are spaces where the pleural cavity is not totally filled by the lung parenchyma. This space is known as the recess - an area where the adjacent surfaces of the parietal pleura come into contact. The two recesses in the pleural cavity include the following:

- Costomediastinal recess which is found between the mediastinal and costal pleura. The space is located just posterior the sternum.
- Costodiaphragmatic recess is found between the diaphragmatic and costal pleura.

The reason these recesses are important is because they provide a space for fluid to accumulate. Pleural effusions usually collect in the costodiaphragmatic recess.

Blood Supply and Lymphatics

The visceral pleura receives its blood supply from the bronchial circulation while the parietal pleura receives its blood supply from the intercostal arteries.

Nerves

The costal and cervical portions of the parietal pleura are innervated by the intercostal nerve, and the diaphragmatic portion is supplied by the phrenic nerve. The parietal pleura is the only portion of the pleura that can sense pain. The visceral pleura is innervated by the autonomic nervous system (ANS) and lacks sensory innervation.

Surgical Considerations

Pneumothorax is a common clinical event, and it occurs when the pleural space is violated. The patient can present with a variety of symptoms depending on the size of the pneumothorax. With a small pneumothorax, the patient may be asymptomatic. But if the pneumothorax is large, the following symptoms will be present:

- Chest pain
- Dyspnea
- Asymmetrical chest expansion

Percussion and auscultation will reveal a hyperresonant chest with no breath sounds.

The two types of pneumothorax include:

Spontaneous: These pneumothoraces occur without any traumatic event. they are most common in young males who smoke. The most common cause of a spontaneous pneumothorax is the presence of small blebs on the superior surface of the upper lobes.

Traumatic: Traumatic pneumothorax is very common and may occur as a result of a central line insertion, penetrating chest trauma or rib fracture.

The treatment of a pneumothorax again depends on the size and presence of symptoms. Most asymptomatic cases can be observed if the patient is reliable and agrees to follow up. Repeat chest x-rays are required to ensure that the pneumothorax is resolving. For patients with large and symptomatic pneumothorax, insertion of a chest tube is the simplest treatment. Unlike the past when large sized chest tubes were inserted, today several kits are available with small size 8-12 French tubes which can be inserted without causing too much pain.

Clinical Significance

Normally, there is a small amount of pleural fluid found in the pleural cavity. When there is a pathological collection of pleural fluid, it is called a pleural effusion. Pleural effusion is classified as either exudative or transudative and can be caused by multiple mechanisms including lymphatic obstruction, increased capillary permeability, decreased plasma colloid pressure, increased capillary, venous pressure, and increased negative intrapleural pressure.

The mediastinum is commonly a site for tumors, and specific regions of the mediastinum are prone to certain tumors. Pneumomediastinum can also develop when air is introduced into the mediastinum most commonly seen in ruptures of the esophagus. A widened mediastinum is a worrisome clinical sign for possible aortic aneurysm or rupture.

The mediastinum is also very important when it comes to lung cancer. All lung cancers when advanced involve the mediastinal lymph nodes. The treatment for a patient with a lung cancer without mediastinal lymph node involvement is surgery, and it has a high cure rate. However, once the mediastinal nodes are involved, surgery alone is not curative, and patients need chemotherapy. To determine if the mediastinal lymph nodes are involved, a CT scan of the chest is necessary. If the nodes are greater than 1 cm, then a biopsy is required. The lymph nodes are biopsied using mediastinoscopy. If they turn out to be negative, then lobectomy alone is sufficient.

The status of the mediastinal lymph nodes is also important when dealing with patients with sarcoidosis, lymphoma, and tuberculosis. In each of these cases, a mediastinoscopy is needed to assess the histology before treatment can be provided.

The parathyroid glands are small endocrine glands located in the anterior neck. They are responsible for the production of **parathyroid hormone**, which acts to control calcium levels in the body.

This article will consider the anatomical location, vessels and nerves of the parathyroid glands, as well as some clinical correlations.

Anatomical Location

The parathyroid glands are located on the posterior aspect of the lateral lobes of the **thyroid gland**. They are flattened and oval in shape, situated external to the gland itself, but within its sheath.

The majority of people have four parathyroid glands, although variation in number is common. Anatomically, the glands can be divided into two pairs:

- **Superior parathyroid glands** – Derived embryologically from the fourth pharyngeal pouch. They are located approximately 1cm superior to the entry of the inferior thyroid arteries into the thyroid gland (at level of the inferior border of the cricoid cartilage).
- **Inferior parathyroid glands** – Derived embryologically from the third pharyngeal pouch. Although inconsistent in location between individuals, the inferior parathyroid glands are usually found near the inferior poles of the thyroid gland. In a small percentage of people, the glands can be found as far inferiorly as the superior mediastinum.

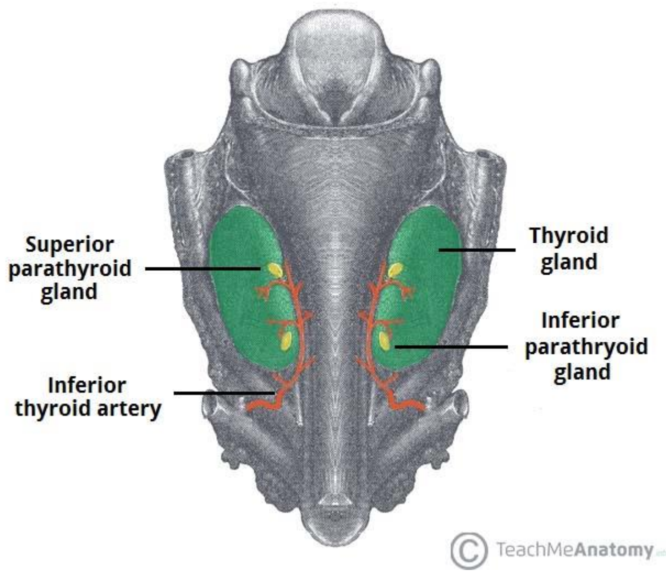


Fig 1.0 – The parathyroid glands and inferior thyroid artery. Note – the point of entry of the ITA into the thyroid gland cannot be seen on this diagram.

Vascular Supply

The posterior aspect of the thyroid gland is supplied by the **inferior thyroid arteries**. Thus its branches also supply the nearby parathyroid glands. Collateral circulation is delivered by the superior thyroid arteries, thyroid ima artery, and laryngeal, tracheal and oesophageal arteries.

The parathyroid veins drain into the **thyroid plexus of veins**.

Lymphatics

The lymphatic vessels of the parathyroid glands drain (along with those of the thyroid gland) into the **deep cervical** lymph nodes and **paratracheal** lymph nodes.

Nerves

The parathyroid glands have an extensive supply of nerves, derived from **thyroid branches** of the cervical (sympathetic) ganglia.

It is important to note that these nerves are **vasomotor**, not secretomotor – endocrine secretion of parathyroid hormone is controlled hormonally.

Clinical Relevance: Surgical Damage to Parathyroid Glands

The inconsistency in location of the parathyroid glands between individuals increases their risk of being damaged or removed inadvertently during neck surgery (i.e. **thyroidectomy**).

Removal of all the parathyroid glands would cause decreased **serum calcium** levels (hypocalcaemia), in turn leading to tetany (severe muscle twitches and cramps). Without urgent treatment this will result in death.

In order to try and prevent parathyroid damage, surgeons may preserve the **posterior** part of the thyroid gland during thyroidectomy. If this is not possible, the parathyroid glands are carefully located prior to removal of the thyroid tissue.

ENDOCRINE GLANDS

Endocrine (or internally secreting) glands are also named ductless glands, since they lack excretory ducts. Instead, the secretory cells release their products, *hormones*, into the extracellular space. From the extracellular space, the hormones may enter the blood stream, by which they reach their target organs. Alternatively, the hormones may affect nearby cells (*paracrine* acting hormones).

The major endocrine glands are the pituitary gland, the pineal body, the thyroid gland, the parathyroid gland, the pancreas, the adrenal glands, the ovaries and the testes. In some of these glands/organs the endocrine tissue constitutes only part of the parenchyma of the organ . Small groups or individual endocrine cells are also found in a variety of other organs, e.g. the GIT and the kidneys.

Pituitary Gland

The pituitary gland (or hypophysis) is attached to the inferior surface of the brain by an extension of the nervous tissue of the tuber cinereum /eminentia mediana of the hypothalamus, the infundibulum. The infundibulum and small amounts of non-neural secretory tissue surrounding it form the *hypophyseal stalk*. The pituitary gland is located in the sella turica, the hypophyseal fossa of the sphenoid bone. The pituitary gland is surrounded by a thin connective tissue capsule. The loose connective tissue between the capsule and the periosteum of the sphenoid bone contains a dense plexus of thin-walled veins, which surround the entire pituitary gland.

Macroscopically, the pituitary gland can be divided into *neurohypophysis*, which includes all neuroectodemal hypophyseal derivatives, and *adenohypophysis*, which includes all ectodermal hypophyseal derivatives. Adenohypophyseal tissue extending dorsally along the anterior and lateral surfaces of the hypophyseal stalk is also called *pars tuberalis* of the hypophysis. The remainder of the adenohypophysis can be divided into a *pars intermedia* and a *pars distalis*.

It becomes a little easier to understand the structural divisions of the pituitary gland if you understand the pattern of the development of this gland.

Any pituitary slide which contains both the adenohypophysis and neurohypophysis id suitable to look at the general organization of the pituitary. Try to identify the portal venules. Several of them can usually be seen in the pars tuberalis, where they descend towards the pars distalis of the adenohypophysis.

Draw the pituitary at low magnification and identify its divisions (those visible in the slide) and portal venules in your drawing.

Cells and secretory products of the hypophysis:

Adenohypophysis

The pars distalis of the adenohypophysis accounts for about 75% of the hypophyseal tissue. The glandular cells are arranged in irregular clumps or cords between a network of capillaries with large and irregular lumina. Connective tissue, which supports the glandular cells, is scant. Traditionally, glandular cells are subdivided into *chromophobe cells* and *acidophil* and *basophil* (*chromophil*) *cells*. This division into three cell types is based on their differential staining with H&E. Cocktails of other dyes, some of which are mentioned below, also allow a differentiation between these cell types.

All known hormones of the adenohypophysis are proteins or glycoproteins.

The contents of the secretory vesicles are responsible for the staining characteristics of the chromophil cells.

Acidophil cells (or acidophils)

Acidophils are rounded cells and typically smaller than basophil cells. Acidophils account for roughly 65% of the cells in the adenohypophysis.

- The most frequent subtype of acidophils are the *somatotrophs* (which can be stained with the dye orange G). Somatotrophs produce *growth hormone* (GH or somatotropin), which e.g. stimulates liver cells to produce polypeptide growth factors which stimulate growth (e.g. somatomedin which stimulates epiphyseal cartilage - overproduction of this hormone may result in gigantism or acromegaly).
- *Mammotrophs* (or lactotrophs), the second group of acidophils, secrete *prolactin*. Their number increases significantly in late pregnancy and the early months of lactation.

Basophil cells (or basophils)

Based on their hormone products basophils are divided into three subtypes.

- *Thyrotrophs* produce *thyroid stimulating hormone* (TSH or thyrotropin).
- *Gonadotrophs* produce *follicle stimulating hormone* (FSH), which stimulates the seminiferous epithelium in males in addition to early follicular growth in females. Gonadotrophs also produce *luteinizing hormone* (LH), which stimulates production of testosterone by Leydig cells in males in addition to late follicular maturation, oestrogen secretion and formation of corpus luteum in females.
- *Corticotrophs* (or adrenocorticolipotrophs) secrete *adrenocorticotropic hormone* (ACTH or corticotropin) and *lipotropin* (LPH, no known function in humans). Corticotropes are the most frequent cell type in the pars intermedia. In the pars intermedia, the precursor of ACTH and LPH undergoes further hydrolysis into *melanocyte stimulating hormone* (MSH, increased pigmentation in patients with Addison's disease) and a number of other peptides (among them endogenous opioids).

When stained with the PAS reaction all three types of basophils appear reddish. Morphological criteria may be used, aside from the secretory products, to distinguish between the cells, but differences are so subtle that it is hopeless to try to tell them apart in the available preparations.

Chromophobe cells

Chromophobe cells are unstained or weakly stained cells. Most chromophobe cells can be assigned to the different classes of chromophils if EM and immunocytochemistry are used. They are now thought to represent acidophil and basophilic cells in a dormant or recently degranulated stage (degranulation = release of most of the secretory vesicles), but may also include stem cells of the secretory cells.

Pituitary, sheep - PAS/ORANGE G or **Pituitary, sheep - H&E**

The best slide to identify the different cell types of the adenohypophysis is the PAS/Orange G stained one. Identify acidophils, basophils and chromophobes. Survey the tissue, and verify that the relative frequencies of the cells are different in different parts of the adenohypophysis.

In the H&E stained sections acidophils are dark pink and basophils look light pink/blue. ***Draw part(s) of the adenohypophysis which contains, if possible, all three cell types at high magnification.***

The blood supply to the pituitary gland is extraordinary complex. At this stage it is important to know that the *primary capillary network* in the neural part of the hypophyseal stalk drains into 20 or more *portal venules*, which form a *secondary capillary network* in the pars distalis of the pituitary gland.

The release of hormones from the adenohypophysis is under the control of hormones which are produced by nerve cells in the hypothalamus.

For each hormone released by the adenohypophysis there exist *release-inhibitory factors* and *releasing-factors*. These factors are also hormones. The axons of hypothalamic nerve cells terminate within the neural stalk and release these regulatory factors into the extracellular space associated with the primary capillary plexus. They are transported towards the adenohypophysis within the portal venules and reach their target cells via the secondary capillary plexus.

Neurohypophysis

The neurohypophysis consists of

- unmyelinated nerve fibres derived from neurosecretory cells of the supraoptic and paraventricular hypothalamic nuclei and
- *pituicytes.*

Usually only the oval or round nuclei of the pituicytes are visible. Hypothalamic nerve fibres typically terminate close to capillaries. Scattered, large, and bluish-violet (in PAAB/PAS/Orange G stained sections) masses represent dilations of these nerve fibres. The dilations are named *Herring bodies*. They are filled by small vesicles which contain the neurosecretory products of the hypothalamic cells.

The neurophypophysis expands posterior to the adenohypophysis, where it forms the posterior lobe of the pituitary.

Release-inhibiting and releasing factors, which regulate the activity of the adenohypophysis, are not the only hormones secreted in the neurohypophysis. Two additional hormones are *oxytocin*, which stimulates the contraction of smooth muscle cell in the uterus and participates in the milk ejection reflex, and *antidiuretic hormone* (ADH or vasopressin), which facilitates the concentration of urine in the kidneys and, thereby, the retention of water.

PINEAL BODY

The pineal body is a flattened, cone-shaped organ attached to the roof of the third ventricle, where it occupies a depression between the superior colliculi.

The pineal body is surrounded by pia mater, which functions as its capsule and which sends connective tissue septa into the pineal body, subdividing it into lobules.

In the pineal we find two cell types: *pinealocytes* (about 95% of the cells; large, light and round nuclei) and *astrocytes* (glial cells; dark, elongated nuclei).

Aside from the cells the pineal gland also contains ..... sand - well - brain sand (or acervuli cerebri or - just for good measure - corpora arenacea). These are calcium-containing concretions in the pineal parenchyma, which increase in size and number with age. These concretions are radioopaque, and, since the pineal is located in the midline of the brain, they provide a *good midline-marker*. They have have no other known function.

The most prominent secretory product of the pineal body is *melatonin*. The cocktail of substances released by the pinealocytes can have several functions: they may decrease secretory activity in most other endocrine glands (in part indirectly, by way of influencing hypothalamic neurones), and they may "delay" puberty through antigonadotrophic effects.

Secretory activity in the pineal gland is stimulated by darkness and inhibited by light. Via the effects of pineal hormones on the adenohypophysis and sex hormones it is likely that the pineal body is involved in phenomena associated with the circadian rhythm and seasonal phenomena (e.g. seasonal affective disorder, SAD). The pineal body is innervated by postganglionic sympathetic fibres derived from the superior cervical ganglion.

Pineal gland, sheep - H&E

The parenchyma of the pineal gland looks rather homogeneous at low magnification. A few blood vessels are visible criss-crossing through the gland. At higher magnification three types of nuclei can be distinguished. Small dark nuclei belong to the astrocytes found in the pineal gland. Pinealocytes have larger, lighter and round nuclei, which are surrounded by a broad rim of light cytoplasm. Most nuclei present are the nuclei of pinealocytes. Endothelial cell nuclei are found in association with the vessels and capillaries traversing the tissue. Both pinealocytes and astrocytes have long processes which give the tissue between the nuclei its "stringy" appearance. Brain sand is not visible in this section.

Draw a small part of the parenchyma of the pineal gland at high magnification. Label pinealocytes and astrocytes.

THYROID GLAND

The thyroid gland is situated on the lateral sides of the lower part of the larynx and upper part of the trachea. The two lateral lobes of the thyroid are connected by a narrow isthmus in front of the trachea. The size is quite variable but typically ranges around 20g (slightly larger in females than in males).

The thyroid gland consists almost entirely of rounded cysts, *follicles*, which are separated by scant interfollicular connective tissue. The follicle is the structural and functional building block of the thyroid gland. It consists of a simple cuboidal epithelium (variable - depending on the functional state) which surrounds a lumen filled with a viscous substance, colloid. The size of the follicles is variable ranging from about 50 µm to about 1 mm.

The colloid is the secretory product of the follicular cell (extracellular storage!). Its main component, *thyroglobulin*, consists of *triiodothyronine* and *tetraiodothyronine (or thyroxine)*.

C cells (or parafollicular cells) are part of the follicles. There are only few of them, and they are typically situated basally in the epithelium, without direct contact with the follicular lumen. They are always situated within the basement membrane, which surrounds the entire follicle.

Arterial supply is abundant with a dense network of capillaries between the follicles. Sympathetic fibres (from the superior, middle and inferior cervical ganglia) are mainly vasomotor (there is some evidence that sympathetic input may have a stimulatory effect on secretory activity).

Hormones of the thyroid gland

The main secretory products of the thyroid gland are thyroxine and triiodothyronine. TSH stimulates the endocytosis of thyroglobulin from the follicular lumen and the subsequent release of its components into the blood stream. TSH also stimulates their synthesis and release into the follicular lumen.

These thyroid hormones *increase metabolic activity in almost all tissues and organs*. Many of the other effects of the hormones are secondary to an increased oxygen consumption of the affected cells and the energy that, as a consequence, becomes available for cellular processes (exceptions to this rule are e.g. effects on lipid metabolism and increases in carbohydrate absorption in the small intestine).

C cells produce the hormone *calcitonin*, which decreases blood calcium concentration by inhibiting the resorption of bone (primarily by inhibiting osteoclast activity).

Thyroid gland, human - H&E

Identify the follicles of the thyroid gland. Have a look at the height of the epithelium and make an educated guess at the functional activity in the thyroid (well, when it was still alive!). Notice the capillaries in the interstices between the thyroid follicles. C cells are very difficult to identify. ***Pick a nice follicle and draw it.***

PARATHYROID GLANDS

The parathyroid glands are four small oval bodies located at the posterior surface of the thyroid gland (close to the middle and inferior ends of the lateral thyroid lobes - but a bit variable; the inferior pair may actually be located in the mediastinum).

These glands are **small** (average total weight is about 130 mg - that's 130 *milli*grams) but essential for life.

Each parathyroid gland is surrounded by a thin connective tissue capsule. Parenchymal cells are arranged in anastomosing chords surrounded by delicate connective tissue septa. Capillaries are abundant. A considerable number of fat cells infiltrate the gland (beginning around puberty) and may account for about half the weight of the parathyroid glands in adults.

Two cell types can be distinguished in the parathyroid glands:

1. *Chief cells* are the most numerous type. They are rather small, a round, light and centrally placed nucleus and a very weakly acidophilic cytoplasm. They synthesise *parathyroid hormone* (PTH or parathormone) which is of pivotal importance for normal calcium concentrations in the fluids and tissues of the body. The effect is mediated by a stimulation of osteoclastic bone resorption, intestinal calcium uptake and calcium resorption in the kidneys. If the parathyroid glands are removed completely, calcium concentrations decrease rapidly, leading to tetany within 2-3 days and eventually death if left untreated.
2. *Oxyphilic cells* are less frequent (entirely lacking in small children; occurring first in children six to seven years old and afterwards increasing in number with age - funny enough they have so far only been demonstrated in Rhesus monkey, the ox and, of course, humans). Their

cytoplasm is strongly acidophilic, the nucleus is small and uniformly intense basophilic. They contain large amounts of mitochondria.

There are plenty of transitional cells, i.e. cells that morphologically represent transitions between chief cells and oxyphilic cells.

Both the release of calcitonin by C cells in the thyroid gland and the release of parathyroid hormone are regulated by negative feedback from blood calcium concentrations.

Parathyroid gland, human - H&E

Your first task, which may not be that easy, is to find the parathyroid glands. The glands are small and usually occupy only a small fraction of the tissue on the slide. Give it a good try before you call for help. Identify chief cells and oxyphilic cells.

Draw a part of the tissue in which both cell types are both visible. Include if possible some of the fat cells which may occupy a large part of the parenchyma of the parathyroid.

ADRENAL GLANDS

The adrenal (or suprarenal) glands consist of an outer *cortex* (the main part of the adrenal glands) and an inner *medulla* (which accounts for about 10% of the adrenal glands). The gland is surrounded by a thick connective tissue capsule. Vessels and nerves reach the medulla by way of connective tissue trabeculae which extend from the capsule towards the medulla. Cortex and medulla are two distinct endocrine organs(in lower vertebrates they may actually form two entirely separate organs).

Cortex

The cortex is divided into three concentric zones which, from the surface inwards, are termed the *zona glomerulosa* (accounting for about 15% of the cortical thickness), the *zona fasciculata* (about 75%) and the *zona reticularis*(about 10%). Transitions are usually gradual.

- Cells of the zona glomerulosa are organised into small rounded groups or curved columns. Cells are smaller than in the two other zones, their nuclei are dark and round, and the cytoplasm is light basophilic. *The zona glomerulosa is not influenced by ACTH*.
- The zona fasciculata consists of radially arranged cell cords separated by fenestrated sinusoid capillaries. The nucleus is light and typically located centrally. The cytoplasm is also light and often has a characteristic foamy or spongy appearance (lipid droplets in the cytoplasm extracted during tissue processing) - they are for this reason also called spongiocytes.
- Anastomosing cell chords separated by sinusoid spaces form the zona reticularis. Cells are typically smaller than in the zona fasciculata. Their cytoplasm is eosinophilic and less spongy than that of other cells in the cortex. The nucleus is rather light and large. Lipofucsin, a pigment, accumulates in the cells with age. These accumulations have an orange tinge in H&E stained preparations.

Both the zona fasciculata and zona reticularis depend on ACTH to sustain their function and survival.

Hormones produced in the cortex are all *steroids*. Consequently, cortical cells contain large amounts of smooth endoplasmatic reticulum and lipid droplets. Since the hormones are synthesised in the cortex they are more precisely termed *corticosteroids*. Corticosteroids are further subdivided into *mineralocorticoids* and *glucocorticoids* . The most important mineralocorticoid is *aldosterone*, which regulates the resorption of sodium and excretion of potassium in the tubules of the kidney. The most important glucocorticoids is *cortisol*, which has a wide range of effects on most cells of the body. Cortisol effects protein catabolism in almost all cells aside from liver cells, gluconeogenesis, glycogen storage, mobilisation of fat from adipocytes, anti-inflammatory effects, inhibition of allergic reactions). Small amounts of androgens, oestrogens and progesterone are also produced.

Kidneys and ureters are organs of the urinary system. They take part in urine production and its transport to the urinary bladder, respectively. Fun fact is that the kidneys filter around 180 liters of blood each day, meaning that your entire blood volume passes through them around 60 times every day.

Adrenal glands (suprarenal glands) rest at the superior poles of the kidneys, but functionally they belong to the endocrine system. The adrenal gland functions are very diverse. They produce steroid hormones which regulate a wide variety of bodily functions, such as blood pressure, metabolism and stress response.

Kidneys

Location

The kidneys are paired retroperitoneal organs of the urinary system. The kidney location is on the posterior abdominal wall at the level of the T12-L3 vertebrae.

Kidneys are bean-shaped structures with superior and inferior poles (extremities), anterior and posterior surfaces, major and minor convexities. The minor convexity is directed towards the median plane and contains the renal hilum. This represents the gateway for passage of the renal artery, renal vein and ureter. Learning a quick mnemonic 'VAD' can help you remember these structures (renal Vein, renal Artery, Duct a.k.a ureter).

The kidneys consist of two portions: an outer renal cortex and an inner renal medulla. The renal cortex shows segmental extensions called renal columns which project into the medulla and separate its pyramids.

The renal medulla consists of 8-18 renal pyramids. The latter are made up of numerous nephrons. The apex of each pyramid (renal papilla) opens medially to the minor calyx, which is the first part of the urinary collecting system within the kidney. Minor calyces unite to form two to three major calyces, which then combine to form the renal pelvis. The ureter emerges from the renal pelvis and leaves the kidney through the hilum.

Nephron

The nephron is the functional unit of the kidney. Each nephron consists of a renal corpuscle and a renal tubule. Based on where their corpuscle is located, nephrons are either cortical (corpuscle high in the cortex) or juxtamedullary nephrons (corpuscle low in the cortex close to the medulla).

Nephron structure: Diagram

The renal corpuscle consists of the glomerular (Bowman's) capsule and a web of capillaries called the glomerulus. The function of the corpuscle is to filter blood, while the renal tubule processes and carries the filtered fluid to the system of calyces. Going from the corpuscle to the calyces, the renal tubules consist of the proximal convoluted tubule, nephron loop (loop of Henle), distal convoluted tubule and collecting tubule.

Collecting tubules from adjacent nephrons empty into a collecting duct, which in turn empties into the system of calyces via the renal papilla. The renal tubules are surrounded by a network of peritubular capillaries into which useful substances are reabsorbed from the filtrate.

Recommended video: Kidney structure

Overview of the structure of the kidney.

Functions

The main function of the kidney is to filter the blood by eliminating metabolic wastes and excess water. It also returns useful substances to the blood, such as minerals and nutrients. Through these actions of filtration and reabsorption the kidneys regulate the levels of minerals, electrolytes and the entire biochemical profile of the body.

By producing urine, the kidneys also regulate the amount of the body fluid, significantly impacting blood pressure.

But that's a part of the wide range of functions the kidneys are responsible for! The whole list is quite easy to learn if you use a mnemonic 'A WET BED', which stands for:

- Maintaining ACID-base balance
- Maintaining WATER balance
- ELECTROLYTE balance
- TOXIN removal
- BLOOD Pressure control
- Making ERYTHROPOIETIN
- Vitamin D metabolism

The ureters are bilateral muscular tubes (25 cm long) connecting the kidneys to the urinary bladder. They are partial retroperitoneal structures found on the posterior abdominal wall and inside the pelvis. Each ureter courses downwards from the renal pelvis (ureteropelvic junction), crosses the bifurcation of the common iliac artery and enters the urinary bladder (ureterovesical junction). These junctions are physiological constrictions frequently obstructed by kidney stones (renal calculi).

Kidneys and ureters: Diagram

The ureter function involves forcing the urine downwards by contracting and relaxing its smooth muscle wall (peristalsis). This pushes the urine away from the kidney and into the urinary bladder.

Suprarenal glands

The suprarenal (adrenal) gland is a bilateral retroperitoneal organ of the endocrine system. It sits on the superior pole of the kidney from which it's separated by a thin layer of fat. Each gland consists of two distinct parts - adrenal cortex and adrenal medulla.

Suprarenal gland (Glandula suprarenalis)

Adrenal cortex

The adrenal cortex is the outer part of the adrenal gland. It is subdivided into three layers all of which secrete different types of steroid hormones:

- Zona glomerulosa produces mineralocorticoids such as aldosterone. They regulate electrolyte and water balance within the body.
- Zona fasciculata synthesizes glucocorticoids such as cortisol, which coordinates responses to stressful situations.
- Zona reticularis produces adrenal androgens. They regulate sexual development and function.

Suprarenal gland hormones

Adrenal medulla

The adrenal medulla is the central part of the adrenal gland consisting of the chromaffin cells. They release two types of catecholamines into the bloodstream; epinephrine (adrenaline) and norepinephrine (noradrenaline).

These hormones activate the fight-or-flight response, which is a physiological reaction to stressful or dangerous situations, such as a bear attack or an anatomy exam. They elevate heart activity and blood pressure, dilate the bronchioles and increase blood flow to the muscles.

Blood vessels

Kidneys and ureters

Each kidney and ureter is supplied by its respective renal artery that arises from the abdominal aorta, just below the superior mesenteric artery.

Blood supply of the kidney: Labeled diagram.

The renal artery enters the hilum of the kidney and divides into a series of smaller vessels. They ultimately end as afferent arterioles, which transport blood into the renal glomerulus for filtration. Filtered blood leaves the glomerulus via the efferent arteriole, which becomes the interlobular vein. Venous blood of the kidney is conveyed by the renal vein which drains into the inferior vena cava.

The ureters receive blood supply from three sources:

- Upper third from the renal arteries
- Middle third from the abdominal aorta, gonadal arteries and common iliac arteries
- Inferior third from the internal iliac arteries

Venous blood from the ureters is drained into the respective renal and gonadal veins.

Adrenal glands

Superior suprarenal artery (Arteria suprarenalis superior)

The adrenal glands receive arterial supply from three sources:

- Inferior phrenic artery - several superior suprarenal arteries
- Abdominal aorta - several middle suprarenal arteries
- Renal artery - one inferior suprarenal artery

Venous blood from the left and right adrenal glands drains into their respective suprarenal veins. The right suprarenal vein is a direct tributary of the inferior vena cava, whereas the left suprarenal vein drains into the renal vein first.

Innervation

Kidneys and ureters

The kidneys receive autonomic innervation from the renal plexus. Sympathetic input is provided by the thoracolumbar splanchnic nerves (T10-L1). Parasympathetic input comes from the vagus nerve (CN X).

The ureters receive autonomic nerve supply from the ureteric plexus. The latter receives fibers from the renal, aortic and hypogastric (superior, inferior) plexuses.

Adrenal glands

The adrenal glands are stimulated by both neuronal and hormonal pathways. They predominantly receive sympathetic innervation, from the thoracolumbar splanchnic nerves (T10-L1). The fibers synapse directly onto the chromaffin cells of the adrenal medulla, inducing the release of catecholamines. The adrenal cortex receives hormonal stimulation from the pituitary gland by way of adrenocorticotropic hormone (ACTH) to produce corticotropic hormones.

The urinary bladder and urethra are pelvic urinary organs whose respective functions are to store and expel urine outside of the body in the act of micturition (urination). As is the case with most of the pelvic viscera, there are differences between male and female anatomy of the urinary bladder and urethra.

In our entire urinary system series, the urinary bladder and urethra represent the final season. This page will discuss the anatomy and function of the urinary bladder and urethra.

Urinary bladder

The urinary bladder is a hollow muscular organ. It temporarily stores urine conveyed by the ureters from the kidneys until the body is ready to expel it through the urethra.

Location

Urinary bladder (Vesica urinaria)

The urinary bladder is found inferior to the peritoneum, sitting on the pelvic floor. In females its inferior surface lays on the pubic symphysis and the posterior wall is in contact with the vagina and uterus.

In males, the inferior surface of the bladder lays over the pubic symphysis and prostate, posteriorly is the distal third of the rectum. Between the posterior surface of the bladder and anterior surface uterus is a peritoneal recess called the vesicouterine pouch. In males, the peritoneal recess between the bladder and recum is called the rectovesical pouch.

Worried about learning all the structures of the urinary system? Ease into this topic at your own pace with our urinary system quizzes & labeled diagrams.

Anatomy

Body of urinary bladder (Corpus vesicae urinariae)

The bladder has four anatomical surfaces: superior, inferior, right inferolateral, and left inferolateral. It also has four parts:

- Body, which is bounded anteriorly by the apex and the fundus posteriorly
- Neck, inferiorly located in the region of the internal urethral orifice, emerges from the union of the right and left inferolateral surfaces

The fundus of the bladder contains three openings which form the trigone of the bladder; the internal urethral orifice and the two ureteric orifices.

The detrusor muscle comprises the wall of the urinary bladder. It forms the internal urethral sphincter around the neck of the bladder. The detrusor muscle contracts around the ureteric orifices when the bladder contracts in order to prevent vesicoureteral reflux (backflow of urine into the ureters).

Micturition reflex

The micturition reflex is a reflex which enables the physiological act of urination when the urinary bladder is full. As the bladder fills with urine, the pressure within the bladder slowly rises until it fills to its maximum point. This translates as the urge to urinate, which is sent to the spinal cord through the inferior hypogastric plexus.

The spinal cord then sends signals through same plexus causing the contraction of the detrusor muscle and relaxation of the internal urethral sphincter. The cerebral cortex imposes voluntary control over this reflex as it controls the relaxation of the external urethral sphincter. This is significant as a person can postpone micturition until it is socially acceptable.Learn more about the anatomy of the urinary bladder and how it differs in males and females with our video tutorials, and quizzes.

Urethra

The urethra is the excretory canal of the urinary bladder. It conveys urine from the urinary bladder to outside the body. It extends from the internal urethral orifice of the bladder to the external urethral orifice of the external genitalia. The course of urethra is different between males and females.

Female urinary bladder and urethra: Diagram

The female urethra is very short (4 centimeters) which is a predisposing factor for contracting urinary tract infection. The female urethra passes through the pelvic floor and then through the deep perineal pouch where it's surrounded by the external urethral sphincter. Finally, the urethra opens through the external urethral opening found between the labia minora, anterior to the vaginal opening.

The male urethra is much longer (20 centimeters). It has four parts:

- Preprostatic (intramural) urethra which extends from the internal urethral orifice to the prostate
- Prostatic urethra penetrates the prostate in which it is joined by the ejaculatory duct of the male reproductive system.
- Membranous urethra passes through the deep perineal pouch where it is surrounded by the external urethral sphincter.
- Spongy (penile) urethra travels through the corpus spongiosum of the penis.

The urethra opens through the external urethral orifice (urethral meatus) at the top of the glans.

Blood vessels

Superior vesical artery (Arteria vesicalis superior)

The urinary bladder is supplied by branches of the internal iliac artery: the superior and inferior vesical arteries (in males). Note that the latter are replaced by vaginal arteries in females. Venous blood is conveyed by similarly named veins that accompany the arteries. Together these veins form the vesical venous plexus. It is a tributary of the internal iliac vein.

The urethra is also supplied by branches of the internal iliac artery. In males, supply is provided by the inferior vesical and middle rectal arteries. Venous blood is drained into the prostatic venous plexus and then the internal iliac vein. The female urethra is supplied by the internal pudendal and vaginal arteries. It is drained by similarly named veins.

Innervation

Inferior hypogastric plexus (Plexus hypogastricus inferior)

Innervation of the bladder comes from the inferior hypogastric plexus. This plexus receives autonomic input from the pelvic splanchnic nerves (parasympathetic), the sympathetic trunk and sacral splanchnic nerves (sympathetic). Parasympathetic innervation to the bladder contracts the detrusor muscle and relaxes the internal urethral sphincter. Sympathetic innervation relaxes the detrusor and contracts the internal urethral sphincters. Note that the sympathetic nervous system is very active during ejaculation in men. It causes the internal urethral sphincter to close and prevents reflux of semen into the bladder.

Both male and female urethrae are innervated by the vesical plexus which originates from the inferior hypogastric plexus. Additional innervation is provided by the pudendal nerve for the female urethra and the prostatic plexus for the proximal male urethra.

Clinical relations

Urinary tract infections

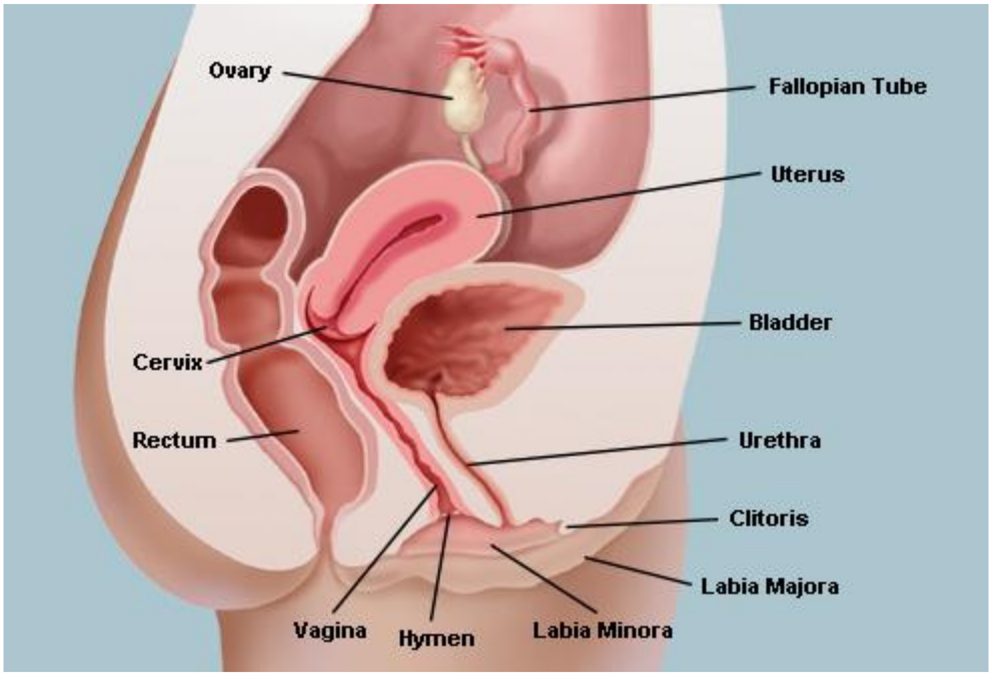
Urinary tract infections (UTIs) can affect any part of the urinary system. Infection of the urinary bladder is called cystitis. Fecal bacteria are usually those who cause cystitis by ascending to the bladder through the urethra. Because the urethra is shorter in females than in males, cystitis occurs much more often in women.

Cystitis often presents as the urge to urinate, a burning sensation during urination, constant pain in the pelvis and lumbar spine, and a notably change in urine appearance (blurry, bloody, strange-smelling). It is treated with antibiotics usually up to 10 days.

The female reproductive system is designed to carry out several functions. It produces the female egg cells necessary for reproduction, called the ova or oocytes. The system is designed to transport the ova to the site of fertilization. Conception, the fertilization of an egg by a sperm, normally occurs in the fallopian tubes. The next step for the fertilized egg is to implant into the walls of the uterus, beginning the initial stages of pregnancy. If fertilization and/or implantation does not take place, the system is designed to menstruate (the monthly shedding of the uterine lining). In addition, the female reproductive system produces female sex hormones that maintain the reproductive cycle.

What Parts Make up the Female Anatomy?

The female reproductive anatomy includes parts inside and outside the body.



The function of the external female reproductive structures (the genitals) is twofold: To enable sperm to enter the body and to protect the internal genital organs from infectious organisms. The main external structures of the female reproductive system include:

- **Labia majora:** The labia majora enclose and protect the other external reproductive organs. Literally translated as "large lips," the labia majora are relatively large and fleshy, and are comparable to the scrotum in males. The labia majora contain sweat and oil-secreting glands. After puberty, the labia majora are covered with hair.
- **Labia minora:** Literally translated as "small lips," the labia minora can be very small or up to 2 inches wide. They lie just inside the labia majora, and surround the openings to the vagina (the canal that joins the lower part of the uterus to the outside of the body) and urethra (the tube that carries urine from the bladder to the outside of the body).
- **Bartholin's glands:** These glands are located beside the vaginal opening and produce a fluid (mucus) secretion.
- **Clitoris:** The two labia minora meet at the clitoris, a small, sensitive protrusion that is comparable to the penis in males. The clitoris is covered by a fold of skin, called the prepuce, which is similar to the foreskin at the end of the penis. Like the penis, the clitoris is very sensitive to stimulation and can become erect.

The internal reproductive organs in the female include:

Vagina: The vagina is a canal that joins the cervix (the lower part of uterus) to the outside of the body. It also is known as the birth canal.

Uterus (womb): The uterus is a hollow, pear-shaped organ that is the home to a developing fetus. The uterus is divided into two parts: the cervix, which is the lower part that opens into the vagina, and the main body of the uterus, called the corpus. The corpus can easily expand to hold a developing baby. A channel through the cervix allows sperm to enter and menstrual blood to exit.

Ovaries: The ovaries are small, oval-shaped glands that are located on either side of the uterus. The ovaries produce eggs and hormones.

Fallopian tubes: These are narrow tubes that are attached to the upper part of the uterus and serve as tunnels for the ova (egg cells) to travel from the ovaries to the uterus. Conception, the fertilization of an egg by a sperm, normally occurs in the fallopian tubes. The fertilized egg then moves to the uterus, where it implants into the lining of the uterine wall.

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What Happens During the Menstrual Cycle?

Females of reproductive age experience cycles of hormonal activity that repeat at about one-month intervals. With every cycle, a woman's body prepares for a potential pregnancy, whether or not that is the woman's intention. The term menstruation refers to the periodic shedding of the uterine lining. (Menstru means "monthly.")

The average menstrual cycle takes about 28 days and occurs in phases: the follicular phase, the ovulatory phase (ovulation), and the luteal phase.

There are four major hormones (chemicals that stimulate or regulate the activity of cells or organs) involved in the menstrual cycle: follicle-stimulating hormone, luteinizing hormone, estrogen, and progesterone.

Follicular Phase of the Menstrual Cycle

This phase starts on the first day of your period. During the follicular phase of the menstrual cycle, the following events occur:

- Two hormones, follicle stimulating hormone (FSH) and luteinizing hormone (LH), are released from the brain and travel in the blood to the ovaries.
- The hormones stimulate the growth of about 15 to 20 eggs in the ovaries, each in its own "shell," called a follicle.
- These hormones (FSH and LH) also trigger an increase in the production of the female hormone estrogen.

- As estrogen levels rise, like a switch, it turns off the production of follicle-stimulating hormone. This careful balance of hormones allows the body to limit the number of follicles that mature.
- As the follicular phase progresses, one follicle in one ovary becomes dominant and continues to mature. This dominant follicle suppresses all of the other follicles in the group. As a result, they stop growing and die. The dominant follicle continues to produce estrogen.

Ovulatory Phase of the Menstrual Cycle

The ovulatory phase, or ovulation, starts about 14 days after the follicular phase started. The ovulatory phase is the midpoint of the menstrual cycle, with the next menstrual period starting about two weeks later. During this phase, the following events occur:

CONTINUE READING BELOW

- The rise in estrogen from the dominant follicle triggers a surge in the amount of luteinizing hormone that is produced by the brain.
- This causes the dominant follicle to release its egg from the ovary.
- As the egg is released (a process called ovulation), it is captured by finger-like projections on the end of the fallopian tubes (fimbriae). The fimbriae sweep the egg into the tube.
- Also during this phase, there is an increase in the amount and thickness of mucus produced by the cervix (lower part of the uterus). If a woman were to have intercourse during this time, the thick mucus captures the man's sperm, nourishes it, and helps it to move towards the egg for fertilization.

Luteal Phase of the Menstrual Cycle

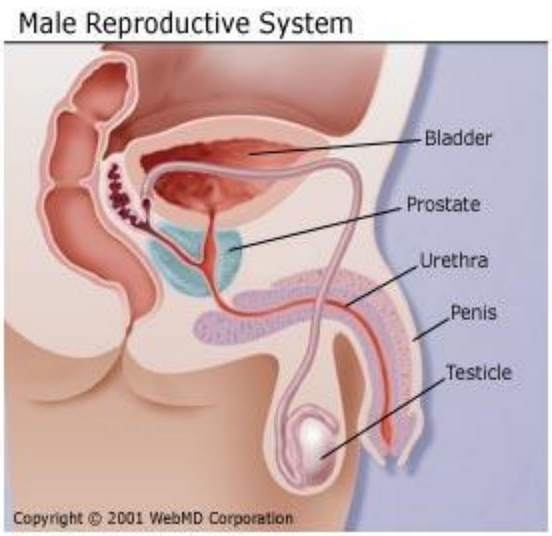
The luteal phase of the menstrual cycle begins right after ovulation and involves the following processes:

- Once it releases its egg, the empty follicle develops into a new structure called the corpus luteum.
- The corpus luteum secretes the hormone progesterone. Progesterone prepares the uterus for a fertilized egg to implant.
- If intercourse has taken place and a man's sperm has fertilized the egg (a process called conception), the fertilized egg (embryo) will travel through the fallopian tube to implant in the uterus. The woman is now considered pregnant.
- If the egg is not fertilized, it passes through the uterus. Not needed to support a pregnancy, the lining of the uterus breaks down and sheds, and the next menstrual period begins.

The purpose of the organs of the male reproductive system is to perform the following functions:

- To produce, maintain, and transport sperm (the male reproductive cells) and protective fluid (semen)

- To discharge sperm within the female reproductive tract during sex
- To produce and secrete male sex hormones responsible for maintaining the male reproductive system



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Unlike the female reproductive system, most of the male reproductive system is located outside of the body. These external structures include the penis, scrotum, and testicles.

- **Penis:** This is the male organ used in sexual intercourse. It has three parts: the root, which attaches to the wall of the abdomen; the body, or shaft; and the glans, which is the cone-shaped part at the end of the penis. The glans, also called the head of the penis, is covered with a loose layer of skin called foreskin. This skin is sometimes removed in a procedure called circumcision. The opening of the urethra, the tube that transports semen and urine, is at the tip of the penis. The glans of the penis also contains a number of sensitive nerve endings.

The body of the penis is cylindrical in shape and consists of three circular shaped chambers. These chambers are made up of special, sponge-like tissue. This tissue contains thousands of large spaces that fill with blood when the man is sexually aroused. As the penis fills with blood, it becomes rigid and erect, which allows for penetration during sexual intercourse. The skin of the penis is loose and elastic to accommodate changes in penis size during an erection.

Semen, which contains sperm (reproductive cells), is expelled (ejaculated) through the end of the penis when the man reaches sexual climax (orgasm). When the penis is erect, the flow of urine is blocked from the urethra, allowing only semen to be ejaculated at orgasm.

- **Scrotum:** This is the loose pouch-like sac of skin that hangs behind and below the penis. It contains the testicles (also called testes), as well as many nerves and blood vessels. The scrotum acts as a "climate control system" for the testes. For normal sperm development, the testes must be at a temperature slightly cooler than body temperature. Special muscles in the wall of the scrotum allow it to contract and relax, moving the testicles closer to the body for warmth or farther away from the body to cool the temperature.

- **Testicles (testes):** These are oval organs about the size of large olives that lie in the scrotum, secured at either end by a structure called the spermatic cord. Most men have two testes. The testes are responsible for making testosterone, the primary male sex hormone, and for generating sperm. Within the testes are coiled masses of tubes called seminiferous tubules. These tubes are responsible for producing sperm cells.

The internal organs of the male reproductive system, also called accessory organs, include the following:

- **Epididymis:** The epididymis is a long, coiled tube that rests on the backside of each testicle. It transports and stores sperm cells that are produced in the testes. It also is the job of the epididymis to bring the sperm to maturity, since the sperm that emerge from the testes are immature and incapable of fertilization. During sexual arousal, contractions force the sperm into the vas deferens.
- **Vas deferens:** The vas deferens is a long, muscular tube that travels from the epididymis into the pelvic cavity, to just behind the bladder. The vas deferens transports mature sperm to the urethra, the tube that carries urine or sperm to outside of the body, in preparation for ejaculation.
- **Ejaculatory ducts:** These are formed by the fusion of the vas deferens and the seminal vesicles (see below). The ejaculatory ducts empty into the urethra.
- **Urethra:** The urethra is the tube that carries urine from the bladder to outside of the body. In males, it has the additional function of ejaculating semen when the man reaches orgasm. When the penis is erect during sex, the flow of urine is blocked from the urethra, allowing only semen to be ejaculated at orgasm.
- **Seminal vesicles:** The seminal vesicles are sac-like pouches that attach to the vas deferens near the base of the bladder. The seminal vesicles produce a sugar-rich fluid (fructose) that provides sperm with a source of energy to help them move. The fluid of the seminal vesicles makes up most of the volume of a man's ejaculatory fluid, or ejaculate.
- **Prostate gland:** The prostate gland is a walnut-sized structure that is located below the urinary bladder in front of the rectum. The prostate gland contributes additional fluid to the ejaculate. Prostate fluids also help to nourish the sperm. The urethra, which carries the ejaculate to be expelled during orgasm, runs through the center of the prostate gland.

- **Bulbourethral glands:** Also called Cowper's glands, these are pea-sized structures located on the sides of the urethra just below the prostate gland. These glands produce a clear, slippery fluid that empties directly into the urethra. This fluid serves to lubricate the urethra and to neutralize any acidity that may be present due to residual drops of urine in the urethra.

How Does the Male Reproductive System Function?

The entire male reproductive system is dependent on hormones, which are chemicals that regulate the activity of many different types of cells or organs. The primary hormones involved in the male reproductive system are follicle-stimulating hormone, luteinizing hormone, and testosterone.

Follicle-stimulating hormone is necessary for sperm production (spermatogenesis), and luteinizing hormone stimulates the production of testosterone, which is also needed to make sperm. Testosterone is responsible for the development of male characteristics, including muscle mass and strength, fat distribution, bone mass, facial hair growth, voice change, and sex drive.

Common Carotid Artery

The CCA makes up what is known as the "anterior circulation," with the ICA supplying the intracranial compartment and the external carotid artery (ECA) supplying the meninges, scalp, and face. The right CCA traverses behind the right sternoclavicular joint as it branches off the BCA. The left CCA, after arising from the aortic arch, ascends posterior to the left sternoclavicular joint. In the neck, both CCAs run upward within the carotid sheath, beneath the anterior border of the sternocleidomastoid muscle. The carotid sheath is a condensation of the fibroareolar tissue around the main vessels of the neck and contains the CCA and ICA, internal jugular vein, and vagus nerve. The CCA bifurcates into the ICA and ECA. The *carotid sinus* and *carotid body* are located at the bifurcation. The carotid sinus functions as a baroreceptor to regulate the blood pressure and receives rich innervation from the sinus nerve of Hering (branch of the IX cranial nerve) and sympathetic nerves (Toorop, Scheltinga, Moll, & Bleys, 2009). The carotid body is located along the posterior border of the bifurcation and is supplied by the glossopharyngeal, vagus, and sympathetic nerves. As a chemoreceptor, the carotid body detects and responds to changes in oxygen, carbon dioxide, and pH levels in the blood (Ponte & Purves, 1974). After division of the CCA, the ICA enters the skull to supply the brain, and the ECA gives branches to the neck and face.

Carotid Artery

The common carotid arteries divide into the external and internal arteries and the internal arteries then branch into the arteries that supply the anterior circulation of the brain. The carotid arteries are derived from the third and fourth ventral aortic arches. Some animals have a rete caroticum, a more evolutionary advanced form of the carotid system that participates in brain cooling and autoregulation. The bifurcation of the common carotid artery is an important site of atherosclerotic disease that can lead to stenosis and occlusion. Carotid endarterectomy and stenting are used to reduce carotid stenosis and the risk of ischemic stroke.

The carotid arteries

The common carotid artery on each side divides into the internal and external carotid arteries at the carotid bifurcation: this is usually at the level of the upper border of the laryngeal cartilage, but may vary considerably up or down the neck. The internal carotid artery is usually posterior to the external carotid artery and tends to lie a little lateral to it.[20] The carotid bulb is seen at the origin of the internal carotid artery, and the lower cervical branches of the external carotid artery can sometimes be identified; the superior thyroid, ascending pharyngeal and lingual arteries may all arise from the external carotid artery, below, or around the level of the angle of the mandible.

The origins of the two common carotid arteries are different. On the right side the common carotid artery arises from the brachiocephalic (innominate) artery behind the sternoclavicular joint, where it can usually be examined using ultrasound. The left common carotid artery, on the other hand, arises directly from the aortic arch in the vast majority of patients, and its origin thus lies too deep in the mediastinum to be seen with ultrasound.

Head Vessels

Common carotid arteries travel superiorly in the neck in the carotid sheath in close proximity to the jugular veins, vagus nerve, and recurrent laryngeal nerve. They split into the external and internal carotid arteries. The external carotid arteries give off superior thyroid, ascending pharyngeal, lingual, facial, occipital, posterior auricular, maxillary, and superficial temporal arteries in the order listed. Internal carotid arteries characteristically do not give off any branches in the neck and enter the scull through the carotid foramen on the corresponding side of the scull base. They split into the anterior and middle cerebral arteries and form the circle of Willis through the anterior and posterior communicating arteries, providing collateral circulation routes for right and left hemispheres as well as to the posterior circulation through the basilar artery.

Posterior circulation is largely supplied by the paired vertebral arteries – first branch of the subclavian arteries, which takeoff superiorly and somewhat posteriorly and ascend in the neck through the transverse foramina of C2–C6 vertebrae. Vertebral arteries enter the scull through the foramen magnum. Thereby, they each give off one posterior inferior cerebellar artery together form anterior spinal artery (providing blood supply to the anterior portion of the spinal cord). They also commonly merge anteriorly to form the basilar artery. Basilar artery gives off paired anterior inferior cerebellar arteries and labyrinthine, pontine, and superior cerebellar arteries. It finally splits into bilateral posterior cerebral arteries and anastomoses with the circle of Willis by way of posterior communicating arteries. Importantly, the circle of Willis is complete in the minority of cases (Moore and Agur, 1995).

Arterial Circulation

The common carotid arteries (CCAs) bifurcate in the neck, usually opposite the upper border of the thyroid cartilage, into the internal carotid arteries (ICAs), which are located posteriorly as a direct extension of the CCA, and into the external carotid arteries (ECAs), which course more anteriorly and laterally. The ICAs travel behind the pharynx; they give off no branches in the neck. Figure 2-10*A* shows the carotid arteries in the neck. Figure 2-10*B* shows the branches of the external carotid artery, which supplies the face and major cranial structures except for the brain. The ICAs then enter the skull through the carotid canal within the petrous bone and form an S-shaped curve. The ICA within this curve is usually referred to as the *carotid siphon*. There are three divisions of the ICA within the siphon—an intrapetrous portion, an intracavernous portion within the cavernous sinus, and a supraclinoidal portion[34] (see Fig. 2-10*C*). The siphon portion of the ICAs (usually the clinoidal segment but occasionally the intracavernous segment) gives rise to ophthalmic artery branches that exit anteriorly. The ICAs then penetrate the dura mater and give rise to anterior choroidal and posterior communicating arteries, which arise and course posteriorly from their proximal supraclinoid portions. The termination of the intracranial ICAs (the so-called T-portion because of its shape) is the bifurcation into the anterior cerebral arteries (ACAs), which course medially, and the middle cerebral arteries (MCAs), which course laterally. Figure 2-11 shows the major intracranial branches of the ICA.

The ECAs have two major vascular channels that ordinarily supply the face that can act as collateral circulation if the ICAs occlude: the facial arteries, which course along the cheek toward the nasal bridge, where they are termed the *angular arteries*, and the preauricular arteries, which terminate as the superficial temporal arteries. The internal maxillary artery and ascending pharyngeal branches of the ECAs also can contribute to collateral circulation when an ICA occludes. The internal maxillary arteries give off the middle meningeal artery branches, which penetrate into the skull through the foramen spinosum. Another important arterial supply of the face involves the frontal and supratrochlear branches that originate from the ophthalmic arteries (ICA system), which supply the medial forehead above the brow. When an ICA occludes, these ECA branches can be an important source of collateral blood supply.

The ACAs course medially until they reach the longitudinal fissures and then run posteriorly over the corpus callosum. They supply the anterior medial portions of the cerebral hemispheres and give off deep branches to the caudate nuclei and the basal frontal lobes. Figure 2-12 shows the small artery branches of the ACAs. The first portion of the ACA is sometimes hypoplastic on one side, in which case the ACA from the other side supplies both medial frontal lobes. The anterior communicating artery connects the right and left ACAs and provides a means of collateral circulation from the anterior circulation of the opposite side when one ACA is hypoplastic or occludes.

The main stem of the MCAs course laterally, giving off lenticulostriate artery branches to the basal ganglia and internal capsule (Fig. 2-13). Although most often the lenticulostriate penetrating branches arise from the mainstem MCA, when the mainstem is short, the lenticulostriate branches may arise from the superior division branch. As they near the sylvian fissures, the MCAs trifurcate into small anterior temporal branches and large superior and inferior divisions. The superior division supplies the lateral portions of the cerebral hemispheres above the sylvian fissures, and the inferior division supplies the temporal and inferior parietal lobes below the sylvian fissures. Figure 2-14 is a view of the lateral surface of the left cerebral hemisphere showing the MCA branches and the supply of the superior and inferior divisions of the left MCA. Figure 2-15 is a drawing of the paramedian sagittal surface of the cerebral hemispheres showing the distribution of the ACA and posterior cerebral artery (PCA) branches.

The anterior choroidal arteries (AChAs) are relatively small arteries that originate from the internal carotid arteries after the origins of the ophthalmic and posterior communicating arteries. The ophthalmic artery projects anteriorly into the back of the orbit, whereas the anterior choroidal and posterior communicating arteries project posteriorly from the ICA. The AChAs course posteriorly and laterally running along the optic tract. They straddle territory between components of the anterior (internal carotid) and posterior circulations (vertebrobasilar system).[35] The AChAs give off penetrating artery branches to the globus pallidus and posterior limb of the internal capsule. They then give branches laterally to the medial temporal lobe, and medial branches supply a portion of the midbrain and the thalamus. The AChAs end in the lateral geniculate body where they anastamose with lateral posterior choroidal artery branches of the posterior cerebral arteries and in the choroid plexus of the lateral ventricles near the temporal horns. Figure 2-16 is a drawing of the course of the AChA. Figure 2-17 shows a drawing of a coronal section of the cerebral hemispheres showing the distribution of the supply of these cerebral arteries and the AChA. More detailed maps of the distribution of the blood supply in the cerebral hemispheres have been published.[36]

Traditionally, by convention, the carotid artery territories just described are referred to as the *anterior circulation* (front of the brain), whereas the vertebral and basilar arteries and their branches are termed the *posterior circulation* (because they supply the back of the brain). Each ICA supplies roughly two fifths of the brain by volume, whereas the posterior circulation accounts for approximately one fifth of the total. Despite its much smaller size, the posterior circulation contains the brainstem, a midline strategically critical structure without which consciousness, movement, and sensations cannot be preserved. The posterior circulation is constructed quite differently from the anterior circulation and consists of vessels from each side (the vertebral and anterior spinal artery branches), which unite to form midline arteries that supply the brainstem and spinal cord. Within the posterior circulation, there is a much higher incidence of asymmetric, hypoplastic arteries; of variability of supply; and of retention of fetal circulatory patterns.[37,38] The proximal portions of the posterior circulation on the two sides differ. On the right, the subclavian artery arises from the innominate artery, a common channel supplying the anterior and posterior circulations. On the left side, the subclavian artery usually arises directly from the aortic arch after the origin of the left CCA.

The first branch of each subclavian artery is the vertebral artery (VA) (Fig. 2-18; see also Fig. 2-10). The VAs course upward and backward until they enter the transverse foramens of the sixth or fifth cervical vertebra and run within the intravertebral foramina, exiting to course behind the atlas before piercing the dura mater to enter the foramen magnum. Their intracranial portions end at the medullopontine junction, where the two VAs join to form the basilar artery. Figure 2-18 shows the divisions of the VAs: the first portion before entry into the bony vertebral column (V1), the portion within the vertebral columns (V2), the portion of the artery after exit from the vertebral column that arches behind the atlas and before entry into the cranium (V3), and the intracranial portion (V4). In the neck, the VAs have many small muscular and spinal branches.

The intracranial portions of the VAs give off posterior and anterior spinal artery branches, penetrating arteries to the medulla and the large posterior inferior cerebellar arteries (PICAs). The basilar artery runs in the midline along the clivus, giving off bilateral anterior inferior cerebellar artery (AICA) and superior cerebellar artery (SCA) branches before dividing at the pontomesencephalic junction into terminal PCA branches (Fig. 2-19). Figure 2-20 is a drawing that shows the major arterial branches of the intracranial vertebral and basilar arteries as they appear on angiograms.

The vascular supply of the brainstem has been worked out by Foix,[39–41] Stopford,[42] Gillilan,[43] and Duvernoy[44] and is illustrated in Figure 2-21. Large paramedian arteries and smaller, short circumferential arteries penetrate through the basal portions of the brainstem into the tegmentum. Long circumferential arteries course around the brainstem giving off branches to the lateral tegmentum. The PCAs give off penetrating arteries to the midbrain and thalamus, course around the cerebral peduncles, and then supply the occipital lobes and inferior surface of the temporal lobes (Fig. 2-22). The circle of Willis allows for connections between the anterior circulations of each side, through the anterior communicating artery, and between the posterior and anterior circulations of each side through the posterior communicating artery (Fig. 2-23).

The blood supply of the spinal cord will be covered in Chapter 15, which deals with spinal cord strokes.

Internal Carotid Arteries System

Four arteries, 2 internal carotids and 2 vertebrals, supply the cerebrum, brain stem, cerebellum, and cervical spinal cord (Fig. 14.1).

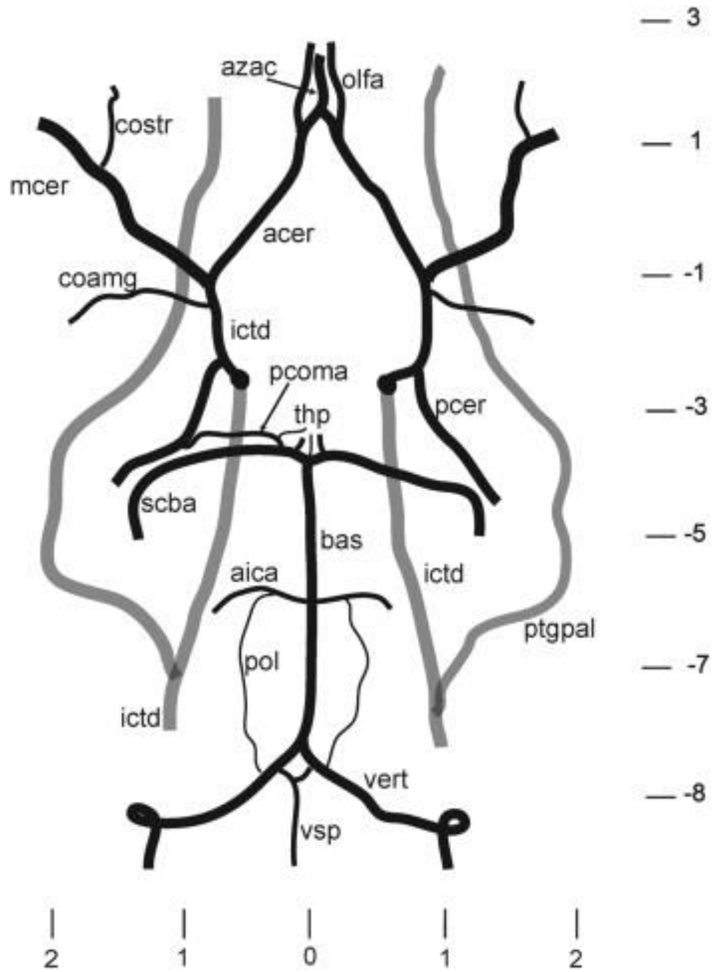


FIGURE 14.1. The anastomotic arterial system at the base of the brain (incomplete circle of Willis). The scales at the bottom and right of the figure represent distance (mm) from midline and from bregma respectively. Arteries shown are the olfactory (olfa), azygos anterior erebral (azac), cortico-striate (costr), middle cerebral (mcer), anterior cerebral (acer), cortico-amygdaloid (coamg), internal carotid (ictd) thalamoperforating (thp), superior cerebelar (scba), posterior communicating (pcoma), basilar (bas), anterior inferior cerebelar (aica), periolivary (pol) vertebral (vert) and ventral spinal (vsp). The two main variations of this system are shown, presence (left) or complete absence (right) of the pcoma.

The common carotid arteries originate from the aortic arch on the left and the brachiocephalic trunk on the right. They divide at the level of the inferior border of the thyroid gland into external and internal carotid arteries. The second one gives origin to the pterygopalatine artery, the equivalent of the pterygopalatine portion of the internal maxillary artery, a branch of the external carotid artery of humans. In rodents, this vessel supplies mostly extracranial structures. Throughout its intracranial course, the pterygopalatine artery remains in the subdural space where it gives origin to the middle meningeal artery that supplies the duramater of the cerebrum. It emerges out of the cranium through the petrotympanic fissure and turns medially, giving off the external ophthalmic artery, an anastomotic branch to the angular artery, the pterygoid artery that anastomoses with the facial artery, the descending palatine, sphenopalatine, and infraorbital arteries. The last terminates by branching into vibrissal arteries and additional branches for the dorsal portion of the nose, after its exit through the infraorbital foramen. All of these extracranial branches are potential sources of collateral flow between the internal carotid artery at the origin of the pterygopalatine artery and the external carotid at its terminal facial branches.

After it has given off the pterygopalatine artery, the internal carotid artery continues in a dorsal and medial direction, to enter the cranium through the carotid foramen, situated between the tympanic bulla and the basal plate of the occipital, midway between the posterior lacerated foramen and the symphysis between the occipital and basisphenoid bones. It emerges inside the skull at the level of the caudal border of the pituitary gland. The first large vessel originating intracranially from the internal carotid is the posterior cerebral artery (pcer) (Fig. 14.1). After supplying perforating branches to the substantia nigra the pcer gives origin to the longitudinal hippocampal artery (Fig. 14.2), which runs initially in the same general direction as its parent vessel, and then follows the longitudinal axis of the hippocampus. The posterior lateral choroidal artery stems from the longitudinal hippocampal artery close to its origin or from the posterior cerebral artery and courses in an anterior, dorsal, and medial direction to join the distal portion of the anterior choroidal artery forming the common choroidal artery. These vessels supply the choroid plexus of the lateral ventricle and the anterior portion of the choroid plexus of the third ventricle. The terminal branches of the posterior lateral choroidal artery supply some of the dorsal thalamic arteries.

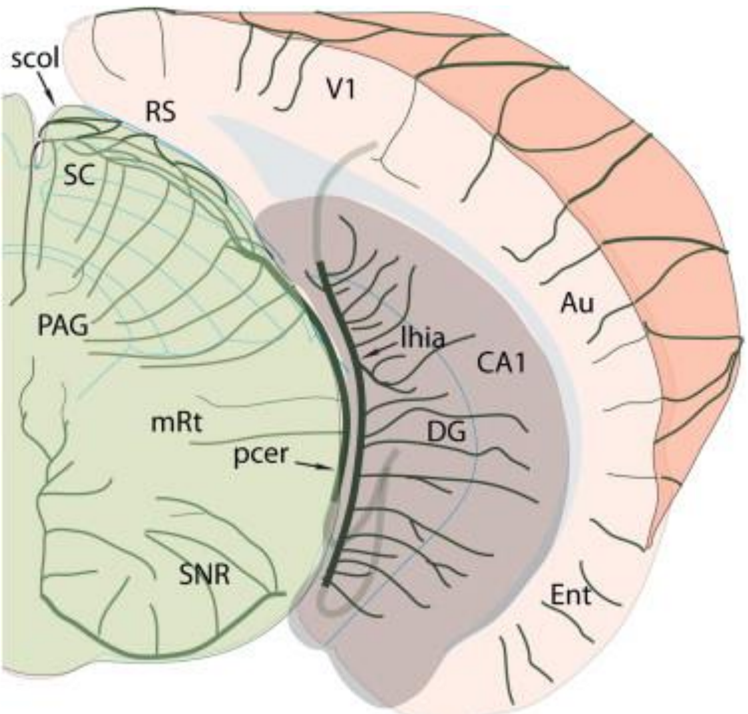


FIGURE 14.2. Distribution of the posterior cerebral artery (pcer) and the longitudinal hippocampal artery (lhia) on the brain stem and hippocampus respectively. The lhia branches out of then runs parallel to the longitudinal axis of the hippocampus giving the transverse hippocampal arteries that penetrate this structure. The pcer provides irrigation to the brain stem. Structures shown for reference are the substantia nigra reticulata (SNR and medial reticular formation (mRt). This vessel terminates on the supracollicular network (scol) that supplies the inferior and superior (SC) colliculi and periaqueductal gray (PAG). The cortical regions shown are the retrosplenial (RS) primary visual (V1), auditory (Au) and entorhinal (Ent). These are supplied by penetrating arteries from the pial middle cerebral artery branches.

The longitudinal (with respect to the axis of the hippocampus) hippocampal artery gives origin, at nearly regular intervals, to perpendicular short transverse arteries (transverse hippocampal arteries) that course in the hippocampal fissure (Fig. 14.2). Beyond the origin of the longitudinal hippocampal artery, the posterior cerebral artery gives off cortical branches that run in a dorsolateral direction over the surface of the occipital pole and reflect over the posterior border of the hemisphere to reach the dorsal aspect of the occipital cortex where they anastomose end to end with the occipital terminal branches of the middle cerebral artery (Fig. 14.4).

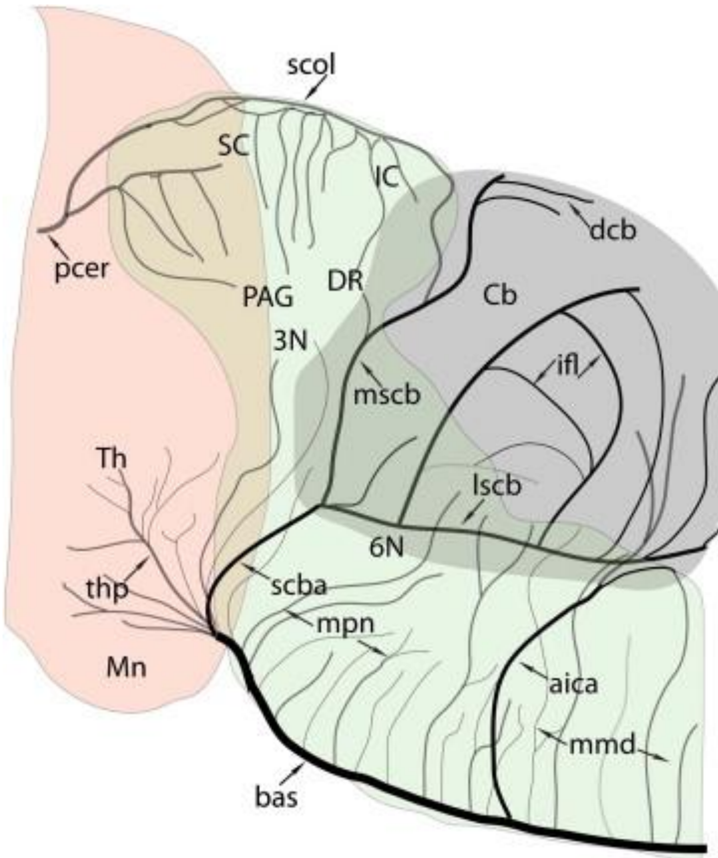


FIGURE 14.3. Lateral view of the distribution and termination of the basilar artery (bas) and termination of the posterior cerebral artery (pcer). The midline and parasagittal vessels are shown in light gray and surface vessels in black. Structures shown are the cerebellum (Cb), nucleus of the 6th nerve (6N), mamillary nucleus (Mn), thalamus (Th), nucleus of the 3rd nerve (3N), periaqueductal gray (PAG), dorsal raphe (DR), superior colliculus (SC), inferior colliculus (IC). Arteries shown are the basilar (bas), median medullary (mmd) and medical pontine (mpn), anterior inferior cerebellar (aica), superior cerebellar (scba), lateral superior cerebellar (lscb), medial superior cerebellar (mscb), dorsal cerebellar (dcb), interfolial (ifl), thalamo-perforating (thp).

The posterior cerebral artery ends in a variable number of branches that feed into an anastomotic network, which spreads over the dorsal surface of the superior and inferior colliculi supplying perforating vessels to these structures (Fig. 14.2). On its anterior border, this network also gives origin to arteries that supply the dorsal hippocampus and dorsal thalamus. On its posterior border, the supracollicular network anastomoses with the cortical pial network over the occipital cortex and on its anteromedial portion, with the terminal branches of the azygos pericallosal artery.

The anterior choroidal artery arises from the internal carotid artery rostral to the emergence of the posterior cerebral artery and it supplies the amygdala, piriform cortex, and the choroid plexus of the lateral ventricle.
Rostral to the posterior border of the optic chiasm, the corticoamygdaloid artery (coamg) originates from the lateral wall of the internal carotid artery (Fig. 14.1) distributing over the caudal portion of the piriform cortex and the amygdaloid complex.
The middle cerebral artery is one of the two terminal branches of the internal carotid artery. It originates from the arterial circle portion of the internal carotid at a point about 1 mm caudal to bregma on the outer border of the optic tract (Fig. 14.1). This vessel courses laterally and rostrally over the olfactory cortex and gives off several branches to the piriform cortex. At the level of the lateral olfactory tract, it yields a forwardly directed vessel, the corticostriate artery (Fig. 14.1). The latter vessel supplies both the anterior portion of the piriform cortex, and the lateral olfactory tract. It then gives off the anterior striate arteries, which course dorsally following the medial edge of the external capsule to supply the lateral and dorsal portions of the caudate-putamen (Fig. 14.5). A variable number of arteries (posterior striate arteries) that supply more caudal areas of the striatum originate from the middle cerebral artery, around the origin of the corticostriate arteries. These vessels are the equivalent of the lenticulate-striate arteries of humans. After giving off the corticostriate artery, the middle cerebral artery curves over the lateral surface of the cerebral hemisphere and branches in a variable pattern that, in general, is represented by groups of rostral, medial and caudal vessels (Fig. 14.4).

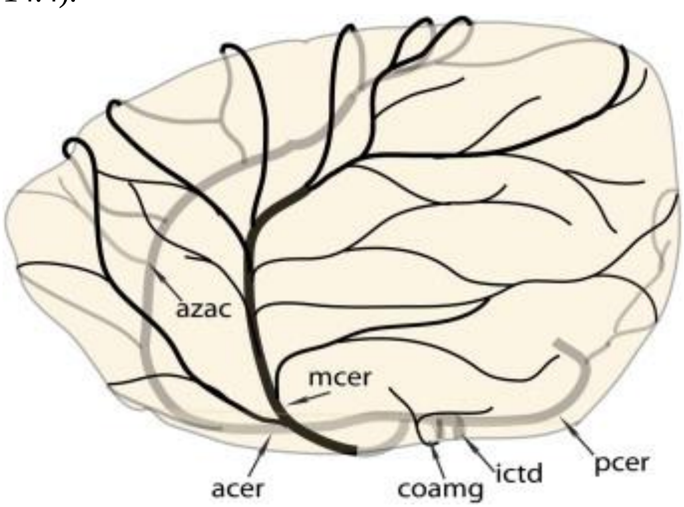


FIGURE 14.4. Distribution of the middle cerebral (mcer), anterior cerebral (acer) and posterior cerebral (pcer) arteries on the cerebral cortex. The vessels running on the midline and on the inferior surface of the cortex are shown in light gray and surface vessels in black. Other arteries shown are the cortico-amigdaloid (coamg), internal carotid (ictd) and azigos anterior cerebral (azac). The anastomoses between branches of the mcer and azac on the parasagittal area and between branches of the mcer and pcer onthe caudal portion of the cortex are shown.

The second terminal branch of the internal carotid artery is the anterior cerebral artery (acer). This vessel courses in a forward and medial direction, immediately ventral to the outer border of the optic chiasm (Fig. 14.1). At a point approximately 1 mm rostral to bregma, it gives off the olfactory artery (olfa). A vessel of similar origin and destination can be found in human embryos (Padget, 1944) but it does not persist into adulthood. The ethmoidal artery takes the place of the olfactory artery in mammals lacking this vessel. The olfactory artery continues under the olfactory bulbs, and finally divides into several terminal branches that pass through the cribriform plate of the ethmoid bone to supply the nasal cavity. This vessel gives off only a few small intracranial branches. The acer then moves medially and dorsally, crossing the outer border of the optic chiasm at its origin and finally fusing with its contralateral homologous artery to form the azygos anterior cerebral artery (azac) (Fig. 14.1). Generally, after the emergence of the olfactory artery, the anterior cerebral artery gives off the lateral orbitofrontal artery, which supplies the olfactory tubercle, the ventral surface of the olfactory bulb, and the rostral portion of the nucleus accumbens. The azygos anterior cerebral artery results from the fusion of the anterior cerebral arteries of both sides. This vessel gives off one medial orbitofrontal artery to each hemisphere from its ventral wall and ends into two terminal branches: (1) a cortical branch that supplies the medial and ventral orbital cortex, cingulate cortex, and frontal cortex and (2) an olfactory branch that irrigates the dorsal aspect of the olfactory bulb. The azygos anterior cerebral artery also gives off the ascending septal artery, which supplies the vertical limb of the diagonal band and the medial septum. The rostral portions of the septum are supplied by smaller branches (rostral septal arteries) that stem off the posterior wall of the azygos anterior cerebral artery in the proximity of the genu of the corpus callosum. The azygos anterior cerebral artery ascends in a dorsal and slightly caudal direction to bend over the genu of the corpus callosum, becoming the azygos pericallosal artery. At this transition, cortical branches emerge (anterior and middle internal frontal arteries) and course over the cingulate cortex and medial portions of the frontal cortex of both hemispheres to finally anastomose end to end with the termination of the medial branches of the middle cerebral artery (Fig. 14.4).

The azygos pericallosal artery proceeds caudally, giving off the posterior internal frontal arteries, the retrosplenial artery, and terminal branches that supply the retrosplenial and occipital cortex. Prominent end to end anastomoses can be seen between these branches and the caudal branches of the middle cerebral artery (Fig. 14.4).

The pial arteries form a complex anastomotic network over the cortical surface. The middle cerebral, anterior cerebral, posterior cerebral, and internal carotid arteries all contribute to it. Predominant in the dorsal view of the brain are the anastomoses between branches from the azygos anterior cerebral, azygos pericallosal, and middle cerebral arteries in the paramedian region and among branches from the azygos pericallosal, middle cerebral, and posterior cerebral in the caudal region (Fig. 14.4). In the lateral views, the rhinal artery, a branch from the middle cerebral artery, running almost horizontally in the caudal direction, receives numerous anastomoses from the most ventral rami of the terminal arborization of the middle cerebral artery and usually joins branches of the posterior cerebral artery with large end to end anastomoses (Fig. 14.4). These communications between territories are of crucial importance in the incidence of infarction following partial occlusion of cortical vessels. Occlusion of the middle cerebral artery, for instance, induces severe ischemia with infarction on its territory of distribution except for the parasagittal region where anastomoses between terminal branches of the mcer and aca are found (Fig. 14.5).

The hypothalamus is supplied by dorsomedially directed perforating vessels that originate from the posterior cerebral, internal carotid, and anterior cerebral arteries, either directly or from branches of these vessels that run medially over the ventral surface of the mamillary body, median eminence, and anterior hypothalamic area.

The internal carotid artery is a major branch of the common carotid artery, supplying several parts of the head with blood, the most important one being the brain. There are two internal carotid arteries in total, one on each side of the neck. They originate from the carotid bifurcation, travel through the carotid sheath in a superior direction along the neck, and enter the skull through the external opening of carotid canal. Each artery is divided into seven segments according to the areas through which it passes. Along its course, the internal carotid artery gives rise to many branches, ultimately dividing into its two terminal ones called the anterior and middle cerebral arteries.

The clinical importance of internal carotid arteries is evident during action movies or martial arts classes where self-defense moves are performed, for example a rear naked choke or a strike to one side of the neck. During these actions, anatomical structures like the carotid sinus (baroreceptor) and internal carotid arteries are either squeezed or directly hit, resulting in an instant knock-out.

Key facts about the internal carotid artery

Segments

Cervical (C1), Petrous (C2), Lacerum (C3), Cavernous (C4), Clinoid (C5), Ophthalmic (C6), Communicating segments (C7)

Mnemonic: Please Let Children Consume Our Candy

Branches

Caritocotympanic (C2), Vidian (C2), Meningeal (C4), Inferior Hypophyseal (C4), Superior Hypophyseal (C6), Ophthalmic (C6), Posterior Communicating (C7), Anterior Choroidal (C7)

Terminal Branches: Anterior Cerebral (C7), Middle Cerebral Arteries (C7)

Mnemonic: A VIP’S COMMA

This article will explain the embryology, functions, origin, course, and branches of the internal carotid artery. It will also help you learn them using mnemonics, saving you countless reviews and a lot of time in the long run.

Contents

Classifications and names

Segment pathways

Branches

Clinical aspects

Infarction and cerebrovascular accidents

Basal skull fractures

+ Show all

Embryology

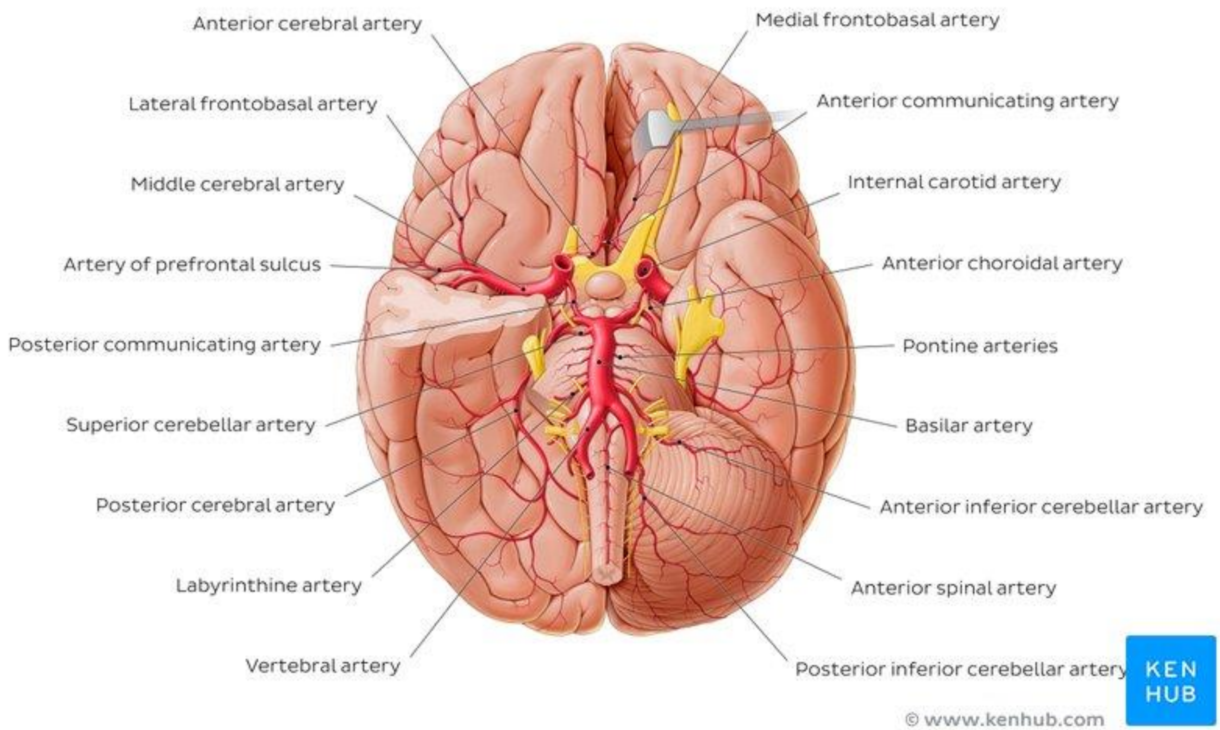
During fetal development, vasculogenesis (formation of new vessels from haematoangioblastic stem cells) is responsible for the formation of two dorsal aortae, six pairs of primitive pharyngeal (branchial) arch arteries, and other vascular structures. The third pharyngeal arch artery fuses with the distal components of the dorsal aortae to give rise to the internal carotid artery. The embryological dorsal aortae (left and right) ultimately form the descending aorta.

Several main and terminal branches of the internal carotid artery start developing from the 4th gestational week onwards when it bifurcates into anterior and posterior components. The former will differentiate into the anterior cerebral, middle cerebral, and anterior choroidal arteries. In turn, the posterior component will form the foetal posterior cerebral artery and the posterior choroidal artery, which will later develop into their adult forms.

Function

As you probably know, the brain is one of the most essential organs in the human body. It oversees the regulation of physiological homeostasis, executes cognitive functions, and micromanages integral body functions subconsciously. To sustain this continuous physiological demand, it requires a constant and large blood supply. To put it into perspective, the brain weighs approximately 2% of your entire body weight, but receives 15-20% of the daily cardiac output.

There are two sources responsible for feeding the brain with its much needed arterial blood called anterior and posterior circulations. The internal carotid arteries are part of the anterior circulation, which is responsible for supplying the forebrain. The two circulations of the brain anastomose and form an anatomical structure called the circle of Willis.



Arteries of the brain - inferior view

Arteries of the brain (inferior view)

Why are there two circulations and so many sources of arterial blood to the brain? It all comes to the significance of this organ in our daily lives. If any of the paths or branches of either circulation becomes blocked or fails in some way, the remaining and hopefully viable circulation can still bring fresh arterial blood to the brain through a different path. It is similar to going to your favourite (or not so favourite) anatomy class. If the main way or access point is obstructed, you will need to take a detour to reach the lecture hall or dissection room.

More information about the arteries supplying the brain is provided below.

Arteries of the brain

Arteries of the brain

Explore study unit

Arteries of the brain II

Arteries of the brain II

Explore study unit

In addition to the forebrain, the internal carotid artery sends several branches that supply the eyes and their accessory organs, forehead, and certain parts of the nose.

Origin

Carotid sinus (Sinus carotidis); Image: Paul Kim

Carotid sinus (Sinus carotidis)

First things first, there are two internal carotid arteries in total, one on the right and one on the left of the neck. They both originate from their respective common carotid arteries from a point called the carotid bifurcation situated at a level between the third and fourth cervical vertebrae (C3-C4).

Situated close to the carotid bifurcation are two anatomical structures called carotid sinus and carotid body. The carotid sinus or bulb is a dilation acting as a baroreceptor for detecting blood pressure changes, while the carotid body acts as a chemoreceptor for acid-base disturbances.

Segments and course

Classifications and names

There are two main ways to categorize the segments of the internal carotid artery. The newest one was put forward in 1998 dividing the artery into four parts, the names of which are related to the areas or anatomical structures through which the internal carotid artery passes:

Cervical part (neck)

Petrous part (temporal bone)

Cavernous part (cavernous sinus)

Intercranial part (after piercing the dura mater)

However, many medical specialties actually use an older method described in 1996, known as the Cincinnati Classification (Bouthillier et. al., 1996). The names are also related to the areas through which the artery passes, but it is more detailed. According to this idea, there are seven segments:

C1 – Cervical Segment

C2 – Petrous Segment

C3 – Lacerum Segment

C4 – Cavernous Segment

C5 – Clinoid Segment

C6 – Ophthalmic (Supraclinoid) Segment

C7 – Communicating (Terminal) Segment

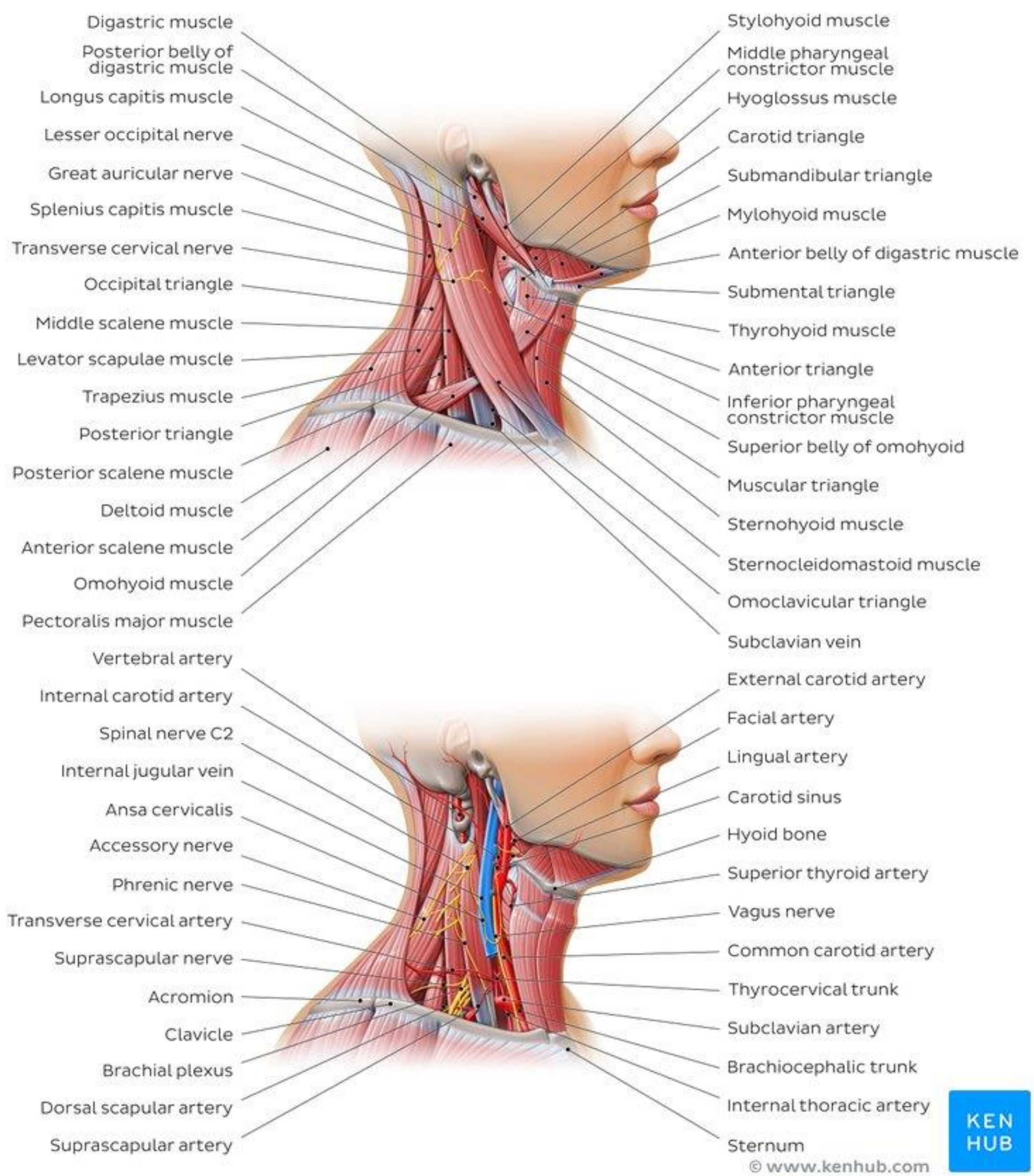
You can easily remember the intracranial segments of the Cincinnati Classification using the mnemonic ‘Please Let Children Consume Our Candy’.

The two classifications are not like oil and water or completely distinct. The cervical segments correspond, while the C2 and C3 segments are referred to collectively as the petrous part. The cavernous parts also match, while C5, C6, and C7 are referred to as the intracranial components.

Segment pathways

In this article, we’ll use the Cincinnati Classification to describe the pathway of the internal carotid artery because it is more detailed. You can easily revert to the newest classification by combining the trajectories of various segments according to the explanations in the previous paragraph.

Cervical segment (C1): You can easily remember the contents by thinking about the mnemonic ‘I See 10 CC’s in the IV’. This part of the internal carotid artery (I.C. or ‘See’) travels superiorly through the carotid triangle of the neck enveloped in the carotid sheath, together with the common carotid artery (CC), internal jugular vein (IV), vagus nerve (CN 10), deep cervical lymph nodes, and sympathetic nerve fibers. As it travels superiorly, the artery passes anteriorly to the transverse processes of C1-C3, advancing towards the carotid canal in the temporal bone of the skull.



Anatomy of the neck - lateral-right view

Anatomy of the neck (lateral-right view)

Petrous segment (C2): inside the carotid canal, this segment travels superiorly before taking an anteromedial course; after which it travels along a superomedial course advancing towards the foramen lacerum.

Lacerum segment (C3): this short segment travels over the cartilage occluding the foramen lacerum (not through it!) and ends at the petrolingual ligament. This anatomical structure is located on the wall of the cavernous sinus.

Cavernous segment (C4): it courses superiorly along the posterior clinoid process of the sphenoid bone, making its way towards the anterior clinoid process before finally emerging through the roof of the cavernous sinus. Within the cavernous sinus, the internal carotid artery travels superomedially to CN VI (abducens nerve) and medially to CN III (oculomotor nerve), CN IV (trochlear nerve), and CN V1 and CN V2 (ophthalmic and maxillary divisions of the trigeminal nerve, respectively).

Clinoid segment (C5): after exiting the cavernous sinus at the proximal dural ring, this segment travels a very short distance until the distal dural ring.

Ophthalmic segment (C6): from the distal dural ring, the C6 segment travels parallel and horizontal in an inferolateral position with respect to CN II (optic nerve). The end point is the origin of the posterior communicating artery.

Communicating segment (C7): this terminal segment bifurcates into its terminal branches before ending at the anterior perforated substance.

Branches

Like every major artery in the human body, the internal carotid has several branches that are often asked about in anatomy exams. They stem from several segments (C2, C4, C6, and C7), the only exceptions being the cervical (C1), lacerum (C3), and clinoid (C5) segments do not give rise to any branches.

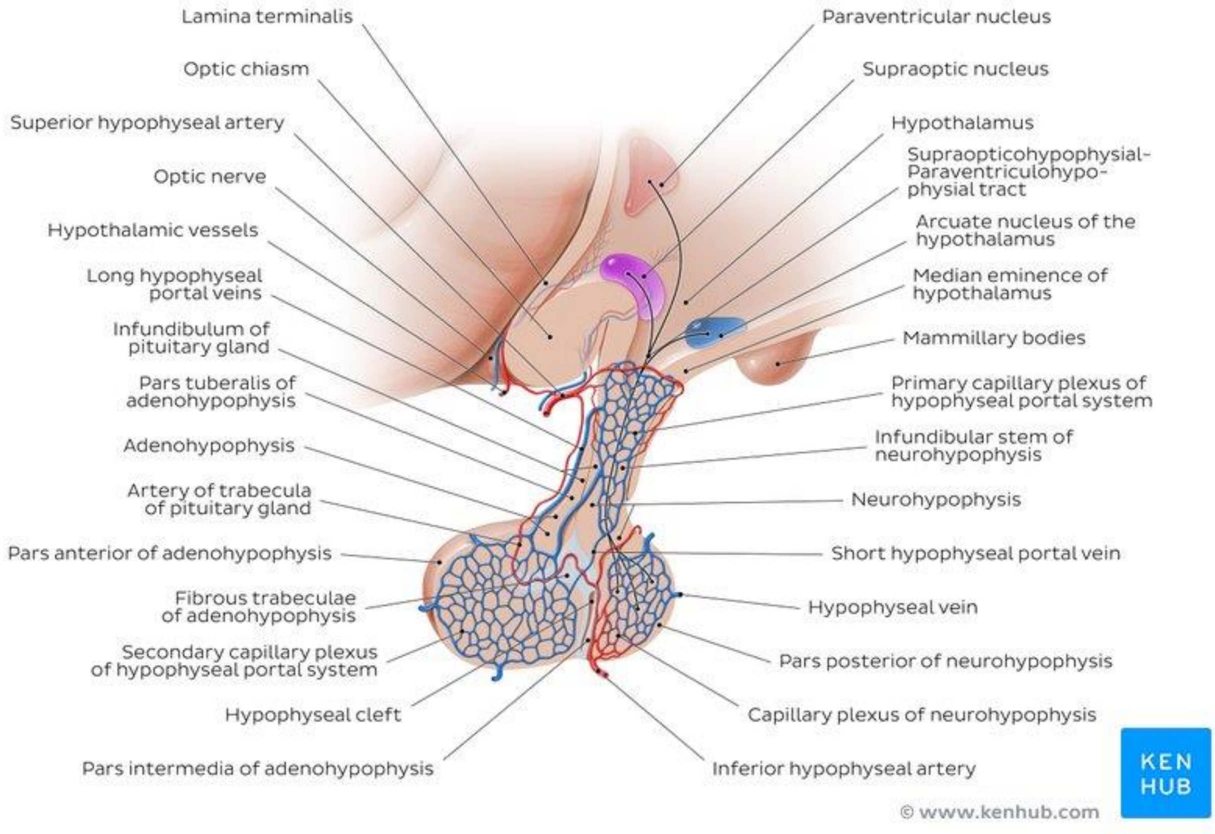
Caroticotympanic artery (C): it originates from the petrous part (C2) and travels through the tympanic cavity via the foramen within the carotid canal. It subsequently anastomoses with the anterior tympanic branch of the stylomastoid artery and the maxillary artery.

Vidian artery (V): also called the artery of the pterygoid canal, or the pterygoid artery, originates from the petrous part (C2) of the internal carotid artery. The Vidian artery courses through the pterygoid canal together with the Vidian nerve, or nerve of the pterygoid canal. It finally anastomoses with a branch of the greater palatine artery. It is important to note that not every individual has the Vidian artery, meaning that it is inconsistent.

Meningeal artery (M): it stems from the cavernous segment (C4) and supplies the dura mater of the anterior cranial fossa. In the end, it anastomoses with the meningeal branch of the posterior ethmoidal artery. In addition, the cavernous segment also gives off several small arteries that supply the trigeminal ganglion, the walls of two dural venous sinuses (inferior petrosal and cavernous), together with the nerves contained in their vicinity.

Inferior hypophyseal artery (I): also coming from the cavernous segment (C4), this artery supplies the neurohypophysis, the posterior part of the pituitary gland. This artery terminates in the pituitary portal system.

Superior hypophyseal artery (S): it stems from the ophthalmic segment (C6), supplying the infundibulum and median eminence of the hypothalamus, as well as the pars tuberalis of the anterior pituitary gland.



Anatomy of the hypophyseal portal system - sagittal view

Anatomy of the hypophyseal portal system (sagittal view)

Ophthalmic artery (O): also stemming from the ophthalmic segment (C6), this artery passes through the optic canal, ultimately entering the orbit and supplying its contents.

Posterior communicating artery (P): it originates from the communicating segment (C7) and anastomoses with posterior cerebral artery coming off the basilar artery, contributing to the formation of the circle of Willis.

Ophthalmic artery (Arteria ophthalmica); Image: Paul Kim

Ophthalmic artery (Arteria ophthalmica)

Anterior choroidal artery (A): also originating from the communicating segment (C7), this artery follows a complex course by crossing the optic tract to supply the crus cerebri, then recrossing it to project onto and supply the lateral geniculate body of the thalamus. It then passes through the choroidal fissure to enter the lateral ventricle and supply its choroid plexus. In addition, the anterior choroidal artery supplies the mesencephalic, diencephalic, and telencephalic anatomical derivatives.

Once the internal carotid artery has followed the previously described course and given off its eight branches, it divides into the two terminal branches described below:

Anterior cerebral artery (A): it is a terminal branch of the internal carotid artery originating from the communicating segment (C7). It travels towards the longitudinal cerebral fissure, where it anastomoses with its contralateral counterpart via the short anterior communicating artery. As a result, they contribute to the formation of the circle of Willis. The paired arteries then travel along the medial surface of the brain through the longitudinal cerebral fissure in a posterior direction along the genu of the corpus callosum. Here, each vessel anastomoses with the ipsilateral posterior cerebral artery. The anterior cerebral artery gives off cortical and central branches. The cortical branches include the parietal, orbital, and frontal branches. The parietal branches supply the precuneus, while the orbital branches are responsible for the olfactory cortex, medial orbital gyrus, and gyrus rectus of the frontal lobe. The frontal branches provide blood to the paracentral lobule, medial frontal, and cingulate gyri, and the corpus callosum. The central branches of the anterior cerebral artery supply the rostrum of the corpus callosum, the septum pellucidum, and areas surrounding the anterior part of the putamen (head of the caudate nucleus and local area of the internal capsule).

Anterior cerebral artery (Arteria anterior cerebri); Image: Paul Kim

Anterior cerebral artery (Arteria anterior cerebri)

Middle cerebral artery (M): it is the second and largest terminal branch of the internal carotid artery, also originating from the communicating segment (C7). The middle cerebral artery travels through the lateral fissure before coursing over the insula. It subsequently divides to supply the lateral cortical surfaces along with the insula. It also has cortical and central branches, similar to the anterior cerebral artery. The cortical branches include the frontal, orbital, parietal, and temporal branches. The frontal arteries perfuse the inferior frontal, middle, and precentral gyri. The lateral orbital parts of the frontal lobe, as well as the frontal gyrus, are supplied by the orbital branches. The inferior parietal lobe, the inferior part of the superior parietal lobe, and the postcentral gyrus receive blood from the parietal branch. Several temporal arteries then go on to perfuse the lateral aspect of the temporal lobe. The central branches are relatively small and include the lenticulostriate arteries that pass through the anterior perforated substance to supply the lentiform nucleus and the posterior limb of the internal capsule.

You can easily remember the branches of the internal carotid artery by arranging the previous letters included in brackets into the mnemonic ‘A VIP’S COMMA’.

The left and right subclavian arteries are two major arteries in the thorax that lie beneath the clavicles. They receive blood flowing from the aortic arch, and once they pass the lateral border of the first rib, they become known as the axillary arteries.

The subclavian artery is the source for supplying the upper limb with arterial blood. Its terminal branch, the axillary artery supplies the axillary region. It continues as the brachial and then ulnar and radial arteries, that suppy the arm and forearm respectively. This article will describe the parts and branches of the subclavian arteries, together with its course and development.

Subclavian artery (Arteria subclavia)

During prenatal development, the right subclavian artery arises from the fourth aortic arch of the right dorsal aorta (between the 4th and 7th intersegmental arteries) and the right 7th intersegmental artery. The left subclavian artery develops from the left 7th intersegmental artery.

As embryonic development progresses, the subclavian arteries course in the neck, after running posterior to the sternoclavicular joints and ascending through the superior thoracic aperture to gain access into the root of the neck.

Parts

Each of the subclavian arteries is made up of three parts, defined in relation to the anterior scalene muscle of the neck. Tributaries to the neck and brain arise from the three parts of the subclavian artery as follows:

First part

This part of the subclavian artery is medial to the anterior scalene muscle. Lying posterior to this part are the cervical pleura, apex of the lung, and sympathetic trunk. Branches from this part of the subclavian artery are the:

- Vertebral artery
- Internal thoracic artery
- Thyrocervical trunk

Second part

This part of the subclavian artery is posterior to the anterior scalene muscle. It gives rise to the costocervical trunk as it courses upwards.

Third part

The third part of the subclavian artery lies lateral to the anterior scalene muscle and gives off the dorsal scapular artery. This part lies on the first rib and it is the longest, most superficial part of the subclavian artery. Its pulsations can be felt by applying deep pressure in the omoclavicular triangle. The inferior trunk of the brachial plexus lies directly posterior to this part of the subclavian artery.

The suprascapular artery may also arise from the third part, however in most individuals, this branch arise from the first part of the subclavian artery as a branch of the thyrocervical trunk.

Third part of the subclavian artery seen anterior to the brachial plexus roots. This part of artery is easily palpable.

Mnemonic

If you find artery branches confusing you can use a mnemonic to help you! Just memorise the phrase 'VIT C & D', which stands for:

- Vertebral a.
- Internal thoracic a.
- Thyrocervical trunk
- Costocervical a.
- Dorsal scapular a.

Right subclavian artery (Arteria subclavia dextra)

The right subclavian artery originates from the brachiocephalic trunk, behind the upper border of the right sternoclavicular joint. It courses upwards above the clavicle, superomedially, and then posterior to the scalenus anterior (anterior scalene muscle), to the lateral border of the first rib, when it becomes the axillary artery.

Left subclavian artery

The left subclavian, in the majority of individuals, originates from the aortic arch independently after the brachiocephalic trunk and the left common carotid artery have branched off. It arises below the left common carotid artery and ascends into the neck lateral to the medial border of scalenus anterior, crosses behind this muscle and then descends towards the lateral border of the first rib, where it becomes the axillary artery.

Arteries are notriously tricky to identify. Why not make your studies easier by making your own anatomy flashcards? They're perfect for improving your identification skills!

Branches

Vertebral artery (Arteria vertebralis)

Apart from supplying blood to the upper limbs (through their terminal branch, the axillary arteries), they also send branches to the neck and brain. The branches of the subclavian artery are the:

- Vertebral artery
- Internal thoracic artery

- Thyrocervical trunk
- Costocervical trunk
- Dorsal scapular artery

Vertebral artery

This branch of the subclavian artery originates from the first part, and it is composed of four parts – cervical, vertebral, suboccipital and cranial.

- Cervical: It arises from the first part of the subclavian artery and ascends in the pyramidal space formed between the scalene and longus muscles.
- Vertebral: It passes deeply to course through the foramina of the transverse processes of cranial vertebrae C1-C6. Occasionally, the vertebral artery may enter a transverse foramen superior to the 6th cervical vertebra.
- Suboccipital: It courses in a groove on the posterior arch of the atlas before it enters the cranial cavity through the foramen magnum.
- Cranial: It supplies branches to the medulla, spinal cord, parts of the cerebellum, and the dura of the posterior cranial fossa. At the caudal border of the pons of the brainstem, the vertebral arteries anastomose to form the basilar artery, which participates in the formation of the the Circle of Willis, a loop of cerebral vessels.

Internal thoracic artery

This branch arises from the anteroinferior aspect of the first part of the subclavian artery, and passes inferomedially into the thorax. It has a thoracic and cervical part.

Thyrocervical trunk

The thyrocervical trunk arises from the anterosuperior aspect of the first part of the subclavian artery, near the medial border of the anterior scalene muscle. It has three branches:

- Inferior thyroid artery: It is the largest and most important one because it is the primary visceral artery of the neck.
- Suprascapular artery: It supplies muscles on the posterior surface of the scapula
- Transverse cervical artery: It sends branches to the muscles in the lateral cervical region, the trapezius and medial scapular muscles.
- Inferior thyroid and ascending cervical arteries: These are the terminal branches of the thyrocervical trunk. The latter artery supplies the lateral muscles of the upper neck.

Costocervical trunk

This branch of the subclavian artery arises from the posterior aspect of the second part, posterior to the anterior scalene on the right side, and usually just medial to this muscle on the left side. The costocervical trunk passes posterosuperiorly and divides into the superior intercostal and deep cervical arteries, which supply the first two intercostal spaces and the posterior deep cervical muscles respectively.

Dorsal scapular artery

This branch arises as the deep descending branch of the transverse cervical artery, but it may be an independent branch arising from the third part of the subclavian artery. When it is a branch of the subclavian, the dorsal scapular artery passes laterally through the trunks of the brachial plexus, anterior to the middle scalene. It then runs deep to the levator scapulae and the rhomboid muscles, supplying both and participating in the arterial anastomoses around the scapula.

Anatomy of the axillary artery and its branches.
Anatomical relations

Brachial artery (Arteria brachialis)
Relationships of the brachial artery to other structures in the arm can be important in clinical practice. The brachial artery is a superficial vessel and is only covered by the layers of the skin, as well as the superficial and deep fasciae, with a few exceptions:

- The first exception to this is at the cubital fossa, where the bicipital aponeurosis, which is the aponeurosis of the biceps brachii muscle, covers the artery, and separates it from the median cubital vein.
- The second exception is when the median nerve crosses the brachial artery near the distal attachment of the coracobrachialis.

Posteriorly, the brachial artery is separated from the long head of the triceps brachii muscle by the profunda brachii artery and the radial nerve. The attachments of the coracobrachialis and the brachialis muscles, as well as the medial head of the triceps brachii muscle, also lie posterior to the brachial artery.
The median nerve and coracobrachialis muscle lie laterally to the brachial artery at its proximal aspect whereas the medial cutaneous nerve of the forearm and the ulnar nerve lie medially to the artery proximally.
At the distal aspect of the brachial artery, the basilic vein and median nerve lie medially. Two venae comitantes, or accompanying veins, run with the brachial artery, and are connected together by transverse and oblique branches.
Anatomical variations
Along with many other structures in the human body, the anatomical course of the brachial artery may vary between people:

- The brachial artery may diverge from its usual course along the medial aspect of the biceps and run more medially towards the medial epicondyle of the humerus. In this case, the brachial artery passes posterior to the supracondylar process of the humerus before running through, or posterior to, the pronator teres muscle.
- The brachial artery can also form anastomoses or branches more proximal than usual. In this case, the artery divides into three branches referred to as the ulnar, radial and common

interosseus arteries. The radial artery usually arises from the brachial artery more proximally, leaving a common division for the ulnar and common interosseus arteries. Occasionally, the ulnar artery may instead branch off more proximally, which then leaves a common division for the radial and common interosseus arteries.

- Sometimes, small slender arteries connect the brachial artery to the axillary artery and these are referred to as vasa aberrantia.

Branches

The brachial artery forms 8 branches including the:

-

Deep brachial artery (Arteria profunda brachii)

Profunda brachii artery

- Nutrient artery of the humerus
- Superior ulnar collateral artery
- Middle ulnar collateral artery
- Inferior ulnar collateral (supratrochlear) artery
- Deltoid (ascending) artery
- Radial artery
- Ulnar artery

The profunda brachii artery is a large posteromedial branch of the brachial artery, distal to the teres major muscle. It accompanies the radial nerve in its course. The profunda brachii artery runs initially posteriorly between the medial and long heads of the triceps brachii muscle before continuing within the spiral groove of the humerus. It then divides into two branches, the middle collateral (posterior descending) branch and the radial collateral (anterior descending) branch.

The middle collateral branch is the larger of the two branches and arises posterior to the humerus before descending posterior to the lateral intermuscular septum to the elbow. Proximally, this branch runs between the brachialis and the lateral head of the triceps brachii. Distally, it runs posterior to the brachioradialis and anterior to the lateral head of the triceps brachii. The middle collateral branch then either remains deep to the fascia or crosses it to become cutaneous before reaching the interosseus recurrent artery posterior to the lateral epicondyle. It gives off five fasciocutaneous perforators, which are small arteries that pass through the fascia between muscles and supply the skin.

Wondering how you can test yourself on the different branches of the brachial artery? Try flashcards! Here's how you can make your own.

The radial collateral branch runs with the radial nerve and crosses the lateral intermuscular septum to descend anteriorly to the lateral epicondyle, between the brachialis and brachioradialis. It then joins the radial recurrent artery and supplies the radial nerve, the brachioradialis and brachialis muscles, as well as some fasciocutaneous perforators.

The nutrient artery arises from the brachial artery around the middle level of the arm before entering the nutrient canal, which is essentially a large foramen or hole in the humerus. It enters this canal posterior to the deltoid tuberosity, near the attachment of coracobrachialis.

The superior ulnar collateral artery arises from the brachial artery slightly distal to the mid-level of the arm but can occasionally arise as a branch of the profunda brachii artery. Along the ulnar nerve, it passes through the medial intermuscular septum into the posterior compartment of the arm to supply the medial head of the triceps brachii muscle. It then runs between the medial epicondyle of the humerus and the ulnar epicondyle. Deep to the flexor carpi ulnaris muscle, it joins the inferior collateral artery and the posterior ulnar recurrent artery. Sometimes, a branch anastomoses with the anterior ulnar recurrent artery after it travels anteriorly to the medial epicondyle.

The middle ulnar collateral artery is present in some people to supply the triceps brachii muscle, in which case it arises from the brachial artery between the superior and inferior ulnar collateral arteries and travels anteriorly to the medial epicondyle before anastomosing with the anterior ulnar recurrent artery. Similar to the middle collateral branch of the profunda brachii artery, it gives off some small fasciocutaneous perforators.

The inferior ulnar collateral (supratrochlear) artery arises from the brachial artery about 5cm proximal to the elbow joint. It runs medially between the brachialis muscle and the median nerve before crossing the medial intermuscular septum. It then spirals round the humerus between the bone and the triceps brachii muscle until it anastomoses with the middle collateral branch of the profunda brachii artery to form an arch located proximally to the olecranon fossa, a depression on the posterior aspect of the humerus. Anterior to the brachialis muscle, the inferior ulnar collateral artery divides into a few branches, which either run anteriorly to the medial epicondyle to anastamose with the anterior ulnar recurrent artery or run posteriorly to it to anastomose with the posterior ulnar recurrent artery and superior ulnar collateral artery.

The deltoid artery is a muscular branch of the brachial artery, which lies between the lateral and long heads of the triceps brachii until it reaches the descending branch of the posterior humeral circumflex artery.

The radial artery runs deep to the brachioradialis to give off the radial recurrent artery distal to the elbow joint. It runs between the superficial and deep branches of the radial nerve before it passes, in a superior direction, posteriorly to the brachioradialis muscle and anteriorly to the supinator and brachialis muscles. It supplies the brachioradialis, supinator and brachialis muscles as well as the elbow joint, before anastomosing with the radial collateral branch of the profunda brachii artery.

The ulnar artery is the largest of the terminal branches of the brachial artery. Before passing below the pronator teres muscle, it gives off two branches distal to the elbow joint. The first branch is the anterior ulnar recurrent artery, which supplies the brachialis and pronator teres muscles before anastomosing with the inferior ulnar collateral artery at the medial epicondyle.The other branch, the posterior ulnar recurrent artery, joins up with the interosseus recurrent arteries and with the ulnar collateral arteries. The ulnar artery then continues along the forearm to give off more divisions.

Radial artery (Arteria radialis)

Mnemonics

Here's an easy way to remember the branches of the brachial artery.

Play "November rain", "Sweet child O' Mine", "I'ts so easy", and Don't stop Rocking Ukulele

- Profunda brachii (P)
- Nutrient artery of the humerus (N)
- Superior ulnar collateral artery (S)
- Middle ulnar collateral artery (M)
- Inferior ulnar collateral artery (I)
- Deltoid artery (D)
- Radial artery (R)
- Ulnar artery (U)

To easily remember the anastomosis of the ulnar collateral and recurrent branches use the following mnemonic.

I Am Pretty Smart

- Inferior ulnar collateral artery goes with Anterior branch of ulnar recurrent artery
- Posterior branch of ulnar recurrent artery goes with Superior ulnar collateral artery

Clinical notes

The brachial pulse can be felt medial to the biceps brachii muscle by applying pressure to the medial edge of the humerus. More proximally, it can be felt in the depression posterior to the coracobrachialis muscle. More distally, it can be felt medially to the biceps brachii tendon. As the brachial artery runs deep to the bicipital aponeurosis, its pulsation cannot be felt beyond this point.

Blood pressure is a vital sign in clinical practice. Hypertension or high blood pressure is an important risk factor for many diseases including stroke and myocardial infarction. Hypotension or low pressure may be an indicator of blood loss or poor myocardial contractility. Blood pressure is measured with a sphygmomanometer and a stethoscope. The cuff of the sphygmomanometer is placed over the arm and is inflated to a pressure 20-30 mmHg greater than the estimated systolic blood pressure in order to compress the brachial artery. The cuff is then slowly deflated to restore blood flow in the artery. The resulting Korotkoff sounds are amplified using a stethoscope, held over the brachial artery in the cubital fossa, and are used in order to determine the systolic and diastolic blood pressures.

Supracondylar fractures of the humeral shaft are common in children after a fall on the elbow or on an extended hand and may cause posterior displacement of the distal fragment. This proximal bone fragment may injure the brachial artery.

Compression of the brachial artery can be performed to control blood loss in trauma patients and is best carried out proximal to the site of laceration and medial to the humerus. Clamping of the brachial artery distal to where the profunda brachii artery branches off can be carried out without causing tissue damage. This is because the branches arising from the brachial artery will still provide adequate blood flow to the more distal ulnar and radial arteries by forming a collateral circulation around the elbow joint.

Ischaemic compartment syndrome happens as a result of severe injury to the arm, leading to swelling of the soft tissues, raised intracompartmental pressure and associated compression of the surrounding nerves and muscles within the affected compartments. Ischaemia ensues and after 6 hours, necrotic tissue in the muscles is replaced by fibrotic scar tissue. This causes contracture due to permanent shortening of the muscles. This can result in pain, paralysis and paraesthesia.

The aorta originates from the left ventricle of the heart. It ends in the abdomen where it branches into the two common iliac arteries. The aorta has five separate segments. The descending aorta begins at the arch of the aorta (where it loops over the heart to begin its descent). It is divided into two segments, the thoracic and the abdominal. The **descending aorta (thoracic aorta)** is between the arch of the aorta and the diaphragm muscle below the ribs. At the origination point, it is on the left side of the vertebrae. As it descends, it winds around the vertebrae and ends in front. The diameter of the artery is 2.32 centimeters. It has six paired branches: bronchial arteries, mediastinal arteries, esophageal arteries, pericardial arteries, superior phrenic artery, and intercostal arteries. There are nine pairs of the intercostal arteries. The right branches are longer than the left, because the descending aorta (thoracic aorta) is on the left side of the vertebrae. Through its various branches, it supplies blood to the esophagus, lungs, and the chest area, including the ribs and mammary glands.

Introduction

The aorta is the largest vessel within the human body. It originates from the left ventricle of the heart anterior to the pulmonary artery before arching posteriorly and descending along the posterior mediastinum. It descends to the level of the L4 vertebral body where it bifurcates into the left and right common iliac arteries. It is the main artery in the body and distributes oxygenated blood to the entire systemic circulation. This section will be limited to the thoracic portion of the aorta, which includes the ascending aorta, aortic arch, and descending thoracic aorta before it crosses the level of the diaphragm where it becomes the abdominal aorta. The thoracic aorta is responsible for supplying oxygenated blood to multiple structures, including the head, neck, upper extremities, and thoracic structures.

Structure and Function

The thoracic aorta originates from the left ventricle, guarded by the aortic valve. Just above the cusp of the aortic valve, the aorta gives off the left and right main coronary arteries that run along coronary grooves of the heart and are responsible for perfusion of the myocardium. The initial portion of the aorta ascending behind the sternum is referred to as the ascending aorta, extends approximately to the level of the T4 vertebral body. From this point, it is known as the aortic arch and begins to arch posteriorly and to the left of the vertebral bodies in the posterior mediastinum. The aortic arch both begins and ends at the level of the second rib; it lies within the superior mediastinum. in the chest radiographs, the aortic arch is identifiable as "the aortic knob." The aortic arch gives off three branches including:

- Brachiocephalic artery (also known as the innominate artery) is the first arch vessel to branch off - it travels superiorly and to the right side of the body and bifurcates into the right subclavian artery and right common carotid artery
- The left common carotid artery is the subsequent vessel to branch from the aortic arch
- Left subclavian artery is the third arch vessel to branch from the aortic arch

The final section of the aortic arch is just distal to the origin of the left subclavian artery and is known as the aortic isthmus. There is a mild narrowing of the aorta that occurs at the site of the ligamentum arteriosum, which is a remnant of the ductus arteriosus. From the fourth thoracic vertebra, it continues as the descending aorta to travels downward to the diaphragmatic hiatus at the level of T12 where it exits the thorax. The descending aorta gives off multiple vessels before exiting the thoracic cavity, including arteries to supply the pericardium, bronchi, mediastinum, and esophagus; it also gives off the superior phrenic arteries, posterior intercostal arteries, and subcostal arteries.

Embryology

The aorta develops during the third gestational week. The ascending aorta and aortic arch develop independently from two different embryologic tracts. The ascending aorta develops from the truncus arteriosus which is a component of heart development. The truncus arteriosus is a single outflow tract that forms during heart development. It originates from both the left and right ventricle of the heart. The truncus arteriosus is then divided by the aorticopulmonary septum to give rise to two separate outflow tracts, later known as the pulmonary artery and ascending aorta.

The aortic arch forms through the development of the branchial arch arteries. There are six branchial arch arteries, also known as the pharyngeal arch vessels. These develop into the following:

- The first branchial arch artery forms the maxillary and external carotid arteries
- The second branchial arch artery leads to the formation of the stapedial arteries
- The third branchial arch artery contributes to the formation of the right common carotid arteries and proximal internal carotid artery
- The fourth branchial arch artery forms the main portion of the aortic arch, as well as the proximal right subclavian artery - the left subclavian artery arises from the left seventh intersegmental artery, which describes a set of arteries that develop from the dorsal aorta
- The fifth branchial arch does not form vessels and regresses
- The sixth branchial arch leads to the formation of the main pulmonary artery, left and right pulmonary artery, and ductus arteriosus

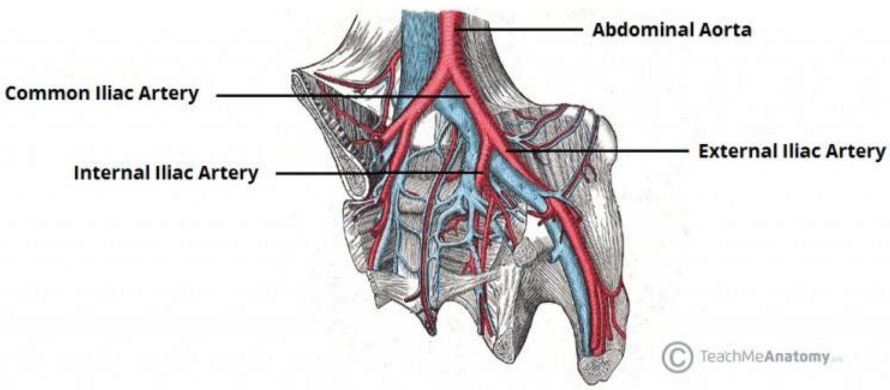
The pelvic cavity contains the organs of reproduction, urinary bladder, pelvic colon, rectum and numerous muscles. Its arterial supply is largely via the **internal iliac artery**, with some smaller arteries providing additional supply.

In this article we will look at the anatomy of the pelvic arteries, detailing their anatomical course, branches and their clinical relevance.

Major Arteries of the Pelvis: Internal Iliac

The internal iliac artery is the major artery of the pelvis. It originates at the bifurcation of the common iliac artery into its internal and external branches, as shown in Figure 1. This approximately occurs at vertebral level L5-S1.

The artery descends inferiorly, crossing the pelvic inlet to enter the lesser pelvis. During its descent, it is situated medially to the external iliac vein and obturator nerve. At the superior border of the greater sciatic foramen, it divides into anterior and posterior trunks.



Anterior Trunk

The anterior trunk gives rise to numerous branches that supply the pelvic organs, the perineum, and the gluteal and adductor regions of the lower limb. The following branches of the internal iliac artery are highlighted in *Figure 2* below, working anti-clockwise from obturator artery to inferior gluteal artery.

Obturator artery – Travels through the obturator canal, accompanied by the obturator nerve and vein. It supplies the muscles of the thigh’s adductor region.

Umbilical artery – Gives rise to the superior vesical artery, which supplies the superior aspect of the urinary bladder.

In utero, the umbilical artery transports deoxygenated blood from the fetus to the placenta.

Inferior vesical artery – Supplies the lower aspect of the bladder. In males, it also supplies the prostate gland and seminal vesicles.

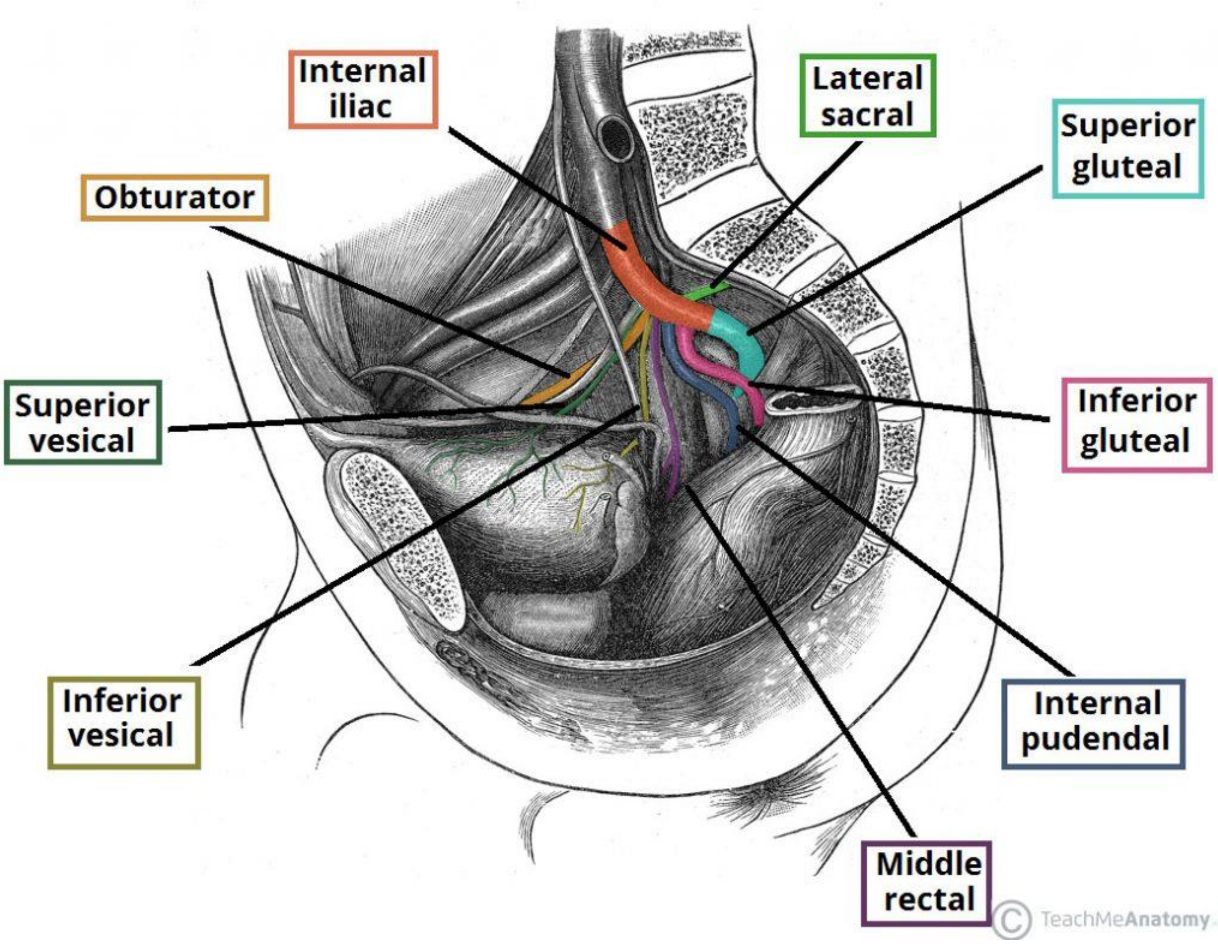
Vaginal artery (female) – Descends to the vagina, supplying additional branches to the inferior bladder and rectum.

Uterine artery (female) (shown in *Figure 3*) – Travels within the cardinal ligament to reach the cervix, where it ascends along the lateral aspect of the uterus. At origin of the fallopian tubes, it anastomoses with the ovarian artery. During its course, it crosses the ureters superiorly.

Middle rectal artery – Travels medially to supply the distal part of the rectum. It also forms anastomoses with the superior rectal artery (derived from the inferior mesenteric) and the inferior rectal artery (derived from the internal pudendal)

Internal pudendal artery – Moves inferiorly to exit the pelvis via the greater sciatic foramen. Accompanied by the pudendal nerve, it then enters the perineum via the lesser sciatic foramen. It is the main artery responsible for the blood supply to the perineum..

Inferior gluteal artery – The terminal branch of the anterior trunk. It leaves the pelvic cavity via the greater sciatic foramen, emerging inferiorly to the piriformis muscle in the gluteal region. It contributes to the blood supply of the gluteal muscles and hip joint.



Posterior Trunk

The posterior trunk gives rise to arteries that supply the lower posterior abdominal wall, posterior pelvic wall and the gluteal region. There are typically three branches:

Iliolumbar artery – Ascends to exit the lesser pelvis, dividing into a lumbar and iliac branch. The lumbar branch supplies psoas major, quadratus lumborum and the posterior abdominal wall. The iliac branch supplies the muscles and bone around the iliac fossa.

Lateral sacral arteries (superior and inferior) – Travel infero-medially along the posterior pelvic wall to supply structures in the sacral canal, and the skin and muscle posterior to the sacrum.

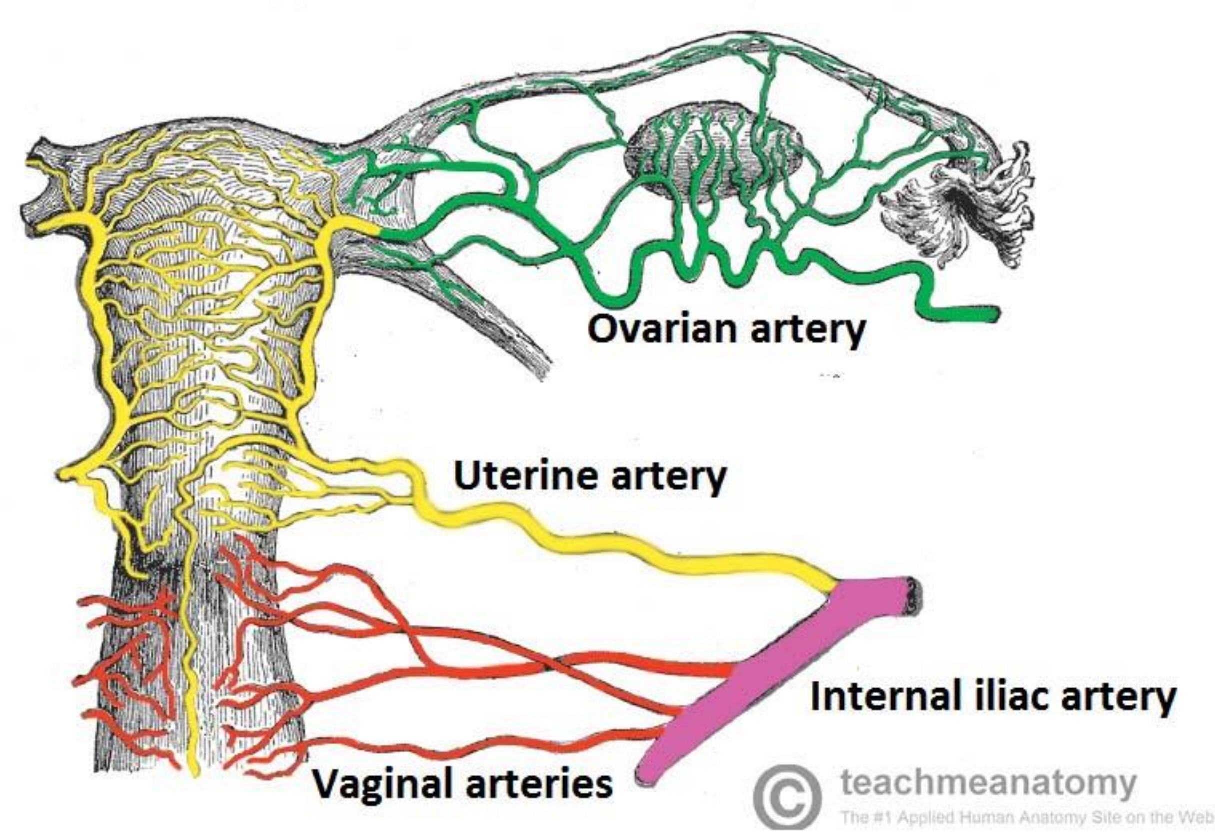
Superior gluteal artery – The terminal branch of the posterior trunk. It exits the pelvic cavity via the greater sciatic foramen, entering the gluteal region superiorly to the piriformis muscle. It is the major blood supply to the muscles and skin of the gluteal region.

Minor Arteries of the Pelvis

Gonadal Arteries

The **ovarian artery** is the major gonadal artery in females. It **arises from the abdominal aorta**, distal to the origin of the renal arteries. The artery descends towards the pelvis, crossing the pelvic brim and the origin of the external iliac vessels. It moves medially, dividing into an **ovarian branch** and **tubal branches**, which supply their respective structures.

Note – the testicular artery reaches the scrotum via the inguinal canal, and therefore does not actually enter the pelvis.



Median Sacral Artery

The **median sacral artery** originates from the posterior aspect of abdominal aorta, at its bifurcation into the common iliac arteries. It descends anteriorly to the L4 and L5 vertebrae, the sacrum and the coccyx, contributing to the arterial supply of these regions.

Superior Rectal Artery

The **superior rectal artery** is the terminal continuation of the inferior mesenteric artery. It crosses the left common iliac artery and descends in the mesentery of the sigmoid colon. It gives rise to branches that supply the rectum.

Femoral artery (anterior view)

Inside the adductor canal

Within the adductor canal, the femoral artery is located deep to the:

- skin
- superficial fascia
- deep fascia
- sartorius muscle

The artery is superficial to the adductor magnus and longus muscles. Both the saphenous nerve and femoral vein vary in their location in relation to the femoral artery. The saphenous nerve is initially found lateral to the femoral artery, but is also found anterior and then medial to the nerve as it travels through the canal. Proximally, the femoral vein is found deep to the artery but is found lateral to the artery distally. The vastus medialis muscle and its nerve are located anterolateral to the femoral artery.

Anatomical variation

Distal to the origin of the profunda femoris artery, the femoral artery rarely divides into two trunks, which reunite near the adductor hiatus. Occasionally, the artery is replaced by the inferior gluteal artery, which accompanies the sciatic nerve as it travels towards the popliteal fossa. In this case, the external iliac artery ends as the profunda femoris artery.

Branches

The femoral artery gives off five branches in the femoral triangle and one in the adductor canal, to give six in total. These branches are described below.

Superficial epigastric artery

Superficial epigastric artery (Arteria epigastrica superficialis)

The superficial epigastric artery arises from the femoral artery, 1 cm distal to the inguinal ligament. It travels through the cribiform fascia and ascends towards the umbilicus within the abdominal superficial fascia. It supplies the skin, superficial fascia and superficial inguinal lymph nodes.

Superficial circumflex iliac artery

The superficial circumflex iliac artery is the smallest branch of the femoral artery. It arises near the superficial epigastric artery. Lateral to the saphenous opening, the artery passes through the fascia lata before coursing towards the anterior superior iliac spine. Like the superficial epigastric artery, it supplies the skin, superficial fascia and superficial inguinal lymph nodes.

Superficial external pudendal artery

The superficial external pudendal artery arises near the superficial epigastric and superficial circumflex iliac arteries. It travels through the cribiform fascia before crossing the spermatic cord deep to the long saphenous vein. It supplies the lower abdominal skin as well as the penile, scrotal or labial skin.

Deep external pudendal artery

The deep external pudendal artery crosses the pectineus and adductor longus muscles before traversing the fascia lata. It supplies the skin of the perineum as well as the skin of the scrotum or labium majus.

Profunda femoris

Deep femoral artery (Arteria profunda femoris)

Profunda femoris, also known as the deep artery of the thigh is the largest branch of the femoral artery, which arises 3.5 cm distal to the inguinal ligament. The profunda femoris is initially found lateral to the femoral artery before it passes deep to it towards the medial aspect of the femur. It travels between the pectineus and adductor longus muscles before passing between the adductor longus and adductor brevis muscles. It then descends between the adductor longus and adductor magnus muscles before it pierces the adductor magnus to anastamose with the muscular branches of the popliteal artery. The profunda femoris is the main blood supply to the muscles that extend, flex and adduct the thigh.

Descending genicular artery

Descending genicular artery is the most distal branch of the femoral artery, which arises just proximal to the adductor opening within the adductor canal. It descends within the vastus medialis muscle to the medial aspect of the knee. Here, it anastomoses with the medial superior genicular artery. Branches of this artery supply the vastus medialis and adductor magnus muscles as well as the proximomedial skin of the thigh.

Mnemonic

In order to easily remember the branches of the femoral artery you can use the following mnemonic; Do Princesses Sew Sweet Superhero Dresses?

- Descending genicular artery
- Profunda femoris artery
- Superficial epigastric
- Superficial circumflex iliac
- Superficial external pudendal
- Deep external pudendal arteries

Anterior tibial artery (Arteria tibialis anterior)

The anterior tibial artery originates from the popliteal artery near the inferior border of the popliteus muscle. During its short course through the posterior compartment of the leg, the anterior tibial artery runs anteriorly between the heads of the tibialis posterior muscle. It then passes through the oval aperture in the proximal part of the interosseous membrane and runs medial to the fibular neck, emerging on the anterior compartment of the leg.

From here, it descends vertically down the anterior aspect of the interosseous membrane towards the distal tibia. Upon reaching the ankle joint, it terminates at the anterior surface of the tibia midway between the medial and lateral malleoli, and is continued by the dorsalis pedis artery.

Relations

Along its course in the posterior compartment of the leg, the anterior tibial artery is found between the heads of the tibialis posterior muscle. Upon its entry in the anterior compartment, the anterior tibial artery runs medially alongside the deep fibular (peroneal) nerve.

The proximal two-thirds of the anterior tibial artery run along the anterior aspect of the interosseous membrane of the leg and are covered by adjoining muscles and deep fascia. The upper third of the artery courses between the tibialis anterior and extensor digitorum longus muscles, while the middle third runs between the tibialis anterior and extensor hallucis longus muscles. The distal third of the artery runs along the anterior surface of the tibia and is covered by the skin, fasciae and extensor retinaculum. At the level of the ankle joint, the artery is crossed by the tendon of extensor hallucis longus. Further distally, it lies in between this tendon and the second tendon of the extensor digitorum longus muscle.

Branches and supply

Anterior lateral malleolar artery (Arteria malleolaris anterior lateralis)

The anterior tibial artery gives off several branches during its course; the posterior and anterior recurrent tibial, muscular, perforating, and anterior medial and lateral malleolar branches.

- Posterior recurrent tibial artery: arises from the anterior tibial artery soon after its origin, while it is still in the posterior compartment of the leg. The posterior recurrent tibial artery courses superiorly, anterior to the popliteus muscle. It travels with the recurrent nerve to popliteus and anastomoses with the inferior genicular branches of the popliteal artery. The posterior recurrent tibial artery supplies the superior tibiofibular joint.
- Anterior recurrent tibial artery: arises near the origin of the posterior recurrent tibial artery and shortly after, it pierces the tibialis anterior muscle. It gives off several branches anterior and lateral to the knee joint which anastomose with the genicular branches of the popliteal and circumflex fibular arteries, forming the patellar arterial network.
- Muscular branches: arise as multiple branches that supply the muscles of the anterior compartment. Some of these branches pierce the deep fascia and supply the skin of the anterior leg, while others pass through the interosseous membrane and anastomose with branches of the posterior tibial and fibular (peroneal) arteries.
- Perforating branches: pass behind the extensor digitorum longus muscle, piercing the deep fascia and supplying the skin of the anterior leg.
- Anterior medial malleolar artery: arises approximately 5 cm proximal to the ankle joint and courses posterior to the tendons of the extensor hallucis longus and tibialis anterior muscle. Upon reaching the medial side of the ankle, it gives off branches to supply the joint, which anastomose with branches of the posterior tibial and medial plantar arteries.
- Anterior lateral malleolar artery: courses posterior to the tendons of extensor digitorum longus and fibularis tertius muscles towards the lateral side of the ankle. Here, it gives off branches that supply the joint and anastomose with the perforating branch of the fibular (peroneal) artery, and the ascending branches of the lateral tarsal artery.

The anterior tibial artery terminates at the level of the ankle joint as the dorsalis pedis artery. The dorsalis pedis artery passes lateral to extensor hallucis longus onto the dorsum of the foot, and is the main artery that supplies this region of the foot.

Anatomical variations

The anterior tibial artery can have several anatomical variations concerning its origin, calibre, course and termination.

- The anterior tibial artery may occasionally be of small calibre or rarely, absent. In this case its supply is functionally replaced by the perforating branches of the posterior tibial artery or by the perforating branch of the fibular (peroneal) artery.
- The anterior tibial artery may take on a different course, running along the lateral side of the leg, only to regain its anterior position at the level of the ankle joint.
- The anterior tibial artery may occasionally terminate before reaching the dorsum of the foot. In this case, the dorsalis pedis artery arises from one of the perforating branches of the fibular (peroneal) artery.
- The anterior tibial artery may occasionally be of large calibre, in which case it supplies both the dorsum of the foot and the plantar arch.

Facial artery (Arteria facialis)

The Facial artery is the 4th branch of the external carotid and branches off in the carotid triangle. It is a very tortuous artery and this serves a functional purpose. That means the artery can accommodate head movements as well as the pharyngeal expansion as in swallowing and facial movements of the cheeks, lips, and jaws. It arises above the ascending pharyngeal artery and passes diagonally up from underneath the stylohyoid and digastric muscles. The vessel arches over the submandibular gland in a groove on its posterior surface.

From there, it arches superiorly over the mandibular body in close association with the lower part of the masseter. The vessel then travels anteriorly and superiorly across the buccal region to reach the angle of the mouth, and then passes upwards along the side of the external nose, and terminates as the angular artery near the medial commissure of the eye.

Angular artery

Angular artery (Arteria angularis)

The angular artery is essentially a terminal branch of the facial artery. The facial artery is the fourth branch of the external carotid artery. The branches of the vessel are closely attached to the angular head of the quadratus labii superioris (also known as levator labii superioris). The angular vein also accompanies the artery in this path.

In the buccal region, this artery distributes small branches that go on to anastomose with the infraorbital artery. The artery then goes on to supply the orbicularis oris, and the lacrimal sac, and ultimately terminates in an anastomosis with the nasal branch of the ophthalmic artery (the fourth branch of the external carotid).

Inferior labial artery

The facial artery gives off a branch known as an inferior labial artery, which supplies the lower lip. It branches off close to the angle of the mouth, and it travels superiorly and anteriorly underneath the triangularis muscle (also knows as depressor anguli oris). It pierces the orbicularis oris and continuous its tortuous journey underneath the lower edge of the lower lip. It goes on to run beneath the mucous membrane and the aforementioned muscle. The vessel goes on to anastomose with the mental branch of the inferior alveolar artery. It then supplies the lower lip muscles and mucous membrane.

Superior labial artery

The superior labial artery is a branch of the facial artery that supplies the upper lip, nasal septum, and ala of the nose. That vessel is larger and more tortuous than its inferior counterpart. It follows a similar course to the inferior artery by passing between the orbicularis oris and mucous membrane, and journeys above the upper edge of the upper lip. The superior labial artery supplies the upper lip but also supplies the nose through a few branches. It also gives off a septal branch that can supply blood as far anteriorly as the nasal tip, and also gives off an alar branch that supplies the ala of the external nose.

Superior labial artery (Arteria labialis superior)

Maxillary artery branches

The maxillary artery (the 7th branch of the external carotid) gives off an infraorbital artery. It also gives off the orbital branches and the anterior superior alveolar arteries. The orbital branches supply the rectus inferior, inferior oblique and the lacrimal sac. The anterior superior alveolar arteries descend through the anterior alveolar canal to supply to the upper incisor, canine teeth and the mucous membrane of the maxillary sinus.

Buccal artery

Maxillary artery (Arteria maxillaris)

The Buccal artery is a small artery of the head and a branch of the second part of the maxillary artery (the 7th branch of the external carotid) and supplies both the buccinator muscle and cheek.

Inferior alveolar artery

The inferior alveolar artery is one of the 5 main branches of the maxillary artery. It supplies the tooth sockets of the mandible. That vessel becomes the incisor branch (to the incisor teeth), the mental branch which escapes via the mental foramen, the mylohyoid branch which is a branch of the inferior alveolar just before it enters the mandibular foramen. It supplies the mylohyoid muscle and runs in the mylohyoid groove.

Submental artery

The submental artery is another branch of the facial artery (the largest cervical branch) which is given off just prior to the facial artery entering the submandibular gland. It runs forward upon the mylohyoid, below the mandible and beneath the digastric muscle. It supplies the surrounding muscles. The supraorbital artery is a branch of the ophthalmic artery that supplies the skin of the forehead, the scalp, the frontal sinus, upper eyelid, diploe and levator palpebrae superioris. The supratrochlear artery is the last branch of the ophthalmic artery. The terminal branches of the vessel anastomose with the supraorbital artery.

Other branches of the external carotid artery

Posterior auricular artery

The posterior auricular artery is the 6th branch of the external carotid and is quite small. The landmarks that it originates superior to are the stylohyoid and digastric muscles. It generally emerges opposite to the tip of the styloid process. The artery passes superiorly deep to the parotid gland and passes with the styloid process. It travels further between the mastoid process and the cartilage of the external ear. The artery supplies the scalp behind the ear and the ear itself.

Occipital artery

The occipital artery is the 5th branch of the external carotid artery. It most commonly arises opposite to the facial artery. The occipital artery passes underneath the posterior belly of the digastric muscle in order to access the occipital region. This vessel supplies the sternocleidomastoid muscles the posterior scalp and other deep neck and back muscles.

Superficial temporal artery

The superficial temporal artery is the 8th and final branch of the external carotid artery and is certainly a large artery of the head. It is commonly used by anesthetists (anesthesiologists) who can readily access its pulse in the temporal region, above the zygomatic arch and above the tragus. The transverse facial artery is a branch of the superficial temporal artery (the terminal branch of the external carotid). It supplies the parotid gland, parotid duct, and masseter muscle.

Posterior auricular artery (Arteria auricularis posterior)

The middle temporal artery arises from the superficial temporal artery. It arises above the zygomatic arch and perforates the temporal fascia, gives branches to temporalis and anastomoses with the deep temporal branches of the internal maxillary artery. The zygomaticoorbital artery is an occasional branch of the middle temporal artery, it runs along the upper border of the zygomatic arch, between the two layers of the temporal fascia, and may arise from the superficial temporal artery also. The vessel supplies the orbicularis oculi and anastomoses with the lacrimal and palpebral branches of the ophthalmic artery.

Veins of the face

Facial vein

The facial vein is a large vessel of the face and is much less tortuous than the artery of the same name. It lies posterior to the facial artery and begins from the lateral side of the nose. It drains the external palatine vein and will go on to join the retromandibular vein. This then forms the common facial vein. The inferior labial vein drains the lower lip and the superior labial vein drain the upper lip. The deep facial vein originates from the pterygoid venous plexus and is of considerable size. It communicates with the anterior facial vein.

Supraorbital vein

The supraorbital vein begins its course on the forehead, and it communicates with the frontal branch of the superficial temporal vein. The vein passes inferiorly, superior to the frontalis muscle and commonly joins the frontal vein at the medial angle of the orbital socket, to form the angular vein. The supraorbital vein drains the forehead, eyebrow, and upper eyelid.

Supratrochlear vein

The supratrochlear vein is also known as the frontal vein. It originates in the forehead in a venous plexus and combines with some frontal branches of the superficial temporal vein. All of these veins will converge onto a single trunk, close to the midline, which is usually parallel to the vein of the other side. The two trunks commonly combine via a transverse branch close to the root of the nose, referred to as the nasal arch. This arch usually receives some small branches of the nose. Rarely, the paired supratrochlear veins combine to form a single trunk, which drains the two angular veins at the nasal root.

Facial vein (Vena facialis)

Superficial temporal vein

The superficial temporal vein begins its course in the lateral aspect of the skull in a venous plexus with the supraorbital vein and the frontal vein. It combines with its partner vein on the opposing side and also combines with the occipital and auricular vein. Numerous veins drain into this plexus, close to the zygomatic arch. This forms a trunk, which combines with the middle temporal vein, that exits from the temporalis muscle. This trunk will then go on to enter the parotid gland and unify with the internal maxillary vein and create the posterior facial vein.

Transverse facial vein

The transverse facial vein begins its journey at the side of the skull in a venous plexus that also drains the supraorbital, posterior auricular, occipital, frontal and opposite transverse facial vein. This network also drains the parietal and frontal branches, which go on to unite superior to the zygomatic arch and eventually form the trunk of the combined veins. The middle temporal vein reveals itself from underneath the temporalis muscle and unites with it. The vein now traverses across the posterior root of the zygomatic arch, and subsequently enters the substance of the parotid gland. It will now meet with the internal maxillary vein to form the large posterior facial vein.

Angular vein

The angular vein is a small vein near the eye and is formed by the combination of the frontal and supraorbital veins. From this location, it passes inferiorly, along with the root of the nose until it reaches the orbital socket. At that point, it becomes the anterior facial vein. The vein receives blood from the nasal veins which run along the ala of the external nose and goes on to combine with the superior ophthalmic vein via the nasofrontal vein. It, therefore, establishes a crucial anastomosis between the cavernous sinus and the anterior facial vein.

Posterior auricular vein

The posterior auricular vein begins its journey on the side of the head and also communicates with the occipital and superficial temporal veins via a venous plexus. From there it goes on to pass downwards posterior to the ear and combines with the posterior division of the posterior facial vein. It now forms the external jugular vein. It also drains some veins from the external ear and the stylomastoid vein.

Anatomy and function of the inferior vena cava.

Anatomy

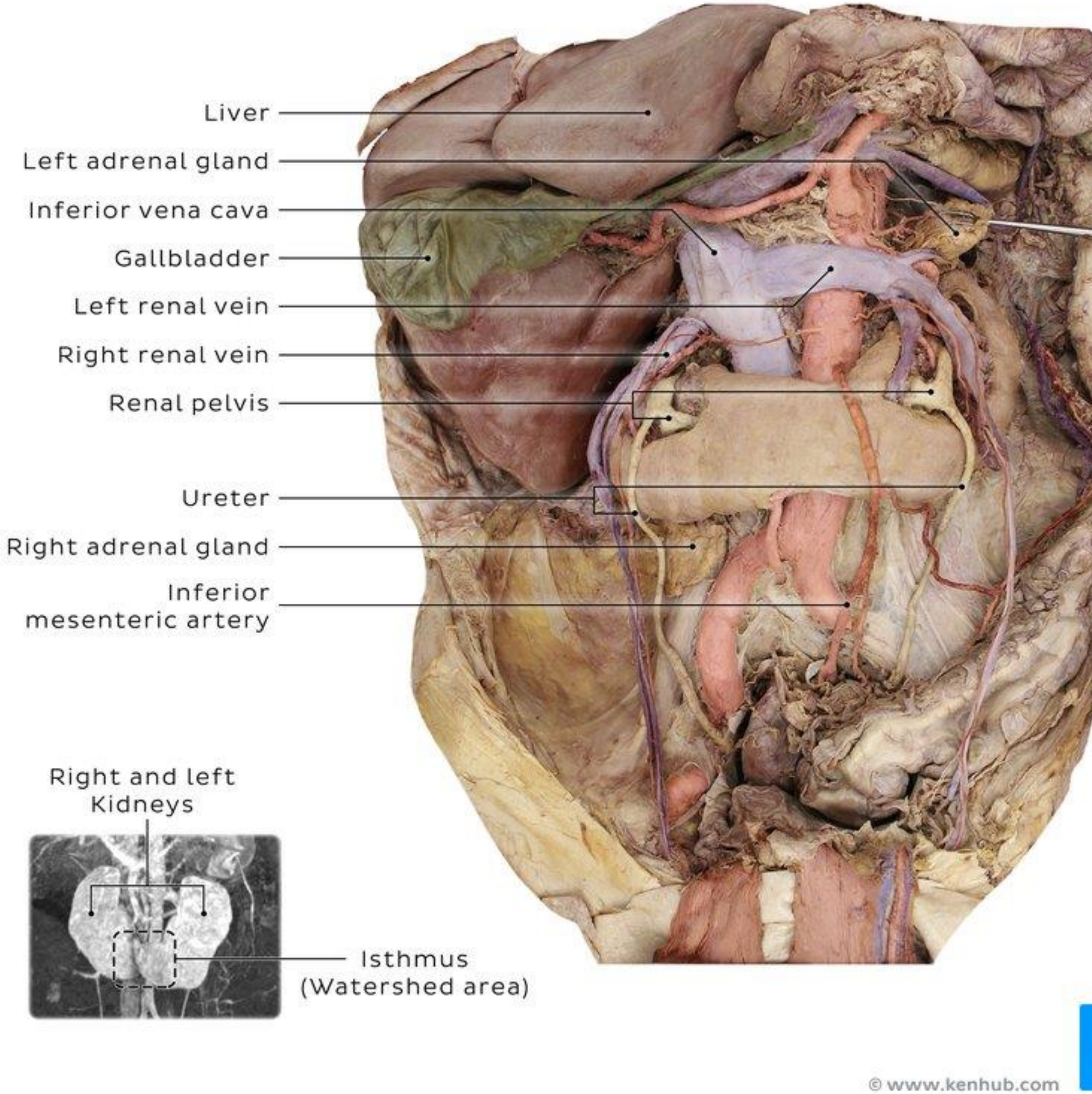
Inferior vena cava (Vena cava inferior)

The inferior vena cava arises from the confluence of the common iliac veins at the level of L5 vertebra, just inferior to the bifurcation of the abdominal aorta. It then ascends the posterior abdominal wall, to the right side of the aorta and the bodies of the L3-L5 vertebrae. After passing through its fossa on the posterior liver surface, the IVC enters the thorax by traversing the inferior vena caval foramen of the diaphragm.

The tributaries of the IVC correspond to the branches of the abdominal aorta. Note that some professors will want you to know at which vertebral level the IVC gets its direct tributaries, so they are as follows:

- The direct tributaries are the inferior phrenic veins (T8), right suprarenal (L1), renal (L1), right testicular (gonadal) (L2), lumbar (L1-L5), common iliac (L5) and hepatic (T8). If you want an easy way to remember them just memorise the mnemonic ' Portal System Returns To Liver In Humans'.
- Left gonadal and left suprarenal renal veins drain first into the left renal vein
- The veins of the stomach, spleen, pancreas, small and large intestines first empty into the hepatic portal vein. The hepatic portal vein carries this blood to the liver to be processed and detoxified. Then, the blood reaches the IVC through the hepatic veins.

The inferior vena cava communicates with the superior vena cava through the collateral vessels, which include the azygos vein, lumbar veins, and vertebral venous plexuses.



Inferior vena cava in a cadaver. Notice how the largest tributaries are the left and right renal veins.

Feel overwhelmed by all of the tributaries to the IVC? We have an article about how to learn anatomy with mind maps to help you learn anatomy more efficiently.

Learn more about the tributaries of the IVC and its anatomy.

Function

The IVC’s function is to convey the blood from the abdomen, pelvis, and lower limbs to the right atrium of the heart. Additional IVC functions are noticeable during some health disturbances, such as hepatic portal vein obstruction or the obstruction of the IVC itself.

Specialized vessels called the portocaval (portosystemic) anastomoses open if the hepatic portal vein is obstructed. The intestinal blood then bypasses the liver and empties into the IVC directly. In cases where the IVC is occluded, the collateral vessels to the superior vena cava open.

Learn more about portocaval anastomoses with our article, then take this specially designed quiz to consolidate everything you’ve learned about the IVC and its tributaries.

Inferior vena cava thrombosis

Thrombosis of the inferior vena cava (IVCT) is a condition in which a blood clot (thrombus) impedes the blood flow through the IVC. The thrombus can be formed within the IVC itself, which is rare, or, more commonly, travel from the deep veins of the legs in a condition called deep venous thrombosis (DVT).

IVC thrombosis may be caused by all the conditions that lead to venous stasis. These include congenital abnormalities of the IVC, immobilization, obesity, pregnancy, sedentary lifestyle, and tumors of surrounding organs. IVCT presents with symptoms of venous obstruction, such as pain and s

Anastomoses of veins.

Key Points

Anastomoses occur normally in the body in the circulatory system, serving as backup routes for blood flow if one link is blocked or otherwise compromised.

Anastomoses between arteries and between veins result in a multitude of arteries and veins, respectively, serving the same volume of tissue.

Pathological anastomoses result from trauma or disease and are referred to as fistulae.

Key Terms

circulatory anastomosis: A connection between two blood vessels, such as between arteries (arterio-arterial anastomosis), between veins (veno-venous anastomosis), or between an artery and a vein (arterio-venous anastomosis).

fistula: An abnormal connection or passageway between organs or vessels that normally do not connect.

An anastomosis refers to any join between two vessels. Circulatory anastomoses are named based on the vessels they join: two arteries (arterio-arterial anastomosis), two veins (veno-venous anastomosis), or between an artery and a vein (arterio-venous anastomosis).

This diagram of the rectum and anus indicates the superior hemorrhoidal vein as well as the superior, inferior, and middle hemorrhoidal arteries.

Anastomoses: The blood vessels of the rectum and anus, showing the distribution and anastomosis on the posterior surface near the termination of the gut.

Anastomoses between arteries and anastomoses between veins result in a multitude of arteries and veins serving the same volume of tissue. Such anastomoses occur normally in the body in the circulatory system, serving as backup routes for blood to flow if one link is blocked or otherwise compromised, but may also occur pathologically.

Examples of Anastomoses

Arterio-arterial anastomoses include actual joins (e.g. palmar arch, plantar arch) and potential ones, which may only function if the normal vessel is damaged or blocked (e.g. coronary arteries and cortical branch of cerebral arteries). Important examples include:

The circle of Willis in the brain.

The arrangement of the brain's arteries into the circle of Willis creates redundancies for the cerebral circulation. If one part of the circle becomes blocked or narrowed or one of the arteries supplying the circle is blocked or narrowed, blood flow from the other blood vessels can often preserve the cerebral perfusion well enough to maintain function.

Joint anastomoses. Almost all joints receive anastomotic blood supply from more than one source. Examples include the knee and geniculate arteries, shoulder and circumflex humeral, and hip and circumflex iliac.

Coronary artery anastomoses. The coronary arteries are functionally end arteries, so these meetings are referred to as anatomical anastamoses, which lack function. As blockage of one coronary artery generally results in death of the heart tissue due to lack of sufficient blood supply from the other branch, when two arteries or their branches join, the area of the myocardium receives dual blood supply. If one coronary artery is obstructed by an atheroma, a degradation of the arterial walls, the second artery is still able to supply oxygenated blood to the myocardium. However, this can only occur if the atheroma progresses slowly, giving the anastomosis time to form.

This diagram of the circle of Willis indicates the anterior and posterior communicating arteries, anterior, and middle cerebral arteries, ophthalmic artery, anterior choroidal artery, posterior cerebral artery, superior cerebellar artery, basilar artery, anterior and posterior inferior cerebellar artery, anterior spinal artery, pontine arteries, posterior communicating artery, and interior carotid artery.

The Circle of Willis: Schematic representation of the circle of Willis—arteries of the brain and brain stem. Blood flows up to the brain through the vertebral arteries and through the internal carotid arteries.

Pathological anastomoses result from trauma or disease and are usually referred to as fistulae. They can be very severe if they result in the bypassing of key tissues by the circulatory system.

Blood Circulation in the Fetus and Newborn

How does the fetal circulatory system work?

During pregnancy, the unborn baby (fetus) depends on its mother for nourishment and oxygen. Since the fetus doesn't breathe air, his or her blood circulates differently than it does after birth:

- The placenta is the organ that develops and implants in the mother's womb (uterus) during pregnancy. The unborn baby is connected to the placenta by the umbilical cord.
- All the necessary nutrition, oxygen, and life support from the mother's blood goes through the placenta and to the baby through blood vessels in the umbilical cord.
- Waste products and carbon dioxide from the baby are sent back through the umbilical cord blood vessels and placenta to the mother's circulation to be eliminated.

While the baby is still in the uterus, his or her lungs are not being used. The baby's liver is not fully developed. Circulating blood bypasses the lungs and liver by flowing in different pathways and through special openings called shunts.

Blood flow in the unborn baby follows this pathway:

- Oxygen and nutrients from the mother's blood are transferred across the placenta to the fetus through the umbilical cord.
- This enriched blood flows through the umbilical vein toward the baby's liver. There it moves through a shunt called the ductus venosus.
- This allows some of the blood to go to the liver. But most of this highly oxygenated blood flows to a large vessel called the inferior vena cava and then into the right atrium of the heart.

Here is what happens inside the fetal heart:

- When oxygenated blood from the mother enters the right side of the heart it flows into the upper chamber (the right atrium). Most of the blood flows across to the left atrium through a shunt called the foramen ovale.
- From the left atrium, blood moves down into the lower chamber of the heart (the left ventricle). It's then pumped into the first part of the large artery coming from the heart (the ascending aorta).
- From the aorta, the oxygen-rich blood is sent to the brain and to the heart muscle itself. Blood is also sent to the lower body.
- Blood returning to the heart from the fetal body contains carbon dioxide and waste products as it enters the right atrium. It flows down into the right ventricle, where it normally would be sent to the lungs to be oxygenated. Instead, it bypasses the lungs and flows through the ductus arteriosus into the descending aorta, which connects to the umbilical arteries. From there, blood flows back into the placenta. There the carbon dioxide and waste products are released into the mother's circulatory system. Oxygen and nutrients from the mother's blood are transferred across the placenta. Then the cycle starts again.

At birth, major changes take place. The umbilical cord is clamped and the baby no longer receives oxygen and nutrients from the mother. With the first breaths of air, the lungs start to expand, and the ductus arteriosus and the foramen ovale both close. The baby's circulation and blood flow through the heart now function like an adult's.

Prior to birth the foetus is not capable of respiratory function and thus relies on the maternal circulation to carry out gas, nutrient and waste exchange. The foetal and maternal blood never mix, instead they interface at the placenta. Consequently the liver and the lungs are non-functional, and a series of shunts exist in the foetal circulation so that these organs are almost completely by-passed.

Shunt 1: The Ductus Venosus

Oxygenated blood travels from the placenta via the umbilical vein and most of it bypasses the liver by way of the ductus venosus. The ductus venosus links the umbilical vein to the caudal vena cava and the flow of blood is controlled by a sphincter, enabling the proportion travelling to the heart via the liver to be altered.

Shunt 2: The Foramen Ovale

The foramen ovale is an opening between the two atria enabling blood to be channelled directly into the systemic circulation thereby bypassing the lungs. The septum secundum directs the majority of the blood entering the right atrium through the foramen ovale into the left atrium. Here it mixes with a small volume of blood returning from the non-functional lungs via the pulmonary veins.

Shunt 3: The Ductus Arteriosus

The ductus arteriosus connects the pulmonary artery to the aorta and allows equivalent ventricular function in the foetus. The blood from the right ventricle is pumped to the pulmonary trunk where, due to the high resistance in the collapsed foetal lungs, a larger volume passes through the ductus arteriosus to the caudal aorta. Most of the blood in the aorta is then returned to the placenta for oxygenation through the umbilical arteries. The ductus arteriosus empties blood into the aorta after the artery to the head has branched off thus ensuring that the brain receives well-oxygenated blood.

Circulatory Changes at Birth

Important circulatory changes occur at birth due to the replacement of the placenta by the lungs as the organ of respiratory exchange. When an newly born animal takes its first breath, the lungs and pulmonary vessels expand thereby significantly lowering the resistance to blood flow. This subsequently lowers the pressure in the pulmonary artery and the right side of the heart. On the other hand the removal of the placenta causes an increase in the resistance of the systemic circulation and hence an increase in the pressure of the left side of the heart.

The birth of the animal also triggers the closure of the foetal shunts:

Closure of the Ductus Venosus

The ductus venosus is weakly responsive to prostaglandin E2 (PGE_2) and prostacyclin (PGI_2) which behave as vasodilators. This influence is lost with the improved pulmonary clearance resulting from the absence of an umbilical blood supply. This loss of blood supply also causes the sphincter in the ductus venosus to constrict thereby diverting blood to the liver. Closure of the ductus venosus becomes permanent after two to three weeks. The remnants of the ductus venosus form the ligamentum venosum.

Closure of the Foramen Ovale

In the foetus the foramen ovale is kept open by the higher pressure of blood in the right atrium compared to the left atrium. At birth the blood pressure in the right atrium decreases due to termination of blood flow from the placenta, whilst pressure in the left atrium increases due to increased pulmonary flow. As a result, the flap of the septum primum presses against the septum secundum closing the foramen ovale. In most individuals, the foramen ovale closes a few months after birth. A scar remains between the two atria once the foramen ovale has closed and this is termed the fossa ovalis.

Closure of the Ductus Arteriosus

The ductus arteriosus is a muscular artery and immediately after birth, contraction of the musculature closes the shunt. Factors which may contribute to the physiological closure of the ductus arteriosus include the increased oxygen content of the blood passing through it and the production of bradykinin, which causes smooth muscle contraction. This physiological closure causes blood to be directed from the pulmonary arteries to the now functioning lungs. Anatomical closure takes about two months and occurs by infolding of the endothelium and proliferation of the subintimal connective tissue layer. The residual ligament is termed the ligamentum arteriosum.

The thoracic duct develops during the seventh and eighth week of gestational life from two vessels anterior to the aorta, which become the left and right embryonic thoracic ducts. The left one gives rise to the upper third of the adult thoracic duct while the lower two-thirds of the adult duct arise from the right embryonic thoracic duct.

The **lymphatic system** functions to drain tissue fluid, plasma proteins and other cellular debris back into the blood stream, and is also involved in immune defence.

Once this collection of substances enters the lymphatic vessels it is known as **lymph**. It is subsequently filtered by lymph nodes, from which it returns to the circulation via venous system.

This article will explore the anatomy of lymphatic drainage throughout the **upper limb** – the lymphatic vessels, lymph nodes, and its clinical correlations.

Lymphatic Vessels

Superficial Lymphatic Vessels

The superficial lymphatic vessels of the upper limb initially arise from **lymphatic plexuses** in the skin of the hand (networks of lymphatic capillaries beginning in the extracellular spaces). These vessels then travel up the arm in close proximity to the major superficial veins:

- The vessels shadowing the **basilic vein** go on to enter the cubital lymph nodes. These are found medially to the vein, and proximally to the medial epicondyle of the humerus. Vessels carrying on from these nodes then continue up the arm, terminating in the lateral axillary lymph nodes.
- The vessels shadowing the **cephalic vein** generally cross the proximal part of the arm and shoulder to enter the apical axillary lymph nodes, though some exceptions instead enter the more superficial deltopectoral lymph nodes.

By TeachMeSeries Ltd (2020)

Fig 1 – The lymphatic vessels of the hand. They give converge to produce the superficial lymphatic vessels of the upper limb.

Deep Lymphatic Vessels

The deep lymphatic vessels of the upper limb follow the major deep veins (i.e. radial, ulnar and brachial veins), terminating in the **humeral axillary lymph nodes**. They function to drain lymph from joint capsules, periosteum, tendons and muscles. Some additional lymph nodes may be found along the ascending path of the deep vessels.

Lymph Nodes

The majority of the upper extremity lymph nodes are located in the axilla. They can be divided anatomically into 5 groups:

- **Pectoral (anterior)** – 3-5 nodes, located in the medial wall of the axilla. They receive lymph primarily from the anterior thoracic wall, including most of the breast.
- **Subscapular (posterior)** – 6-7 nodes, located along the posterior axillary fold and subscapular blood vessels. They receive lymph from the posterior thoracic wall and scapular region.
- **Humeral (lateral)** – 4-6 nodes, located in the lateral wall of the axilla, posterior to the axillary vein. They receive the majority of lymph drained from the upper limb.
- **Central** – 3-4 large nodes, located near the base of the axilla (deep to pectoralis minor, close to the 2nd part of the axillary artery). They receive lymph via efferent vessels from the pectoral, subscapular and humeral axillary lymph node groups.
- **Apical** – Located in the apex of the axilla, close to the axillary vein and 1st part of the axillary artery. They receive lymph from efferent vessels of the central axillary lymph nodes, therefore

from all axillary lymph node groups. The apical axillary nodes also receive lymph from those lymphatic vessels accompanying the cephalic vein.

Efferent vessels from the apical axillary nodes travel through the cervico-axillary canal, before converging to form the **subclavian lymphatic trunk**. The right subclavian trunk continues to form the **right lymphatic duct**, and enters the right venous angle (junction of internal jugular and subclavian veins) directly. The left subclavian trunk drains directly into the **thoracic duct.**

By TeachMeSeries Ltd (2020)

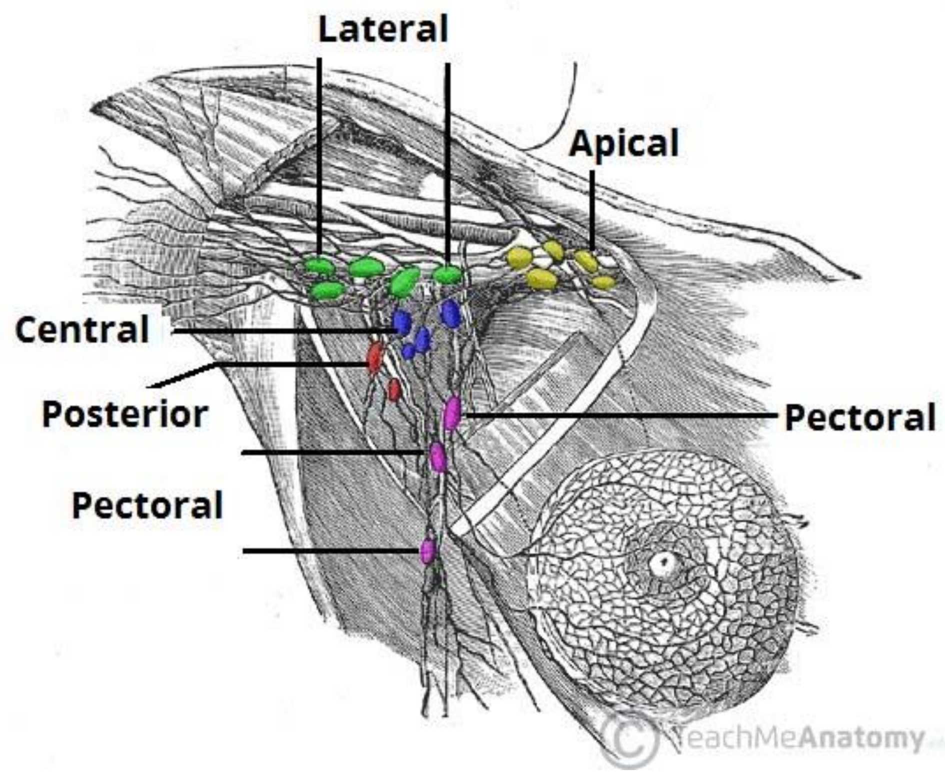


Fig 2 – The 5 groups of axillary lymphatic nodes. All groups drain into the apical nodes.

Clinical Relevance

Axillary Lymphadenopathy

Axillary lymphadenopathy refers to enlargement of the axillary lymph nodes. Common causes include:

- Infection of the upper limb, resulting in **lymphangitis** (inflammation of lymphatic vessels, with tender, enlarged lymph nodes).
  - The humeral group of lymph nodes is usually affected first, and red, warm and tender streaks are visible in the skin of the upper limb.
- Infections of the pectoral region and breast.
- Metastasis of breast cancers.

Axillary Lymph Node Dissection

Removal and analysis of the axillary lymph nodes is often a vital tool for the staging of breast cancers. Interruption of lymphatic drainage from the upper limb can however result in **lymphoedema**, a condition whereby accumulated lymph in the subcutaneous tissue leads to painful swelling of the upper limb.

During this procedure there is also a risk of damage to either of the long thoracic nerve (potentially causing a winged scapula deformity), or the thoracodorsal nerve.

Lymph nodes are important structures of the lymphatic system of the thorax and abdomen. They are small, oval or kidney-shaped encapsulated centres of antigen presentation and lymphocyte activation, differentiation and proliferation. They vary in size from 0.1 to 2.5 cm in length. Lymph nodes generate mature, antigen-primed, B and T cells, and filter particles, including microbes, from the lymph by the action of numerous phagocytic macrophages.

A normal young adult body contains up to 450 lymph nodes, of which 60-70 are found in the head and neck, 100 in the thorax and as many as 250 in the abdomen and pelvis. Lymph nodes are particularly numerous in the neck, mediastinum, posterior abdominal wall, abdominal mesenteries, pelvis and proximal regions of the limbs (axillary and inguinal lymph nodes). By far the greatest number lie close to the viscera, especially in the abdominal mesenteries.

Arteries, veins, nerves and lymph nodes of the neck.

Thoracic nodes

The lymph nodes of the thorax may broadly be divided into parietal and visceral regions — the former being situated in the thoracic wall, the latter in relation to the viscera. Those forming the parietal group include the axillary nodes, subscapular nodes, pectoral nodes, parasternal nodes, intercostal nodes, and diaphragmatic nodes. Lymph from the thoracic visceral nodes or deep tissues of the thorax drain ultimately into the diaphragmatic, intercostal or parasternal lymph nodes.

Parasternal lymph nodes

This is also referred to as the internal thoracic nodes. There are 4 or 5 parasternal nodes along each internal thoracic artery, at the anterior ends of the intercostal spaces. They drain afferents from the breast, deeper structures of the supra-umbilical anterior abdominal wall, the superior hepatic surface (through a small group of nodes behind the xiphoid process), and deeper parts of the anterior thoracic wall.

Parasternal lymph nodes (anterior view)

Their efferents usually unite with those from the tracheobronchial and brachiocephalic nodes to form the bronchomediastinal trunk. The later may open, on either side, directly into the jugulo-subclavian junction. Alternatively, it may open into either the great vein near the junction or may join the right subclavian trunk or right lymphatic duct. It can also join the thoracic duct on the left.

Intercostal lymph nodes

The intercostal nodes occupy the intercostal spaces near the heads and necks of the ribs. They receive the deep lymph vessels from the posterolateral aspects of the chest and the breast, some of which are interrupted by small lateral intercostal nodes. Efferents of nodes in the lower 4 – 7 intercostal spaces unite into a trunk that descends to the abdominal confluence of lymph trunks or to the start of the thoracic duct. Efferents of nodes in the left upper spaces end in the thoracic duct, while those of the right upper spaces end in one of the right lymph trunks.

Intercostal lymph nodes (lateral left view)

Diaphragmatic lymph nodes

This group of nodes is located on the thoracic surface of the diaphragm. They are arranged in anterior, lateral (right and left), and posterior groups.

- Anterior group: this group consists of two or three small nodes behind the base of the xiphoid process, draining the convex hepatic surface, and one or two nodes on each side near the junction of the 7th rib and cartilage, which receive anterior lymph vessels from the diaphragm. The anterior group drains to the parasternal nodes.
- Lateral group: the lateral group each contain two or three nodes, and lie close to the point where the phrenic nerves enter the diaphragm. On the right, some nodes lie within the fibrous pericardium anterior to the intra-thoracic end of the inferior vena cava. Their afferents drain the central diaphragm, while those on the right also drain the convex surface of the liver. Their efferents pass to the posterior mediastinal, parasternal and brachiocephalic nodes.
- Posterior group: the posterior group consists of a few nodes that lie on the posterior aspect of the crura and connects with the lateral aortic and posterior mediastinal nodes.

The visceral lymph nodes drain deeper structures of the thorax and muscles attached to the ribs. They empty lymph from these structures into the intercostal, parasternal and the axillary nodes. Some of the most important nodes draining the thoracic viscera include the brachiocephalic node and tracheobronchial nodes which return lymph from the lungs and heart.

Tracheobronchial lymph nodes (lateral left view)

Axillary lymph nodes

Groups

The axillary nodes receive more than 75% of the lymph from the breast. There are 20-40 nodes arranged in five principal groups: pectoral, subscapular, humeral, central, and apical. The groups are arranged in a manner that reflects the pyramidal shape of the axilla. Three groups of axillary nodes are related to the triangular base and one group is located at each corner of the pyramid. The fibrofatty connective tissue of the axilla (axillary fat) also contains many lymph nodes.

- Pectoral group: the pectoral (anterior) nodes consist of three to five nodes that lie along the medial wall of the axilla, around the lateral thoracic vein and the inferior border of the pectoralis minor. The pectoral nodes receive lymph mainly from the anterior thoracic wall, including most of the breast (especially the superolateral {upper outer} quadrant and subareolar plexus).

Pectoral axillary lymph nodes (anterior view)

- Subscapular group: the subscapular (posterior) nodes consist of six or seven nodes that lie along the posterior axillary fold and subscapular blood vessels. These nodes receive lymph from the posterior aspect of the thoracic wall and scapular region.

Subscapular axillary lymph nodes (anterior view)

- Humeral group: the humeral (lateral) nodes consist of four to six nodes that lie along the lateral wall of the axilla, medial and posterior to the axillary vein. These nodes receive nearly all the lymph from the upper limb, except that carried by the lymphatic vessels accompanying the cephalic vein. The latter nodes primarily drain directly to the apical and infraclavicular nodes.
- Central group: the central nodes are three or four large nodes situated deep to the pectoralis minor near the base of the axilla, in association with the second part of the axillary artery.

- Apical group: the apical nodes are located at the apex of the axilla along the medial side of the axillary vein and the first part of the axillary artery. They receive lymph from all other groups of the axillary lymph nodes as well as from lymphatics accompanying the proximal cephalic vein.

Surgically, the nodes are described in relation to pectoralis minor. Those lying below pectoralis minor are the low nodes (level 1), those behind the muscle are the middle group (level 2), while the nodes between the upper border of the clavicle are the upper or apical nodes (level 3). There may be one or two other nodes between the pectoralis minor and major; this interpectoral group of nodes are also known as Rotter's nodes.

Did you know that interactive anatomy is one of the best ways to study? Find out exactly what it is and how you can use it to study the lymph nodes of the thorax and abdomen.

Drainage

Efferent vessels directly from the breast pass around the anterior axillary border through the axillary fascia to the pectoral lymph nodes. Some pass directly to the subscapular nodes. A few vessels pass from the superior part of the breast to the apical axillary nodes, sometimes interrupted by the infraclavicular nodes or by small, inconstant, interpectoral nodes. Most of the remainder drains to the parasternal nodes from the medial and lateral part of the breast. They accompany perforating branches of the internal thoracic artery. Lymphatic vessels occasionally follow lateral cutaneous branches of the posterior intercostal arteries to the intercostal nodes.

Efferent lymphatic vessels from the pectoral, subscapular and humeral groups pass to the central nodes. In turn, efferent vessels from the central nodes pass to the apical ones. Subsequently, vessels from the apical group of nodes traverse the cervicoaxillary canal. These efferent vessels ultimately unite to form the subclavian lymphatic trunk, although some vessels may drain en route through the clavicular (infraclavicular and supraclavicular) nodes. Once formed, the subclavian trunk may be joined by the jugular and bronchomediastinal trunks on the right side to form the right lymphatic duct, or it may enter the right venous angle independently. On the left side, the subclavian trunk most commonly joins the thoracic duct.

Abdominal lymph nodes

Superficial group

The abdominal lymphatic nodes are also arranged into superficial and deep groups. The superficial group primarily drains the abdominal wall. The deep group returns lymph from the abdominal viscera and are usually associated and named according to such viscera.

Superficial lymphatic vessels accompany the subcutaneous blood vessels. Vessels from the lumbar and gluteal regions run with the superficial circumflex iliac vessels. Those from the infra-umbilical skin run with the superficial epigastric vessels. Both drain into the superficial inguinal lymph nodes. The supra-umbilical region is drained by vessels running obliquely up to the pectoral and subscapular axillary nodes, and there is some drainage to the parasternal nodes.

Deep group

The deep lymphatic vessels of the abdomen accompany the deep arteries. The vessels from the posterior portion of the abdominal wall pass with the lumbar arteries to drain into the lateral aortic and retro-aortic nodes. Vessels from the upper anterior abdominal wall run with the superior epigastric vessels to the parasternal nodes. Vessels of the lower abdominal wall drain into the circumflex iliac, inferior epigastric and external iliac nodes. Furthermore, the lymphatic drainage of the abdominal viscera occurs almost exclusively through the cisterna chyli and the thoracic duct.

Some lymphatic drainage may occur across the diaphragm from the bare area of the liver and the uppermost retro-peritoneal tissues, but this is probably of little clinical consequence other than during obstruction of the thoracic duct. The lymph nodes of the retro-peritoneal tissues lie around the abdominal aorta and form pre-aortic, lateral aortic and the retro-aortic groups. Collectively, they are referred to as the para-aortic lymph nodes and clinically it is difficult to distinguish between them, either at operation or on cross sectional imaging.

Preaortic group of lymph nodes

The pre-aortic groups tend to lie around the origins of the anterior (visceral) arteries and receive lymph from the gastrointestinal tract and its accessory structures (liver, spleen, pancreas) from the abdominal oesophagus to the level of the anus. They give rise to lymphatic vessels, which drain upwards to form the intestinal trunks that enter the abdominal confluence of lymph trunks. They are divisible into coeliac, superior mesenteric and inferior mesenteric groups, being near the origins of these arteries.

Celiac lymph nodes

The coeliac nodes lie anterior to the abdominal aorta around the origin of the coeliac artery. They are a terminal group and receive lymph draining from the regional lymph nodes around the branches of the coeliac artery (left gastric, hepatic and pancreaticosplenic nodes) and from the lower pre-aortic groups (the superior mesenteric and inferior mesenteric). The coeliac nodes give rise to the right and left intestinal lymph trunks.

- Gastric Lymph Nodes: There are numerous gastric lymph node groups. They drain the stomach, upper duodenum, abdominal oesophagus and the greater omentum into the coeliac group.
- Hepatic Lymph Nodes: The hepatic nodes extend in the lesser omentum along the hepatic arteries and bile duct. They vary in number and site, but almost always occur at the junction of the cystic and common hepatic ducts (the cystic node), alongside the upper common bile duct and in the anterior border of the epiploic foramen. Hepatic nodes drain the majority of the liver, gallbladder and bile ducts, but also receive drainage from some parts of the stomach, duodenum and pancreas. They drain into the coeliac nodes and thence to the intestinal trunks.
- Pancreaticosplenic Lymph Nodes: The pancreaticosplenic nodes drain the spleen, pancreas and parts of the stomach into the coeliac nodes.

Superior mesenteric and inferior mesenteric lymph nodes

These nodes lie anterior to the aorta near the origin of their respective arteries. The superior and inferior mesenteric nodes are preterminal groups of the alimentary canal from the duodenojejunal flexure to the upper anal canal. They collect lymph from the outlying groups, including the mesenteric, ileocolic, colonic and pararectal nodes and drain into the coeliac nodes.

Lateral aortic group of lymph nodes

The lateral aortic nodes lie on either side of the abdominal aorta anterior to the medial margins of psoas major, diaphragmatic crura and sympathetic trunks. On the right, some nodes lie lateral and anterior to the inferior vena cava near the end of the right renal vein. Nodes rarely lie between the aorta and inferior vena cava where they are closely related.

The lateral aortic nodes drain the viscera and other structures supplied by the lateral and dorsal aortic branches. The upper lateral groups receive the lymph drainage directly from the suprarenal glands, kidneys, ureters, gonads, uterine tubes and upper uterus. They also receive lymph directly from the deeper tissues of the posterior abdominal wall. The lateral aortic group drains into the two lumbar lymph trunks, one on each side, which terminate in the confluence of lymph trunks. A few vessels may pass to the pre-aotic and retro-aortic nodes, while others cross the midline to flow into the contralateral nodes, forming a loose plexus.

Retroaortic group of lymph nodes

This is the smallest of all the para-aortic lymph nodes and has no particular areas of drainage, although it may receive some lymph directly from the paraspinal posterior abdominal wall. Retro-aortic nodes are effectively peripheral nodes of the lateral aortic groups and provide interconnections between surrounding groups.

The duct connects with lymph nodes over time. The thoracic duct wall and lymph nodes are not fully formed at birth. Disturbances in formation result in various structural variations. The first lymph sacs that develop are the paired jugular lymph sacs located at the border between the internal jugular and subclavian veins. A single retroperitoneal lymph sac also develops at the root of the mesentery, with the cisterna chyli also developing behind the retroperitoneal sac. The lymph vessels grow out from the lymph sacs, along the major veins of the head, neck, and arms. Longitudinal lymph vessels that ultimately form the thoracic duct gradually connect the cisterna chyli and the jugular lymph sacs.

Recommended video: Introduction to the lymphatic system

Overview of the anatomy, function and main structures of the lymphatic system.

Anatomy

Characteristics, course and location

The thoracic duct (also known as van Hoorne's canal) is the largest lymphatic vessel of the lymphatic system of the body. It is approximately 40 cm in length in adults, and approximately 5 mm in width at its abdominal origin.

The thoracic duct extends from the twelfth thoracic vertebra to the root of the neck. The thoracic duct is formed from the abdominal confluence of the left and right lumbar lymph trunks, as well as the left and right intestinal lymph trunks between T12 and L2. If the confluence of lymph trunks is saccular, it is referred to as cisterna chyli. The action of breathing helps chyle flow up the thoracic duct. The duct also contains smooth muscle within its walls, as well as interval valves (much like large veins), which prevent backflow of lymph.

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The thoracic duct crosses the diaphragm at the aortic hiatus at the level of the twelfth thoracic vertebra. The aortic opening is located in the posterior mediastinum, and is formed either side by the left and right crura of the diaphragm. The duct continues to ascend, between the thoracic aorta on the left, and the azygous vein on the right, and crosses over to the left side between the fourth and sixth thoracic vertebrae. From this point, the duct ascends behind the aortic arch and the left subclavian artery. The duct will also lie anterior to the anterior scalene muscle and left phrenic nerve before its final destination. The fluid drains at the level of the venous angle (Pirogoff's angle) between the left subclavian vein and the left internal jugular vein, where it reenters the systemic venous circulation. It is often dilated or enlarged at its terminal segment. There is a bicuspid valve located at the junction of the thoracic duct with the draining vein (e.g. left internal jugular vein or left subclavian vein depending on anatomical variations), which prevents backflow of venous blood into the lymphatic system.

Left lumbar lymph trunk (Truncus lymphaticus lumbalis sinister)

Within the thoracic duct, you find a milky white fluid containing both emulsified fats, and the lymph fluid found in the rest of the lymphatic system. This fluid is called chyle. The thoracic duct drains the lymph from 75% of the body, aside from the right upper right limb, right breast, right lung and right side of the head and neck (which are drained by the right lymphatic duct).

Neurovasculature of the neck and superior thorax: Notice the location of the thoracic duct. During a cadaveric dissection, the thoracic duct resembles a small vein without blood in it. It is also thin and easily torn.

Tributaries

The thoracic duct drains lymph from the right and left descending thoracic lymph trunks, originating from the lower 6 intercostal spaces (6 to 11). The duct also receives lymph from intercostal spaces 1 to 5 via the upper intercostal lymph trunks. Additional tributaries include the:

- mediastinal lymph trunks
- left jugular trunk,
- left bronchomediastinal trunk
- left subclavian trunk

Variations

The thoracic duct occasionally divides into a right and left duct, with the left entering the venous system as normal, and the right draining into the right subclavian vein. The duct may also drain into the left internal jugular vein, or into the left brachiocephalic vein.

Glossary

- **abdomen**: Latin abdomen = the belly, the part of the trunk between thorax and the perineum, adjective - abdominal.
- **abducent**: Latin ab = from, and ducens = led, hence, moving from, or effecting separation.
- **abduction**: Latin ab = from, and ductum = led, hence, movement from; verb - abduct.
- **aberrant**: Latin ab = from, and errare = to wander, hence, deviating from normal.
- **accessory**: adjective, Latin accessum = added, hence, supplementary.
- **accommodation**: Latin ad = to, and modus = measure, hence, adaptation of the optical power (focussing) of the eye for shorter distances.
- **acetabulum**: Latin acetum = vinegar (cf. acetic), and abulum = small receptacle, hence, a vinegar cup, hence, the socket for the head of the femur, adjective - acetabular.
- **acoustic**: adjective, Greek akoustikos, related to hearing.
- **acromion**: Greek akros = summit (cf. Acropolis) and omos = shoulder, hence, the tip of the shoulder.
- **adduction**: Latin ad = to, and ductum = led, hence, movement towards; verb - adduct.
- **adenoid**: Greek aden = a gland, eidos = shape or form.
- **adhesion**: Latin ad = to, and haesus = stuck, hence, stuck to, e.g., interthalamic adhesion - variable and functionally insignificant.
- **adipose**: Latin adeps = fat, hence fatty
- **aditus**: Latin ad = to, towards, iter = a way, hence an opening or entrance.
- **adrenal**: Latin ad = towards, at, ren = kidney, hence situated near the kidney (see suprarenal)

- **adrenergic**: adjective, Latin ad = at, ren = kidney, and Greek ergon = work, hence, stimuli which cause the adrenal (suprarenal) gland to produce adrenaline. Used to specify neurons or pathways which use adrenaline as a transmitter.
- **afferent**: adjective, Latin ad = to, and ferent = carrying (cf. ferry), hence, carrying to, e.g., axons carrying information from retina to lateral geniculate nucleus are afferents to that nucleus.
- **agger nasi**: Latin = eminence of the nose.
- **agonist**: Greek agonistes = rival, hence, a muscle in apparent contest with another. Used for a prime mover.
- **ala**: Latin wing, hence a wing-like process; plural - alae.
- **alaeque**: Latin ala = wing (ala of nose), suffix -que = and, hence levator labii superioris alaeque nasi muscles = lifter of the upper lip and ala of nose.
- **alba**: Latin albus = white
- **albicans**: Latin = becoming white; albus = white
- **albuginea**: Latin albus = white, Greek gen = form, hence, like boiled white of an egg.
- **alimentary**: adjective, Latin alimentum = food, e.g., alimentary canal.
- **allantois**: Greek allantos = sausage, eidos = like, form.
- **allocortex**: Greek allos = other (than usual), and Latin cortex = bark, hence non-laminated external grey matter. It refers to paleo- or archi-cortex, as distinct from neocortex.
- **alveolus**: Latin a basin, hence any small hollow. Plural - alveoli, adjective - alveolar.
- **alveus**: Latin = tray. The allusion is unclear. The alveus is a layer of fibres on the free surface of the hippocampus.
- **ambiguus**: adjective, Latin = doubtful (nucleus ambiguus).
- **ampulla**: Latin = a two-handed flask, a local dilatation of a tube.
- **amygdaloid**: adjective, Greek amygdala = almond, and eidos = shape or form, hence, amygdaloid body is an almond-shaped mass.
- **amylacea**: Greek amylon = starch, hence, starchy.
- **anaesthesia**: Greek an = negative, and aisthesis = sensation, hence, loss of sensation; adjective - anaesthetic.
- **analgesia**: Greek an = negative, and algesis = pain, hence insensibility to pain; adjective - analgesic.
- **analogous**: Greek ana = up, apart, towards, and logos = word. A part with similar function through different morphology e.g., fish gills and mammalian lungs (c.f. homologous).
- **anastomosis**: Greek ana = of each, and stoma = mouth, hence the end-to-end continuity of 2 vessels; adjective - anastomotic.
- **anatomy**: Greek ana = up, and tome = a cutting, hence cutting up of a body (c.f. dissection).
- **anconeus**: Greek ancon = elbow, hence the muscle attached to the (lateral surface of the) olecranon.
- **aneurysm**: Greek angeion = blood vessel, and eurys = wide, hence a pathological dilatation of a blood vessel.
- **angiography**: Greek angeion (v.s.) and graphe = a record, hence a picture of a blood vessel which has been injected with a dye or radiopaque material.
- **anhidrosis**: (anhydrosis, anidrosis) Greek an = negative, and hidros = sweat, hence absence of sweating, typical of skin deprived of its sympathetic innervation.
- **ankle**: the region between the leg and the foot.
- **annulus**: diminutive of Latin anus = ring, hence little ring.
- **ansa**: Latin a handle or loop. Applicable to nerves.
- **anserinus**: Latin anser = a goose, hence like a goose, plural - anserina.
- **antagonist**: Greek anti = against, and agonistes = rival, hence a muscle which may oppose an agonist.

- **anteflexion**: Latin ante = before, and flexere = to bend, hence anterior angulation between the body and cervix of the uterus.
- **anterior**: comparative of Latin ante = before, in front.
- **anteversion**: Latin ante = before, and versum = turned, hence, the anterior angulation between cervix uteri and the vagina.
- **antidromic**: adjective, Greek a = negative, and dromos = current, hence conducting in the opposite direction to the usual.
- **antrum**: Greek antron - cave, hence a space in a bone or organ.
- **anulus**: diminutive of Latin anus = ring, hence little ring.
- **anus**: Latin = ring, adjective - anal.
- **aorta**: Latin aorta, from Greek aorte = literally 'what is hung up,' from aeirein 'to lift, heave, raise,' of uncertain origin. Originally applied by Aristotle to the great artery of the heart, earlier by Hippocrates to the bronchial tubes.
- **aponeurosis**: Greek apo = from, and neuron = tendon (later applied to nerve cell and its fibres), used for sheet-like tendons. Adjective - aponeurotic.
- **apophysis**: Greek apo = from, and physis = growth, hence, a bony process - reserved for the articular process of a vertebra; adjective - apophysial.
- **appendage**: Latin appendere = to hang on, supplement.
- **appendix**: Latin appendere = to hang on, supplement.
- **apposition**: Latin appositus = placed at, hence, in contact, in juxtaposition.
- **aqueduct**: Latin aqua = water, and ductus = drawn or led off, hence a channel for conducting fluid, e.g. the cerebral aqueduct of the midbrain, which transmits fluid from the 3rd to the 4th ventricle.
- **arachnoid**: adjective, Greek arachne = spider, and eidos = shape or form, hence like a spiders web. This middle layer of the three meninges is spread web-like over the brain when the dura has been removed.
- **arbor vitae**: Latin arbor = tree, and vita = life, hence, resembling the tree of life. This colourful term is used to describe the pattern of cerebellar folia seen in a median section.
- **archaeocerebellum**: Greek archi = first, hence the oldest part of the cerebellum, which is the flocculonodular lobe.
- **archaeopallium**: Greek archi = first, and pallium = cloak, hence the cortex which developed first in vertebrates. Often synonymous with hippocampal formation.
- **archicerebellum**: Greek archi = first, hence the oldest part of the cerebellum, which is the flocculonodular lobe.
- **archipallium**: Greek archi = first, and pallium = cloak, hence the cortex which developed first in vertebrates. Often synonymous with hippocampal formation.
- **archistriatum**: Greek archi = first, and Latin striatum = streaked or fluted.
- **arcuate**: Latin arcuatum = curved or arched.
- **arcus**: Latin an arch, Latin arcuatum = curved or arched.
- **area**: a part of a surface.
- **areola**: Latin small, open space.
- **arm**: the upper limb, between shoulder and elbow.
- **arrector**: Latin adrectus = raised, hence, arrector pili = a hair-raising muscle.
- **artery**: Latin arteria (which originally meant air- or wind-pipe, and later a blood vessel carrying blood away from the heart).
- **articulation**: Latin artus = joint, hence, articulate - to form a joint.
- **arytenoid**: Greek arytaina = pitcher, and eidos = shape or form, hence the arytenoid cartilage because it curves like a spout.
- **aspect**: a view of more than one surface.
- **aspera**: Latin rough.

- **asterion**: Greek asterios = starry.
- **astrocyte**: Greek astron = star, and kytos = cell, hence a star-shaped (neuroglial) cell.
- **ataxia,**: Greek a = negative, and taxis = order, hence inability to co-ordinate the voluntary muscles.
- **atlas**: Greek atlao = I sustain. Atlas was a mythical god who sustained the globe on his shoulders. The 1st vertebra sustains the skull, and its upper surface bears 2 concavities which suggest Atlas' palms, not shoulders.
- **atresia**: Greek a = negative, and tresis = a hole, hence an absence or closure of a body orifice or tubular organ
- **atrium**: Latin = entrance hall, adjective - atrial.
- **atrophy**: Greek a = negative, and trophe = food, hence wasting from starvation.
- **auditory**: Latin audire = to hear, hence, pertaining to the ear.
- **auricle**: Latin auricula = a little ear.
- **auscultate**: Latin ausculto = to listen to, hence, auscultation, the act of listening to a bodily activity.
- **autonomic**: adjective, Greek auto = self, and nomos = law, hence self-regulating.
- **axilla**: Latin armpit.
- **axis**: Latin axis = the central line of a body or part thereof, especially the imaginary line around which rotation takes place.
- **axon**: Latin axis = axis, hence the main process of a neuron conducting impulses away from the cell body.
- **azygos**: adjective, Greek a = negative, and zygos = paired, hence, unpaired.
- **basilar**: adjective, Latin basis = base.
- **basilic**: adjective, Arabic al-basilik = inner; the basilic vein is on the inner side of the forearm and arm. Previously thought to be of Greek origin, basilikos = royal (king-sized).
- **biceps**: Latin bis = double, and caput = head, hence 2-headed, adjective - bicipital.
- **bifid**: adjective, Latin bis = double, and findo = to split.
- **bifurcate**: Latin bis = double, and furco = fork, hence to divide into two.
- **bilateral**: Latin bi = two, lateral = side, hence, pertaining to two (both) sides.
- **bipennate**: adjective, Latin bis = double, and pinna = feather, hence converging from 2 sides.
- **body**: the main part.
- **border**: see margin.
- **brachiocephalic**: Latin brachium = arm, and Greek kephale = head, hence a blood vessel related to the upper limb and head.
- **brachium**: Latin = arm, adjective - brachial.
- **branchia**: Greek = gills, adjective - branchial.
- **bregma**: from a Greek word implying moist, referring to the site of the anterior fontanelle (q.v.), a little fountain, the site of junction of the coronal and sagittal sutures, where the brain can be felt pulsating in infancy.
- **brevis**: Latin = short - cf. brief.
- **bronchiole**: diminutive of bronchus, hence a small bronchus (bronchi have cartilage in their walls, bronchioles have no cartilage).
- **bronchus**: derivation unhelpful - a branch of the trachea, adjective - bronchial.
- **buccal**: adjective, Latin bucca = cheek.
- **buccinator**: Latin = trumpeter - hence the muscle which blows air out from the cheek under pressure.
- **bulbus**: Latin = bulb or onion.
- **bulla**: Latin = bubble.
- **bursa**: Greek = a purse, hence a flattened sac containing a film of fluid.
- **caecum**: Latin = blind.

- **calcaneus**: Latin calx = heel, hence the bone of the heel.
- **calcar**: Latin = a spur.
- **calcar avis**: Latin the spur of a bird, hence a spur-like elevation.
- **calcarine**: Latin calcar = spur, hence spur-shaped.
- **calf**: the soft tissue swelling at the back of the leg.
- **calix**: Latin = a wine-cup (plural - calices).
- **callosum**: Latin callum = hard.
- **calvaria**: Latin calva = bald head, hence the part of the skull containing the brain - i.e. cranium minus the facial skeleton.
- **calyx**: Latin = a wine-cup (plural - calyces).
- **canal**: Latin canalis = a water-pipe or canal.
- **canaliculus**: diminutive of canal.
- **cancellous**: adjective, Latin cancelli = grating or lattice.
- **canine**: adjective, Latin canis = dog.
- **canthus**: Greek kanthos - used at first for rim of eye, then angle between ends of rims.
- **capillary**: Latin capillaris = hair-like, hence a very thin blood vessel.
- **capitate**: adjective, having a caput from Latin capitis = of a head (q.v.).
- **capitulum**: diminutive of caput, Latin = head.
- **capsule**: Latin capsa = box, hence an enclosing sheet.
- **caput**: Latin = head. Capitis - of a head, adjective - capitate = having a head (cf. decapitate).
- **caput medusae**: Latin caput = head, Medusa = Greek mythical female with snake like hair.
- **cardiac**: adjective, Greek kardia = heart.
- **cardinal**: Latin cardinalis = principal, of primary importance.
- **carina**: Latin = a keel.
- **carneae**: Latin carnea = fleshy.
- **carotid**: Greek karoo, to put to sleep (heavy sleep), because compression of the common or internal carotid artery may cause coma.
- **carpus**: Greek = wrist, adjective - carpal.
- **cartilage**: Latin = gristle; adjective - cartilaginous.
- **caruncle**: diminutive of Latin caro = flesh, hence, a small fleshy elevation.
- **cauda**: Latin = tail, adjective - caudate - having a tail.
- **cauda equina**: Latin = a horse's tail.
- **caudal**: Latin cauda = tail, hence toward the tail, inferior (in human anatomy).
- **caudate**: Latin cauda = tail, hence having a tail.
- **cava**: Latin cavum = cave, hollow.
- **cavernous**: Latin containing caverns or cave-like spaces.
- **cavity**: Latin cavitas = a hollow.
- **cavum**: Latin = cave.
- **cecum**: Latin = blind.
- **celiac**: adjective, Greek koilia = belly.
- **celom**: Greek koilos = a hollow
- **central**: adjective, Latin centrum = centre.
- **centrum**: Latin = centre.
- **cephalic**: adjective, Greek kephale = head. The term cephalic, as applied to the cephalic vein, was a mistranslation of Arabic and interpreted to be from the Greek term kephale = head. Arabic al-kifal = outer; the cephalic vein is on outer side of the forearm and arm (compare to basilic).
- **cerebellum**: diminutive of Latin cerebrum = brain.
- **cerebrum**: Latin = brain, adjective - cerebral.
- **cerumen**: Latin cera = wax.

- **cervical**: adjective, Latin cervix = neck, hence, pertaining to the neck.
- **cervix**: Latin = neck, adjective - cervical.
- **chiasma**: Greek kiasma = cross. (The Greek letter chi = c).
- **choana**: Greek = funnel, plural - choanae.
- **chondral**: adjective, Greek chondros = cartilage.
- **chorda**: Latin = cord.
- **choroid**: adjective, Greek chorion = skin and eidos = shape or form, hence, like a membrane.
- **chyle**: Greek = juice.
- **chyli**: Greek = juice.
- **ciliary**: adjective, Latin cilia = eyelashes.
- **cilium**: Latin = eyelid, hence, an eyelash; adjective - ciliary, or ciliated.
- **cinereum**: Latin cineris = of ashes.
- **cingulum**: Latin girdle or belt, adjective - cingulate.
- **circumflex**: verb and adjective, Latin circum = around, and flexere = to bend, hence, bend or bent around.
- **cisterna**: Latin = a cistern.
- **claustrum**: Latin clausum = closed, hence a barrier.
- **clavicle**: diminutive of Latin clavis = key - old Roman key was S-shaped.
- **cleido**: Greek, cleis = key, a combining form denoting relationship to the clavicle.
- **clinoid**: adjective, Greek kline = bed, eidos = shape or form, hence, like a bed-post.
- **clivus**: Latin = slope (cf. declivity).
- **cloaca**: Latin = a drain, sewer; common opening for intestinal, urinary and genital tracts in lower vertebrates, it is a transitory structure in human embryological development.
- **coccyx**: Greek kokkyx = cuckoo, whose bill the coccyx resembles.
- **cochlea**: Latin = snail, hence the spiral cochlea, adjective - cochlear.
- **coeliac**: adjective, Greek koilia = belly.
- **coeruleus**: adjective, Latin = blue, hence, locus coeruleus, a group of nerve cells in the rostral pons coloured blue or black by melanin.
- **coli**: Latin = of the colon.
- **collateral**: adjective, Latin con = together, and latus = side, hence, alongside.
- **colli**: genetive (possessive case) of collum, Latin = neck
- **colliculus**: diminutive of Latin collis = hill.
- **collum**: Latin = neck (cf. collar).
- **colon**: Greek kolon = large intestine.
- **columna**: Latin = column, or pillar.
- **comitans**: adjective, Latin = accompanying.
- **commissure**: Latin con = together, and missum = sent, hence fibres which cross between symmetrical parts.
- **communicans**: adjective, Latin = communicating.
- **concha**: Latin = shell.
- **condyle**: Greek kondylos = knuckle.
- **confluens**: Latin con = together, and fluens = flowing, hence the meeting of more than one stream.
- **conjunctiva**: Latin con = with, and junctus = joined (cf. junction), hence the continuous bulbar and palpebral lining membrane.
- **conoid**: Greek konoeides = resembling a cone, cone shape
- **constrictor**: Latin con = together, and strictum = drawn tight, hence, producing narrowing.
- **contour**: Greek tornos = lathe, hence a line which turns - an outline.
- **contralateral**: Latin contra = against, latus = side, hence, the opposite side (as opposed to ipsilateral)

- **conus**: Latin = cone, conus medullaris - the lower end of the spinal cord.
- **coracoid**: adjective, Greek korax = a crow, and eidos = shape or form, hence, like a crow's beak.
- **cornea**: Latin cornu = horn, hence, the dense tissue forming the front of the eyeball.
- **corniculate**: Latin = shaped like a small horn.
- **cornu**: Latin = horn.
- **corona**: Latin = crown. adjective - coronary or coronal; hence a coronal plane is parallel to the main arch of a crown which passes from ear to ear (cf. coronal suture).
- **coronal**: Latin corona = crown; hence a coronal plane is parallel to the main arch of a crown which passes from ear to ear (cf. coronal suture).
- **coronary**: adjective, Latin = crown, hence, encircling like a crown.
- **coronoid**: adjective, Greek korone = a crown, eidos = shape or form, hence, shaped like a crown.
- **corpus**: Latin = body, plural - corpora.
- **corpuscle**: Latin = a little body.
- **corrugator**: Latin con = together, and ruga = wrinkle, hence a muscle that produces wrinkles.
- **cortex**: Latin = bark, adjective, cortical.
- **costa**: Latin = rib. adjective - costal.
- **coxa**: Latin = hip, hence os coxae = the hip bone.
- **cranium**: Greek kranion = skull. (In anthropology = skull minus mandible) adjective - cranial.
- **cremaster**: Greek = suspender, hence the muscle which suspends the testis.
- **cribriform**: adjective, Latin cribrum = sieve, hence, sieve-like.
- **cricoid**: adjective, Greek krikos = ring, and eidos = shape or form, hence, ring-like, i.e. circular.
- **crista**: Latin = crest, crista galli = the (median) crest of a cock.
- **cruciate**: adjective, Latin crux = cross, hence, crossed like the letter X.
- **crus**: Latin = leg, plural - crura.
- **cubital**: adjective, Latin cubitus = elbow.
- **cuboid**: adjective, Greek kuboides = cube-shaped.
- **culmen**: Latin = summit (cf. culminate).
- **cuneate**: adjective, Latin = a wedge.
- **cuneiform**: adjective, Latin cuneus = wedge, hence wedge-shaped.
- **cuneus**: Latin = a wedge, adjective - cuneate.
- **cupola**: Latin = little dome.
- **cupula**: Latin = little dome.
- **cusp**: Latin cuspis = a pointed elevation.
- **cutaneous**: adjective, Latin cutis = skin.
- **cyst**: Greek kystis = bladder, adjective - cystic.
- **dartos**: Greek = flayed or skinned.
- **declive**: Latin declivitas = slope (cf. clivus).
- **decussation**: Latin decussatus = crossed like the letter X.
- **deep**: further from the surface.
- **deferens**: adjective, Latin = carrying down.
- **deglutition**: Latin deglutire = to swallow, hence the act of swallowing.
- **dehiscence**: Latin de = away, hiscere = to gape, hence, a separation, a splitting away.
- **deltoid**: adjective, Greek delta (D). The capital has a triangular shape (cf. the delta of the Nile river).
- **dendrite**: or dendron, Greek = a tree, hence like the branches of a tree.
- **dens**: Latin = tooth (cf. dentist), adjective - dental.
- **dentate**: Latin dens = tooth, hence, having a toothed margin.
- **denticulate**: Latin dens = tooth, hence, having small tooth-like projections.

- **dentine**: from Latin dens = tooth; the substance of the tooth surrounding the pulp.
- **depress**: Latin de = prefix implying descent, and pressum = pressed, hence to press down, and depression = downward movement or a concavity on a surface.
- **dermatome**: Greek derma = skin, tome = a cutting or division, hence a segment of skin supplied by a single spinal ganglion.
- **dermis**: Greek = skin, adjective - dermal.
- **detrusor**: Latin detrusio = thrust away.
- **diaphragm**: Greek dia = across, and phragma = wall, hence, a partition, adjective - diaphragmatic (see also phrenic).
- **diaphysis**: Greek dia = apart, and physis = growth, hence, the body of a long bone between the growing regions near the ends.
- **diastole**: Greek dia = apart, and stellein = sending, hence sending the walls of the heart apart, i.e. relaxation or dilatation. Adjective - diastolic.
- **diencephalon**: Greek dia = between, and enkephalos = brain, hence in general the structures surrounding the 3rd ventricle. adjective - diencephalic.
- **digastric**: adjective, Greek dia = double, and gaster = belly, hence, 2-bellied.
- **digit**: Latin digitus = a finger or toe, usually excepting the pollex (thumb) or hallux (big toe), adjective - digital.
- **diplopia**: Greek diploos = double, and opsis = vision, hence double vision.
- **diplo�**: Greek = fold, hence the cancellous bone between the inner and outer tables of the skull, adjective - diploic.
- **discus**: Latin = disc.
- **dissection**: Latin disssecare = to cut up, from dis = apart, sectum = cut (c.f. anatomy).
- **distal**: adjective, Latin di = apart, and stans = standing, hence, standing apart, implying farther from a given point, usually the root of a limb.
- **diverticulum**: Latin = by-road, hence a blind tubular process or sac.
- **dorsal**: adjective, Latin dorsum = back.
- **dorsum**: Latin = back.
- **ductus**: Latin = duct.
- **duodenum**: Latin duodenarius = twelve, because it is 12 fingerbreadths long.
- **dura**: adjective, Latin = hard (cf. durable); dura mater, the tough covering membrane of the central nervous system.
- **dysphagia**: Greek dys = difficult, and phagein = to eat, hence, difficulty in swallowing.
- **ectoderm**: Greek ektos = outside, and derm = skin, hence, the outermost germ layer of the embryo.
- **ectopic**: Greek ek = out, and topos = place, hence out of place.
- **edge**: border or margin of a surface.
- **efferent**: adjective, Latin ex = out, and ferens = carrying, hence, conducting from.
- **ejaculatory**: Latin ex = out, and jacere = to throw, hence throwing out.
- **elbow**: the junction between arm and forearm.
- **elevate**: Latin elevatus = raised up, hence, to raise up, and elevation = a raised part.
- **emboliformis**: adjective, Greek embolus = wedge or blocking matter.
- **embryo**: Greek en = within, and bryein = to swell or grow, hence the early stage of intrauterine development.
- **eminence**: Latin eminens = projecting, hence, a projection (usually smooth).
- **emissary**: adjective, Latin e = out, and emissum = sent out; emissary vein, one connecting intra- with extra-cranial venous channels.
- **encephalon**: Greek en = within, and kephalos = head, hence, the brain.
- **endocardium**: Greek endo = within, and kardia = heart, hence, the endothelial lining of the chambers of the heart.

- **endocranium**: Greek endo = within, and kranion = skull, hence, the outer endostial layer of the dura mater.
- **endocrine**: Greek endo = within, and krinein = to separate, hence, the organs that ductlessly secrete their products into the bloodstream.
- **endoderm**: Greek endo = within, and derm = skin, hence, the germ layer of the embryo that gives rise to epithelium of the gastrointestinal and respiratory tracts.
- **endolymph**: Greek endo = within, and Latin lympha = clear water, hence the fluid within the membranous labyrinth of the internal ear.
- **endometrium**: Greek endo = within, and metra = uterus, hence the mucosal lining of the uterine cavity.
- **endothelium**: Greek endo = within, and thele = the nipple; the squamous epithelium lining the heart and blood vessels.
- **ependyma**: Greek = an upper garment. It may refer to a vest or singlet, i.e. an under-garment, hence, the lining membrane of the ventricles of the brain and central canal of the spinal cord.
- **epicanthus**: Greek epi = upon, and kanthos = corner, hence, the fold of skin over the inner angle of the upper eyelid, a normal characteristic in certain races, and a congenital anomaly in others.
- **epicardium**: Greek epi = upon, and kardia = heart, hence, the visceral layer of serous pericardium which covers the heart.
- **epicondyle**: Greek epi = upon, and kondylos = knuckle, hence a prominence on a condyle of the humerus or femur.
- **epicranial**: adjective, Greek epi = upon, and kranion = skull, hence, the epicranial aponeurosis (galea) connecting frontalis to occipitalis muscles.
- **epidermis**: Greek epi = upon, and derm = skin, hence, the most external layer of the skin.
- **epididymis**: Greek epi = upon, and didymos = testis, hence, the organ perched posterosuperior to the testis.
- **epidural**: adjective, Greek epi = upon, Latin dura = tough, hence, external to dura mater.
- **epigastrium**: Greek epi = upon, and gaster = belly, hence, the upper median zone of the abdomen.
- **epiglottis**: Greek epi = upon, and glottis = larynx, hence the uppermost part of the larynx.
- **epimysium**: Greek epi = upon, and mys = muscle, hence the connective tissue surrounding an entire muscle.
- **epiphysis**: Greek epi = upon, and physis = growth, hence, the end of a long bone beyond the cartilaginous growth disc, adjective - epiphysial.
- **epiploic**: adjective, Greek epiploon = a net, which the greater omentum resembles with fat entangled in it.
- **epithelium**: Greek epi = upon, and thele = the nipple; the cell layer lining the internal and external surfaces of the body.
- **erector**: Latin erectus = straight or upright.
- **erigentes**: plural, Latin erigere = to erect.
- **ethmoid**: adjective, Greek ethmos = sieve, and eidos = shape or form, hence, like a sieve; an unpaired skull bone.
- **eversion**: Latin e = out, and versum = turned, hence turned outwards.
- **exophthalmos**: Greek exo = out, and ophthalmos = eye, hence, prominent eyeball.
- **extend**: Latin extendo = extend or stretch out, hence, extension = extended or straightened; the position opposite to the flexed or bent.
- **external**: adjective, Latin externus = outward, hence, further from the inside.
- **extraperitoneal**: adjective, Latin extra = outside, Greek peri = around and teinein = stretched, hence outside the serous membrane stretched around the inside of the abdominal wall and around the viscera.

- **extrapyramidal**: Latin extra = outside, and pyramidal (q.v.), hence descending nerve tracts that do not traverse the pyramids of the medulla.
- **extrinsic**: Latin extrinsecus = from without, hence (usually) a muscle (usually) originating outside the part on which it acts.
- **fabella**: diminutive of Latin faba = a bean, hence, a sesamoid bone found in the lateral head of gastrocnemius.
- **facet**: Latin facies = face, hence a small smooth bony surface, either coated with articular cartilage or the site of a tendinous attachment (cf. a facet on a diamond).
- **facilitate**: Latin facilis = easy, hence, to make easy.
- **falciform**: adjective, Latin falx = a sickle, and forma = form, hence, shaped like a sickle.
- **falx**: Latin = sickle, hence, the sickle-shaped falx cerebri and falx cerebelli, adjective - falciform.
- **fascia**: Latin = band or bandage, hence the fibrous wrapping of muscles - deep fascia, or the subcutaneous layer of fatty connective tissue - superficial fascia, adjective, fascial.
- **fasciculus**: diminutive of Latin fascis = bundle, hence, a bundle of nerve or muscle fibres.
- **fastigius**: Latin fastigium = summit, hence the peak of the 4th ventricle, adjective - fastigial.
- **fauces**: Latin = throat, adjective - faucial.
- **femur**: Latin = thigh, adjective - femoral.
- **fenestra**: Latin = window.
- **fetus**: the developing mammal in utero; in Man, after the 2nd month in utero, adjective - foetal or fetal.
- **fibre**: Latin fibra = a fibre, adjective, Latin fibrosus = fibrous.
- **fibril**: diminutive of Latin fibra = a fibre.
- **fibula**: Latin = brooch, which the tibia and fibula resemble, the fibula representing the movable pin, adjective - fibular.
- **filament**: Latin filamentum = a delicate fibre, adjective - filamentous.
- **filum**: Latin = a thread. Filum terminale - a thread of pia continuous with the lower end of the spinal cord.
- **fimbria**: Latin = a fringe, hence, fimbria hippocampi, a scalloped band of fibres alongside the hippocampus.
- **fissure**: Latin = a cleft.
- **fixator**: Latin fixus = fixed, hence, a muscle which fixes a part.
- **flaccid**: adjective, Latin flaccidus = weak or slack.
- **flavum**: adjective, Latin flavus = yellow.
- **flex**: Latin flexum = bent, hence, flexor, a muscle which bends a part of the body, and flexion = the act of flexing.
- **flexure**: Latin flexura = a bending.
- **flocculus**: diminutive of Latin floccus, a tuft. Hence resembling a picture of a little cloud, with a woolly top and a flat base, as in flocculus cerebelli.
- **foetus**: the developing mammal in utero; in Man, after the 2nd month in utero, adjective - foetal or fetal.
- **folia**: plural of Latin folium = leaf.
- **follicle**: Latin folliculus = a little bag, adjective - follicular.
- **fontanelle**: French diminutive of Latin fons = fountain, associated with the palpable pulsation of the brain in the anterior fontanelle of an infant.
- **foramen**: Latin = hole.
- **forceps**: Latin = tongs.
- **forearm**: the upper limb between the elbow and the wrist.
- **fornix**: Latin = arch (hence fornication, because the Roman prostitutes plied their profession beneath the arches of the bridges over the river Tiber).

- **fossa**: Latin = a ditch or trench, hence a concavity in bone, or an organ, or on a lining surface.
- **fovea**: Latin = a pit (usually smaller than a fossa).
- **foveola**: diminutive of fovea.
- **frenulum**: diminutive of frenum.
- **frenum**: Latin = bridle or curb.
- **frontal**: adjective, Latin frontis = of the forehead, or coronal.
- **fundiform**: adjective, Latin fundus = bottom or base (cf. fundamental), hence, sling-shaped.
- **fundus**: Latin = bottom or base. (But note that the fundus of the stomach and uterus are at the top, and the fundus of the eye and of the bladder are posterior!).
- **funiculus**: diminutive of Latin funis = cord (used usually for bundles of nerve fibres).
- **fusiform**: adjective, Latin fusus = spindle, hence, spindle-shaped.
- **galea**: Latin = helmet, hence, galea aponeurotica - the aponeurosis of occipitofrontalis muscle.
- **galli**: genetive (possessive case) of Latin = cock, hence, crista galli, the cock's comb.
- **gallus**: Latin = cock, hence, crista galli, the cock's comb.
- **gamma**: the 3rd letter of the Greek alphabet, typically used in a naming sequence - alpha, beta, gamma, delta, etc.
- **ganglion**: Greek = swelling, referring to a peripheral collection of nerve cells, adjective - ganglionic.
- **gastric**: Greek gaster = belly or stomach.
- **gastro**: Greek gaster = belly or stomach.
- **gastrocnemius**: Greek gaster = belly, and kneme = leg, hence, the bulging muscle of the calf.
- **gelatinosa**: Latin gelatus = frozen.
- **gemellus**: Latin diminutive of geminus = twin.
- **genial**: adjective, Greek geneion = chin.
- **geniculate**: Latin geniculare = to flex the knee, hence, a bent knee.
- **geniculum**: Latin geniculare = to flex the knee, hence, a bent knee.
- **genital**: adjective, Latin genitalis = reproductive, hence, genitalia, the sexual organs.
- **genu**: Latin = knee.
- **gingiva**: Latin = gum (of tooth).
- **girdle**: a ring of bones which may be complete or incomplete.
- **glabella**: diminutive of Latin glaber = bald, hence a smooth bony prominence between the eyebrows.
- **gladiolus**: diminutive of Latin gladius = a sword, hence, hance a small sword, term applied to the body of the sternum.
- **gland**: Latin glans = an acorn, adjective - glandular; a secreting organ.
- **glandula**: diminutive of Latin glans = acorn.
- **glans**: Latin = acorn.
- **glenoid**: adjective, Greek glene = socket, and eidos = shape or form.
- **glia**: Greek = glue, hence, an adhesive connective tissue.
- **globus**: Latin = a globe.
- **glomerulus**: Latin glomerare = to roll up, from glomus = a ball of thread (cf. conglomeration).
- **glossal**: adjective, Greek glossa = tongue.
- **glottic**: adjective, Greek = larynx.
- **glottis**: Greek = larynx, hence, the boundaries of rima glottidis.
- **gluteal**: adjective, Greek gloutos = rump or buttock.
- **gluteus**: Greek gluteos = rump or buttock. One of 3 muscles of the buttock, adjective - gluteal.
- **gonad**: Greek = reproduction, hence a gland producing gametes - ovary or testis, adjective - gonadal.
- **gracile**: adjective, Latin gracilis = slender.
- **gracilis**: adjective, Latin = slender.

- **granulation**: diminutive of Latin granum = a grain.
- **gravid**: adjective, Latin gravida = pregnant.
- **griseum**: adjective, Latin griseus = bluish or pearly grey.
- **gubernaculum**: Latin something which governs or directs, like a rudder (cf. gubernatorial).
- **gustatory**: adjective, Latin gustatio = taste, hence, pertaining to the sense of taste.
- **gyrus**: Greek gyros = circle, hence a coil of brain cortex.
- **habenula**: diminutive of Latin habena = rein.
- **haemorrhoid**: Greek haima = blood, and rhoia = to flow, hence likely to bleed.
- **hallux**: Latin hallex = great toe (hallucis = of the great toe).
- **hamate**: adjective, Latin hamus = a hook, hence, hooked.
- **hamstrings**: the tendons of the muscles of the ham - i.e. of the back of the thigh - felt behind the knee when the leg is flexed against resistance (semimembranosus, semitendinosus and biceps femoris).
- **hamulus**: diminutive of Latin hamus = hook.
- **haustra**: Latin = saccules.
- **helicine**: Greek helix = a coil, spiral.
- **helicotrema**: Greek helix = a coil, and trema = hole, hence the aperture at the apex of the bony cochlea whereby scala vestibuli communicates with scala tympani.
- **helix**: Greek = coil.
- **hemianopia**: Greek hemi = half, an = negative, opsis = vision, hence loss of half of the field of vision.
- **hemianopsia**: Greek hemi = half, an = negative, opsis = vision, hence loss of half of the field of vision.
- **hemiparesis**: Greek hemi = half, paresis = paralysis, used usually to denote weakness rather than paralysis.
- **hemiplegia**: Greek hemi = half, plegia = stroke, hence, paralysis of one half of the body.
- **hemisphere**: Greek hemi = half, sphaira = ball, hence, half of a sphere.
- **hepar**: Greek = liver, adjective - hepatic.
- **hepatic**: adjective, Greek hepar = the liver.
- **hernia**: Latin = a protrusion, adjective - hernial.
- **hiatus**: Latin = a gap (like that between some people's ears).
- **hilum**: Latin = the point of attachment of a seed, hence the part of an organ where the vessels and nerves are attached; adjective - hilar.
- **hindbrain**: the part of the brain below tentorium cerebelli, comprising medulla oblongata, pons and cerebellum.
- **hip**: the lateral prominence of the hip bone and greater trochanter.
- **hippocampus**: Greek hippokampos = a sea-horse, hence, the curled shape of the hippocampus in coronal section; adjective - hippocampal.
- **homologous**: adjective, Greek homos = same, and logos = word, hence a part with similar morphology but different function.
- **horizontal**: adjective - parallel to the horizon.
- **horn**: a projection, often pointed.
- **humerus**: Latin = the arm-bone.
- **humour**: Latin humor = liquid, hence the aqueous and vitreous humour of the eyeball.
- **hyaline**: adjective, Greek hyalos = glassy.
- **hydrocephalus**: Greek hydor = water, koilos = head. (cf. cephalic).
- **hymen**: Greek = membrane; across the virginal vagina.
- **hyoid**: adjective, Greek = U-shaped.
- **hyperacusis**: Greek hyper = over, and akousis = hearing, hence excessive sensitivity to sound.
- **hypoglossal**: adjective, Greek hypo = under, and glossa = tongue.

- **hypophysis**: Greek hypo = down, physis = growth, hence, a downgrowth (from the brain). However, this is not the whole truth. Part is an upgrowth from the pharynx, adjective - hypophysial.
- **hypothalamus**: Greek hypo = under, and thalamus (q.v.), refers to part of diencephalon.
- **ileum**: Greek eilein = twisted. adjective - ileal.
- **ilium**: Latin the bone of the flank, adjective - iliac.
- **ima**: adjective, Latin = lowest, hence artery thyroidea ima.
- **impar**: Latin = unpaired.
- **incisor**: Latin incisum = cut up.
- **incisura**: Latin = notch.
- **incus**: Latin = anvil, hence the anvil-shaped ossicle of the middle ear.
- **index**: Latin = a pointer, hence, the fore-finger.
- **indicis**: genitive of Latin index = a pointer, hence, of the fore-finger.
- **indusium**: Latin = tunic.
- **inferior**: adjective, Latin = lower down, hence, farther from the head end.
- **infra**: Latin = below.
- **infundibulum**: Latin = funnel.
- **inguinal**: adjective, Latin inguen = groin.
- **inhibition**: Latin inhibitus = restrained, hence, reduction of the excitability of a synapse.
- **innervate**: Latin in = into, and nervus = nerve, hence, to supply a nerve to a part.
- **innominate**: Lain in = not, and nomen = name, hence, without a name.
- **insert**: Latin insertio = to join into, implant, hence, to attach; noun - insertion.
- **inspection**: Latin inspectus = examined, hence, visual examination.
- **insula**: Latin = island.
- **integument**: Latin in = on, tegmen = roof, hence the skin coat.
- **intercalated**: adjective, Latin inter = between, and calatum = inserted, hence interposed.
- **interdigitate**: Latin inter = between, and digitus = a digit. Hence, to interlock like fingers.
- **internal**: adjective, Latin internus = inward, hence, nearer the inside.
- **internuncial**: adjective, Latin inter = between, nuncius = messenger.
- **interstitial**: adjective, Latin inter = between, and sistum = set, hence, set between.
- **intestine**: Latin intestinum = the digestive tube beyond the stomach.
- **intima**: Latin = innermost.
- **intra**: Latin = within.
- **intrafusal**: adjective, Latin intra = within, fusus = spindle.
- **intrinsic**: adjective, Latin = on the inside.
- **introitus**: Latin intro = within, and ire = to go, hence, an orifice or point of entry to a cavity or space.
- **inversion**: Lain in = in, and vertere = to turn, hence to turn inward, inside out, upside down.
- **ipsilateral**: Latin ipsi = self, the same, and latus = side, hence on the same side.
- **iris**: Latin = a rainbow.
- **ischium**: Greek ischion = socket, because the ischium contributes more than either the ilium or pubis to the acetabulum.
- **iso**: Greek = equal.
- **isthmus**: Greek isthmos - a narrow passage.
- **jejunum**: Latin jejunus = empty, adjective - jejunal.
- **joint**: the meeting of 2 or more bones or cartilages, at which movement is possible.
- **jugular**: adjective, Latin jugulum = neck.
- **jugum**: Latin = yoke (cf. conjugal).
- **juxta**: Latin = near.
- **keratin**: Greek keras = horn.

- **kinocilium**: Greek kineo = to move (cf. kinetic), and cilium Latin = eyelash, hence protoplasmic thread of hair process in cupula of crista ampullaris of a semicircular duct.
- **knee**: the junction of the thigh and the leg.
- **koniocortex**: Greek konis = dust, and Latin cortex = bark, hence, sensory cortex containing mostly granular layers.
- **kyphosis**: Greek kyphos = bent or bowed forward.
- **labium**: Latin = lip (plural labia), adjective - labial.
- **labrum**: Latin = rim.
- **labyrinth**: Greek labyrinthos = maze, adjective - labyrinthine.
- **lacerum**: Latin lacer = mangled, hence, lacerated, torn.
- **lacrimal**: adjective, Latin lacrima = a tear (drop).
- **lactation**: Latin lactans = suckling. Hence, the act of secreting milk.
- **lacteal**: adjective, Latin lac = milk, hence, resembling milk.
- **lactic**: adjective, Latin lac = milk.
- **lactiferous**: adjective, Latin lac = milk, and ferre = to carry.
- **lacuna**: Latin lacus = lake, hence, a small pond or gap, adjective, lacunar.
- **lambda**: Greek letter representing a capital 'L' and written as an inverted V.
- **lambdoid**: adjective, Greek lambda, representing a capital 'L' and written as an inverted V; hence, like that letter.
- **lamella**: diminutive of Latin lamina = plate; hence, a small plate.
- **lamina**: Latin = plate, either a layer of nervous tissue, like the laminae of the lateral geniculate body, or a connective tissue membrane, like lamina cribrosa sclerae, or of bone, as in vertebral laminae; hence, laminectomy = lamina + Greek ektome = excision - excision of the vertebral laminae to give access to the spinal cord; adjective - laminar.
- **lanugo**: Latin lana = wool, hence, the fine downy hair on the skin of the foetus, or cheeks.
- **larynx**: Greek = voice-box, adjective - laryngeal.
- **lata**: Latin latus = side.
- **lateral**: adjective, Latin latus = side, hence, nearer the side.
- **latissimus**: superlative of adjective, Latin latus = wide, hence, latissimus dorsi muscle, the widest muscle of the back; earlier name was anitersor - wiper of the anus.
- **leg**: the lower limb between the knee and the ankle.
- **lemniscus**: Greek lemniskos = a band or ribbon (applied to nerve fibres).
- **lens**: Latin = lentil - a transparent body with one or both surfaces curved to re-direct light rays, adjective - lentiform or lenticular.
- **lentiform**: adjective, Latin lens = lentil, and forma = shape, hence, lentil-shaped.
- **leptomeninx**: Greek lepto = delicate, and meninx = membrane. Usually refers to pia and arachnoid. Plural leptomeninges.
- **levator**: Latin = elevator.
- **lien**: Latin = spleen, adjective - lienal.
- **ligament**: Latin ligamentum = bandage, usually tying parts to each other, adjective - ligamentous.
- **limbic**: adjective, Latin limbus = a margin, usually curved.
- **limbus**: Latin = a margin, usually curved, hence, limbus of cornea, its circular junction with the sclera, adjective - limbic; limbic lobe of the brain comprises structures which encircle the junction of the diencephalon and telencephalon.
- **limen**: Latin = a threshold, hence, subliminal - below threshold.
- **linea**: Latin = line.
- **lingua**: Latin = tongue, adjective, lingual.
- **lingula**: diminutive of lingua, hence, a little tongue, adjective - lingular.
- **lissencephalic**: adjective, Greek lissos = smooth, hence, a cerebrum lacking sulci.

- **lobule**: diminutive of lobus.
- **lobulus**: Latin diminutive of lobus, hence, a lobule.
- **lobus**: Greek lobos = lobe, adjective - lobar.
- **locus**: Latin a place (cf. location, locate, dislocate).
- **loin**: Latin lumbus - the part of the back between the ribs and the hip bone.
- **longissimus**: superlative of Latin longus = long, hence, the longest.
- **longitudinal**: adjective, Latin longitudo = length, hence, lengthwise.
- **longus**: adjective, Latin = long, hence, longissimus (superlative) = the longest.
- **lucidum**: Latin lucidus = clear.
- **lumbar**: adjective - see loin.
- **lumbrical**: Latin lumbricus = worm, hence worm-shaped muscles of the palm.
- **lumen**: Latin = opening, hence the space within a tube.
- **lunate**: adjective, Latin luna = moon, hence, crescentic.
- **luteum**: adjective, Latin = yellow.
- **lymph**: Latin lympha - clear spring water.
- **lymphatic**: a vessel carrying lymph.
- **macroscopic**: adjective, Greek makros = large, and skopein = to examine; hence, large enough to be seen with the naked eye, e.g., pertaining to gross anatomy.
- **macula**: Latin = spot (cf. immaculate - spotless); adjective - macular.
- **magna**: Latin = great.
- **malleolus**: diminutive of Latin malleus = hammer, adjective - malleolar.
- **malleus**: Latin = a hammer.
- **mamma**: Latin = breast; adjective - mammary.
- **mammilla**: diminutive of mamma; adjective - mammillary.
- **mandible**: Latin mandere = to chew; hence, the movable lower jaw; adjective - mandibular.
- **manubrium**: Latin = handle; adjective - manubrial.
- **manus**: Latin = hand (cf. manual).
- **margin**: the edge or border of a surface; adjective - marginal.
- **masseter**: Greek = chewer; adjective - masseteric.
- **mastication**: Latin masticere = to chew.
- **mastoid**: adjective, Greek mastos = breast or teat, and eidos = shape or form.
- **matrix**: Latin = a female animal used for breeding, womb; refers to ground substance of connective tissue, and nail bed.
- **maxilla**: Latin = jaw-bone; now used only for the upper jaw; adjective - maxillary.
- **meatus**: Latin = passage; adjective - meatal.
- **medial**: adjective, Latin medius = middle; hence, nearer the median plane.
- **median**: Latin medianus = in the middle.
- **mediastinum**: derivation doubtful, but possibly from Latin medius = middle, and stans = standing; hence, a median vertical partition, adjective - mediastinal.
- **medius**: Latin = middle.
- **medulla**: Latin = marrow; applied to part of an organ deep to its cortex, and to the spinal cord and adjoining part of brain stem, which may have been thought to be the marrow of the vertebral column, adjective - medullary pertains to the medulla of an organ or medulla oblongata.
- **membrane**: Latin membrana = a thin sheet; adjective - membranous.
- **meninges**: plural of Greek meninx = a membrane; adjective - meningeal.
- **meniscus**: Latin menis - a small crescent.
- **mental**: adjective - Latin mentum = chin; or Latin mens = mind.
- **mesencephalon**: Greek mesos = middle, and enkephalos = brain; adjective - mesencephalic.

- **mesenchyme**: Greek mesos = middle, and chymos = juice; the embryonic connective tissue of the mesoderm.
- **mesentery**: Greek mesos = middle, and enteron = intestine; hence, the peritoneal fold which tethers the centrally situated small intestine; adjective - mesenteric.
- **mesial**: adjective - medial, used in dental anatomy.
- **mesoderm**: Greek mesos = middle, and derma = skin; the middle germ layer of the embryo.
- **mesosalpinx**: Greek mesos = middle, and salpinx = tube; hence, the intermediate part of the broad ligament.
- **metacarpus**: Greek meta = after, and karpus = wrist; adjective - metacarpal.
- **metaphysis**: Greek meta = after, and physis = growth; hence, the end of the shaft of a bone alongside the epiphysial or growth cartilage; adjective - metaphysial.
- **metatarsus**: Greek meta = after, and tarsos = ankle; hence, the bones beyond the tarsus, adjective - metatarsal.
- **metencephalon**: Greek meta = beside, behind, or after, and enkephalos = brain; hence the parts of the hindbrain immediately caudal to the fore- and midbrain, namely the pons and cerebellum.
- **metopic**: adjective, Greek metopon = forehead.
- **micturition**: Latin micturare = to desire to pass urine.
- **minimus**: Latin = smallest.
- **miosis**: Greek meiosis = lessening; hence, pupillary constriction; adjective - miotic.
- **modality**: Latin modus = mode; hence, a form of sensation - e.g. touch, pain, sight.
- **modiolus**: Latin a cylindrical borer with a serrated edge; hence, like a screw; the central stem of the bony cochlea.
- **molar**: adjective, Latin mola = mill.
- **mons**: Latin = mountain; mons pubis, the soft tissue bulge over the female pubes.
- **morphology**: Greek morphos = form, and logos = word or relation; hence, study of pattern of structure; adjective - morphological.
- **multifidus**: Latin multus = much, and findere = to split.
- **muscle**: Latin musculus, diminutive of Greek mus = mouse, the body and head of which represent the main belly of a muscle, and the tail, the tendon.
- **mydriasis**: Greek = dilatation of the pupil.
- **myelencephalon**: Greek myelos = marrow (= Latin medulla), and enkephalos = brain; hence the medulla oblongata. See also medulla.
- **myelin**: Greek myelos = marrow; hence, white fatty sheath of an axis cylinder; adjective - myelinated.
- **myenteric**: Greek mys = muscle, and enteron = intestine, hence, pertaining to the muscle of the gut.
- **mylohyoid**: Greek mylo = molar, and hyoeides = U-shaped.
- **myocardium**: Greek mys = muscle, and kardia = heart, adjective - myocardial.
- **myotome**: Greek mys = muscle, and tome = a cutting or division; hence, a group of muscles innervated by a single spinal segment.
- **nares**: plural, Latin naris = nostril.
- **naris**: Latin = nostril, plural - nares.
- **nasal**: adjective, Latin nasus = nose; hence, pertaining to the nose.
- **natal**: adjective, Latin natus = born; hence, relating to birth.
- **navicular**: adjective, Latin navicula = a little ship (cf. naval); hence, the tarsal bone which is concave posteriorly, resembling a boat.
- **neo-**: Greek prefix - neos = new.
- **neonatal**: adjective, Greek neos = new, and Latin natos = born; hence, new-born.
- **neopallium**: Greek neos = new, and Latin pallium = cloak; hence, the cerebral cortex which developed more recently than the archipallium or olfactory cortex.

- **nerve**: Latin nervus = tendon; later reserved for a peripheral bundle of fibres which conduct impulses from or to the central nervous system.
- **neural**: adjective, Greek neuron = nerve.
- **neuroglia**: Greek neuron = nerve, and gloia = glue; hence, the connective tissue of the central nervous system; adjective - neuroglial.
- **neurohypophysis**: or posterior lobe of hypophysis - Greek hypo = down, and physis = growth; hence, the posterior part of the hypophysis evaginated downwards from the diencephalon, and its stalk.
- **neurolemma**: Greek neuron = nerve, and lemma = peel or rind; hence, the covering layer of a nerve.
- **neuron**: Greek = nerve; refers to the nerve cell body, with its axon and dendrites; adjective - neuronal.
- **nigra**: Latin niger = black, dark.
- **node**: Latin nodus = knot.
- **nodule**: diminutive of Latin nodus = knot, hence, a little knot.
- **norma**: Latin = pattern or rule, or aspect; adjective, normal - according to rule.
- **notch**: an indentation in the margin of a structure. Etymology uncertain.
- **notochord**: Greek notos = back, and chorde = cord; hence, the primitive axial skeleton around which the vertebrae develop, parts persisting in the nuclei pulposi.
- **nucha**: French nuque = nape or back of the neck; adjective - nuchal.
- **nucleus**: Latin = kernel or nut; may refer to the vital centre of a cell body, or to a cluster of neuron cells in the central nervous system; adjective - nuclear.
- **nystagmus**: Greek = drowsiness, to nod, hence, involuntary, rapid, rhythmic eye movements.
- **obex**: Latin = barrier; hence, the coronal fold of ependyma over the lower angle of the 4th ventricle.
- **oblique**: adjective, Latin obliquus; slanting, or deviating from the perpendicular or the horizontal.
- **oblongata**: Latin oblongus = oblong; medulla oblongata.
- **obturator**: Latin obturatus = stopped up; hence, a structure which closes a hole.
- **occiput**: Latin ob = prominent (cf. obvious), and caput = head; hence, the prominent convexity of the back of the head; adjective - occipital.
- **occlusion**: Latin occlusum = closed up; hence, apposition of reciprocal teeth, or the blocking of any tubular structure; adjective - occlusal.
- **oculomotor**: Latin oculus = eye, and movere = to move, hence, pertaining to moving the eye.
- **oculus**: Latin = eye.
- **odontoid**: Greek odous = tooth, and eidos = form, shape, hence, tooth-like.
- **oesophagus**: Greek = gullet (passage from pharynx to stomach); adjective - oesophageal.
- **olecranon**: Greek olene = ulna, and kranion = upper part of head; hence, the upper end of the ulna.
- **olfactory**: adjective, Latin olfacto = smell.
- **olive**: Latin oliva - the oval fruit of the olive tree; oval eminence on medulla oblongata; adjective - olivary.
- **omentum**: Latin = apron; adjective - omental.
- **omohyoid**: Greek omos = shoulder; hence, a muscle attached to the scapula and hyoid.
- **operculum**: Latin = lid or cover; hence, operculum insulae, the cerebral cortex covering and hiding the insula (the 5th lobe of cerebral cortex).
- **ophthalmic**: adjective, Greek ophthalmos = eye.
- **opponens**: Latin = placing against, opposing.
- **oppose**: Latin oppositum = put against; hence, to resist or place in contact with, and opposition - the action of opposing.

- **optic**: adjective, Greek optos = seen; hence, pertaining to sight.
- **ora**: Latin ora = margin or edge.
- **ora serrata**: Latin ora = margin, and serra = saw; hence, the serrated anterior edge of the functional part of the retina.
- **oral**: Latin oris = a mouth, hence, pertaining to the mouth.
- **orbit**: Latin orbis = circle; the name given to the bony socket in which the eyeball rotates; adjective - orbital.
- **orifice**: Latin orificium = opening.
- **os, oris**: Latin os = mouth; plural - ora, adjective - oral.
- **os, ossis**: Latin os = bone; plural - ossa, adjective - osseous.
- **ossicle**: Latin ossiculus, diminutive of os = bone.
- **ossify**: Latin os = bone, and facio = make; hence, to form bone; and ossification, the process of bone formation.
- **osteology**: Greek osteon = bone, and logy = a field of study.
- **ostium**: Latin = a door, an opening, an orifice.
- **otic**: adjective, Greek otos = ear.
- **otolith**: Greek otos = ear, and lithos = stone; hence, calcareous particles in the utricle and saccule of the membranous labyrinth.
- **ovary**: Latin ovum = egg; hence, the organ containing ova (the largest cells in the female).
- **ovum**: Latin = egg, plural - ova.
- **pachymeninx**: Greek pachys = thick, and meninx = membrane; hence, the thick membrane covering the central nervous system, i.e., dura mater.
- **palaeo**: Greek palaios = old; hence, palaeocerebellum, the earliest stage in the evolution of the cerebellum.
- **palate**: Latin palatum = palate, adjective - palatal or palatine.
- **paleo**: Greek palaios = old; hence, paleocerebellum, the earliest stage in the evolution of the cerebellum.
- **pallidus**: adjective, Latin = pale.
- **pallium**: Latin = cloak; hence, the cerebral cortex forming the outer covering of the cerebral hemisphere.
- **palma**: Latin palma = palm; adjective, palmar - Latin palmaris.
- **palpate**: Latin palpare = to touch, and palpatus = touched; hence, to examine by feeling, and palpation, such an examination.
- **palpebra**: Latin = eyelid, probably from palpitare = to flutter.
- **pampiniform**: adjective, Latin pampinus = tendril, and forma = shape.
- **pancreas**: Greek = sweetbread, derived from Greek pan = all, and kreas = flesh; adjective - pancreatic.
- **panniculus**: diminutive of Latin pannus = cloth.
- **papilla**: Latin = nipple or teat; adjective - papillary.
- **paradidymis**: Greek para = beside of near, and didymis = twinned or paired, refers to testes; hence the collection of convoluted tubules in the spermatic cord, above the head of the epididymis.
- **paraesthesia**: Greek para = beside, and aisthesia = sensation; hence, abnormal sensation, usually burning or pricking.
- **paralysis**: Greek para = beside, near, lyein = to loosen; hence loss or impairment of muscle function.
- **parametrium**: Greek para = beside, and metra = womb; hence, connective tissue alongside the body of the uterus, within the broad ligament.
- **paraplegia**: Greek para = beside, and plege = a stroke; hence, paralysis of the lower limbs.

- **pararenal**: adjective, Greek para = beside, Latin ren = kidney; hence, beside the kidney, e.g., pararenal fat, the fatty capsule of the kidney.
- **parasternal**: adjective, Greek para = beside, and sternon = chest; hence, the parasternal line is a vertical line about midway between the sternal edge and the midclavicular line.
- **parasympathetic**: adjective, Greek para = beside, syn = with, and pathos = feeling; hence, the division of the autonomic nervous system complementary to the sympathetic system.
- **parathyroid**: adjective, Greek para = beside, and thyroid; hence, beside the thyroid gland.
- **parenchyma**: Greek para = beside or near, en = in, and chein = to pour; hence a general term to designate the functional elements of an organ, as opposed to the framework or stroma.
- **paresis**: Greek = relaxation, but has come to mean partial paralysis.
- **parietal**: adjective, Latin parietalis, pertaining to paries = wall.
- **parotid**: adjective, Greek para = beside, and otos = of the ear; hence, beside the ear.
- **parous**: adjective, Latin pario = I bear (children); hence, adjective, applied to woman who has borne one or more children (cf. nulliparous, multiparous).
- **pars**: Latin = part.
- **patella**: Latin a small pan; adjective - patellar.
- **pecten**: Latin = comb.
- **pectinate**: adjective, from Latin pecten = a comb; applied to structures having the appearance of parallel teeth arising from a straight back (musculi pectinati), or the sellar appearance of the superior pubic ramus, which may have resembled the body of antique combs.
- **pectineal**: adjective, from Latin pecten = a comb; applied to structures having the appearance of parallel teeth arising from a straight back (musculi pectinati), or the sellar appearance of the superior pubic ramus, which may have resembled the body of antique combs.
- **pectineus**: Latin, pecten = a comb; hence the muscle attaching to the pecten (pectineal line) of the pubic bone.
- **pectoral**: adjective, Latin pectoris = of the front of the chest.
- **pectoralis**: adjective, Latin pectoris = of the front of the chest.
- **pedicle**: diminutive of Latin pedis = of the foot.
- **pedis**: Latin = of the foot.
- **peduncle**: variation of pedicle.
- **pellucidum**: adjective, Latin per = through, and lucere - to shine; hence, translucent.
- **pelvis**: Latin = basin, adjective - pelvic.
- **penis**: Latin = tail, the male organ of copulation (cf. appendix, appendage).
- **pennate**: Latin penna = feather; hence, a muscle whose fibres approach the tendon from one direction is unipennate; from two, bipennate, and from more than two, multipennate.
- **pennatus**: (pinnate) - adjective, Latin penna = feather; hence, a muscle whose fibres approach the tendon from one direction is unipennate; from two, bipennate, and from more than two, multipennate.
- **perianal**: adjective, Greek peri = around, and Latin anus = lower opening of alimentary canal.
- **pericardium**: Greek peri = around, and kardia = heart; hence, the membranes enclosing the heart.
- **perichondrium**: Greek peri = around, and chondros = cartilage; hence, the membrane covering cartilage.
- **pericranium**: Greek peri = around, and kranion = skull; hence, the external periosteum of the skull.
- **perilymph**: Greek peri = around, and lympha - Latin = clear water; hence, the fluid in the bony labyrinth surrounding the membranous labyrinth (and continuous with the cerebrospinal fluid).
- **perineum**: Greek the caudal aspect of the trunk between the thighs, or, the region of the trunk below the pelvic diaphragm; adjective - perineal.
- **periodontal**: adjective, Greek peri = around, and odont = tooth.

- **periosteum**: Greek peri = around, and osteon = bone; hence, the membrane around a bone.
- **peripheral**: adjective, Greek peri = around and phero = carry; hence, away from the centre (cf. periphery).
- **peristalsis**: Greek peri = around, and stellein - to constrict; hence, a circular constriction passing as a wave along a tube; adjective - peristaltic.
- **peritoneum**: Greek periteino = to stretch around; hence, the membrane stretched around the internal surface of the walls and the external aspect of some of the contents of the abdomen; adjective - peritoneal.
- **peroneal**: adjective, Greek perone = clasp, brooch - see fibula.
- **pes**: Latin = foot.
- **petrosal**: adjective, Latin petrosus = rocky.
- **petrous**: adjective, Latin petrosus = rocky.
- **phalanx**: Latin = row of soldiers; hence, one of the small bones of a digit, plural - phalanges, adjective - phalangeal.
- **phallus**: Greek phallos = penis.
- **pharynx**: Greek = throat; adjective - pharyngeal.
- **philtrum**: Greek philtron - the median sulcus of the upper lip. Derivation doubtful.
- **phonation**: Greek phone = sound or voice; hence, the production of either.
- **phrenic**: Greek phren = diaphragm or mind; hence, diaphragmatic (cf. schizophrenic).
- **pia**: Latin = faithful, hence, the membrane which faithfully follows the contour of the brain and spinal cord.
- **pilomotor**: Latin pilus = a hair, and movere = to move; hence the action of the arrectores pilorum muscles.
- **pilus**: Latin = a hair.
- **pineal**: adjective, Latin pinea = a pine cone; hence, the pineal gland which is cone-shaped.
- **piriform**: adjective, Latin pirum = a pear; hence, pear-shaped.
- **pisiform**: adjective, Latin pisum = a pea; hence, pea-shaped.
- **pituitary**: Latin pituita = mucous or phlegm, the gland was thought to produce mucous that discharged through the nose.
- **placenta**: Latin = a flat, round cake.
- **placode**: Greek plax = plate or flat, and eidos = shape or form.
- **plane**: Latin planus = flat; hence, a real or imaginary flat surface.
- **planta**: Latin the sole of the foot; adjective - plantar or plantaris.
- **plantar**: adjective, Latin planta = the sole of the foot.
- **platysma**: Greek = flat object; hence, the flat subcutaneous muscle extending from below the clavicle to the mouth.
- **pleura**: Greek = a rib. Later used to name the serous membrane lining the chest walls and the lung on each side.
- **plexus**: Latin = a network or plait.
- **plica**: Latin plicare = to fold; hence, a fold.
- **pneumon**: Greek pneuma = air.
- **pollex**: Latin = thumb.
- **pollicis**: genitive (possessive case) of Latin pollex = thumb; hence of the thumb.
- **pons**: Latin = bridge; adjective - pontine; part of the brain stem.
- **popliteus**: Latin poples = the ham or thigh, and sometimes, the knee; adjective, popliteal, referring to the fossa behind the knee or its contents.
- **porta**: Latin = a gate, also Latin portare = to carry; hence, the portal system carries venous blood from the alimentary tract to the porta hepatis; adjective - portal.
- **porus**: Latin a pore or foramen; hence, the openings of the acoustic meatuses.
- **posterior**: adjective, Latin post = behind (in place or time).

- **posture**: Latin positus = placed; hence, the position of the body as a whole at a given moment, e.g. erect, recumbent, prone, supine, sitting, kneeling.
- **precuneus**: Latin pre = before, and cuneus = wedge; hence, the parietal lobule anterior to the cuneus.
- **prepuce**: Latin praeputium = foreskin (of penis or clitoris).
- **princeps**: Latin primus = chief, and capere = to take; hence chief or principal.
- **procerus**: Latin = slender, elongated; hence, the vertical slip of muscle between the medial part of frontalis and the root of the nose.
- **process**: Latin = going forwards, used to indicate growing out, i.e., an outgrowth, usually of bone, e.g., the zygomatic process of the temporal.
- **processus**: Latin going forwards, used to indicate growing out, i.e., an outgrowth, usually of bone, e.g., the zygomatic process of the temporal.
- **profundus**: Latin pro = before, and fundus = bottom; hence profundus = deep.
- **prominens**: Latin = projecting.
- **promontory**: Latin promontorium = a headland, i.e., part of land jutting into the sea - used for a bony prominence.
- **pronate**: Latin pronatus = bent forwards; hence to pronate = to turn the hand so that the palm faces posteriorly.
- **prone**: Latin pronatus = bent forwards; hence, recumbent face-down posture.
- **proprioceptive**: Latin proprius = one's own, and captum = taken; hence, sensory impulses received by the joints and muscles within one's own body.
- **prosection**: Latin pro = before, and sectum = cut. A dissection prepared for demonstration of anatomic structures.
- **prosector**: Latin pro = before, and sectum = cut. One who prepares a dissection for demonstration.
- **prosencephalon**: Latin pro = in front, and Greek enkephalos = brain; hence, the part of the brain rostral to the midbrain.
- **prostate**: Greek pro = before, and Latin = statum = stood; hence, something which stands before - the prostate stands before the urinary bladder.
- **protract**: Latin protractus = drawn out; hence, to put forwards (e.g., shoulder or mandible). Protraction - the act of protracting.
- **protrude**: Latin protrudo = thrust forwards, e.g. the tongue; protrusion - the act of protruding.
- **protuberance**: Latin protubero = I bulge out; hence, a bulging bony feature (see tuber).
- **proximal**: adjective, Latin proxime = nearest; hence, nearer to the root of a limb.
- **psoas**: Greek = loin.
- **pterion**: Greek pteron = wing; hence, the region where the tip of the greater wing of the sphenoid meets or is close to the parietal, separating the frontal from the squamous temporal; alternatively the region where these 4 bones meet.
- **pterygoid**: adjective, Greek pteryx = wing, and eidos = shape; hence, wing-shaped.
- **ptosis**: Greek = fall; hence, drooping of an eyelid, or descent of an internal organ.
- **puberty**: Latin puber = adult; hence, the time when hair appears in the pubic region - i.e., near the pubis - as a secondary sexual characteristic.
- **pubes**: Latin = adult or signs of manhood, hence the lower abdominal secondary sexual hair.
- **pubis**: Latin pubes (see pubes)
- **pudendal**: adjective, Latin pudendus = shameful; hence, pertaining to the external genitalia.
- **pulmonary**: adjective, Latin pulmo = lung.
- **pulp**: Latin pulpa = a soft part of the body or tooth.
- **pulposus**: Latin pulpa = a soft part of the body or tooth, hence pulpy or soft.
- **pulvinar**: Latin pulvinus = rounded cushion; the posterior end of the thalamus.
- **punctum**: Latin = a sharp point; hence a very small point or orifice.

- **pupil**: Latin pupilla = the central black orifice in the iris; adjective - pupillary.
- **putamen**: Latin = peel, husk or shell of fruit or seed (the external part of the lentiform nucleus).
- **pyelogram**: Greek pyelos = basin, and gramma = diagram; hence, radiograph of the renal pelvis (and usually of the ureter) after filling with contrast medium.
- **pylorus**: Greek = gate-keeper; hence, the part of the pyloric canal containing the sphincter, which guards the opening into the duodenum; adjective - pyloric.
- **pyramid**: Greek pyramis = a pyramid (solid with 3- or more-sided base, and flat sides meeting at the apex), adjective - pyramidal.
- **quadrangular**: Latin quadri = four and angulus = angle; hence square or rectangular.
- **quadratus**: Latin = square or rectangular.
- **quadriceps**: Latin quadri = four, and caput = head; hence, a 4-headed muscle.
- **quadrigeminus**: Latin quadri = four, and gemini = paired or twinned; hence four-fold.
- **radiation**: Latin radiatus = radiant; hence, divergence from a common centre (cf. radius).
- **radicle**: diminutive of Latin radix = root; hence a small root, adjective - radicular.
- **radius**: Latin = spoke of a wheel, which rotates around the hub; hence, the lateral bone of the forearm, which rotates (though around an almost vertical axis); adjective - radial.
- **radix**: Latin = root.
- **ramify**: Latin ramus = a branch; and facere = to make; hence, to branch.
- **ramus**: Latin = branch; hence, a branch of a nerve.
- **raphe**: Greek a seam; hence, the line of junction of the edges of 2 muscles or areas of skin.
- **recess**: Latin recessus = a secluded area or pocket; hence, a small cavity set apart from a main cavity.
- **rectum**: adjective, Latin rectus = straight. (The rectum was named in animals where it is straight - which it is not in Man).
- **rectus**: Latin rectus = straight.
- **recurrent**: Latin re = back, and currere = to run; hence a structure that bends, and runs back toward its source.
- **reflex**: an involuntary response - muscular or secretory - to a stimulus mediated by the central nervous system.
- **renal**: adjective, Latin ren = kidney.
- **rete**: Latin = a net; hence, a network of veins or tubules.
- **reticular**: adjective, Latin reticulum = small net; hence having a network.
- **reticulum**: diminutive of Latin rete = net; adjective - reticular.
- **retina**: derivation uncertain - the innermost of the 3 layers of the eyeball.
- **retinaculum**: Latin = a tether; hence, a thickened band of deep fascia which retains tendons or the patella.
- **retract**: Latin re = back, and tractum = pulled; hence, to pull something back, and retraction - the act of retracting.
- **retro**: prefix - Latin = backwards.
- **retroflexion**: Latin retro = backwards, and flexion = bent; hence, the position of being bent backwards, applied to the angulation of the body of the uterus on the cervix.
- **retroversion**: Latin retro = backwards, and version = turned; hence, the position of being turned backwards, applied to the angulation of the cervix uteri on the vagina.
- **rhinencephalon**: Greek rhinion = nostril, and enkephalos = brain; hence, the part of the brain concerned with smell (relatively large in lower animals).
- **rhombencephalon**: Greek rhombos = rhomboid, and enkephalos = brain; hence, the hind-brain - the medulla oblongata, pons and cerebellum, which enclose the rhomboid fossa (the floor of the 4th ventricle).
- **rhomboid**: Greek rhombus = a figure with 4 equal sides, not at right angles, and eidos = shape or form, hence, the shape of a rhombus.

- **rima**: Latin = chink; hence, e.g., rima palpebrarum = the chink between the free edges of the eyelids.
- **risorius**: Latin risor = scoffer; hence, muscle risorius is the facial muscle which expresses laughter by drawing the corner of the mouth laterally.
- **rostral**: adjective, Latin rostrum = beak, implying nearness to the corpus callosum.
- **rostrum**: Latin beak, which decorated the Roman orator's platform; hence, a platform or beak-like structure; adjective - rostral.
- **rotate**: Latin rota = wheel; hence, to turn, and rotation, the act of turning.
- **rotundum**: Latin rotnudus = round.
- **rubro**: prefix, Latin rubrum = red.
- **ruga**: Latin = a wrinkle.
- **rugose**: adjective, Latin ruga = a wrinkle, hence, wrinkled.
- **sac**: Latin saccus = a sack.
- **sacciform**: Latin saccus = sac-shaped
- **saccule**: Latin sacculus, diminutive of saccus.
- **sacrum**: Latin os sacrum = sacred, via Greek hieron osteon = sacred bone. Called so either because the sacrum was the part of an animal offered in sacrifice or because of the belief that the soul of the man resides there. A different origin is suggested by an alternate translation of the heron, which can also mean �strong,' and that the Latin stems from a mistranslation of Galen, who was calling it 'the strong bone.'
- **sagittal**: adjective, Latin sagitta = arrow, because the sagittal suture is notched posteriorly, like an arrow, by the lambdoid sutures.
- **salivary**: adjective, Latin saliva = spit.
- **salpinx**: Greek = trumpet; hence, the uterine or auditory tube, each of which is trumpet-shaped.
- **saphenous**: adjective, Greek saphenes = obviously visible. The saphenous veins become very apparent when varicose.
- **sartorius**: Latin = tailor; hence, sartorius muscles, which produce the posture in which tailors once worked, squatting on the floor.
- **scala**: Latin = stairs; hence the parallel spiral passages which wind up to, or down from, the cupula of the bony cochlea.
- **scalene**: adjective, Greek skalenos = uneven, hence a triangle with unequal sides, an apt description of the shape of scalenus anterior and scalenus medius muscles.
- **scalenus**: adjective, Greek skalenos = uneven, hence a triangle with unequal sides, an apt description of the shape of scalenus anterior and scalenus medius muscles.
- **scaphoid**: adjective, Greek skaphe = skiff, and eidos = shape or form; hence the carpal which is hollowed out on its distal surface for the head of the capitate; also the fossa occupied by tensor veli palatini muscle.
- **scapula**: Greek skapto = I dig, because of the resemblance to a spade.
- **sciatic**: adjective, Greek ischion = hip-joint. Ischiadikos meant pertaining to the ischium or hip - later changed to sciatic. (The ischium earns its name because it forms > 2/5 of the acetabulum, whereas the ilium contributes < 2/5, and the pubis only 1/5). The sciatic nerve lies on the ischium.
- **sclera**: Greek skleros = hard; hence the tough, outer layer of the eyeball; adjective - scleral.
- **sclerotome**: Greek skleros = hard, and tome = a cutting.
- **scoliosis**: Greek skolios = crooked or curve, and -osis = condition, hence, the lateral curvature of the spine.
- **scrotum**: possibly derived from Latin scorteus = leather; adjective - scrotal.
- **secrete**: Latin secretus = separated; hence, to produce a chemical substance by glandular activity - adjective, secretory; noun, secretion.
- **sella**: Latin = saddle; adjective - sellar, sella turcica = Turkish saddle.

- **semen**: Latin = seed; adjective - seminal (seminal vesicle).
- **semilunaris**: adjective, Latin semi = half, and luna = moon; hence, having a half-moon shape.
- **semimembranosus**: adjective, Latin semi = half, and membrana = membrane; hence, the hamstring muscle of which the upper half is membranous.
- **seminiferous**: Latin semen = seed and ferre = to carry, to bear; hence, the sperm-producing tubules in the testes.
- **semitendinosus**: adjective, Latin semi = half, and tendo = I stretch; hence, the hamstring muscle of which the lower half is tendinous.
- **septum**: Latin saeptum = fenced in; hence, a dividing fence or partition.
- **serous**: Latin = like serum.
- **serratus**: adjective, Latin = notched like the edge of a saw (serrate).
- **sesamoid**: adjective, Greek sesamodes, eidos = shape or form; like grains of sesame, hence, small bone in tendon at site of friction.
- **sialogram**: Greek sialon = saliva, and gramma = a diagram; hence, a radiograph of a salivary duct.
- **sigmoid**: adjective, Greek sigma, the form used at the end of a word having an S-shape; hence, S-shaped.
- **sinister**: adjective, Latin = left-sided.
- **sinus**: Latin = a hollow or space which may contain air, venous or arterial blood, lymph or serous fluid; adjective, sinusoid.
- **sole**: the lower surface of the foot - see soleus.
- **soleus**: adjective, Latin solea = flatfish or sandal; hence soleus muscle which does not enter the sole of the foot, but resembles the fish.
- **solitarius**: Latin = solitary, alone.
- **soma**: Greek = the body.
- **somatic**: adjective, Greek soma = the body; hence, pertaining to the body frame but not to its viscera.
- **somite**: Greek soma = body, hence an embryonic body segment.
- **spasm**: Greek spasmos = an involuntary contraction of a muscle; adjective - spastic, or spasmodic.
- **sperma**: Greek = seed or semen, adjective, spermatic.
- **sphenoid**: adjective, Greek sphen = wedge, and eidos = shape or form; hence the unpaired bone which is wedged into the base of the skull between the unpaired frontal and occipital.
- **sphincter**: Greek sphinkter = a tight binder; hence, a circular muscle which closes an orifice; adjective - sphincteric.
- **spine**: Latin spina = a thorn; hence, a sharp process, or a lay term for the vertebral column; adjective, spinous, spinal.
- **splanchnic**: adjective, Greek splanchnon = a viscus or internal organ; hence pertaining to viscera.
- **spleen**: Latin splen = the spleen; hence; adjective - splenic (Latin - lien).
- **splenium**: Greek splenion = a bandage. The splenium of corpus callosum resembles a partly rolled bandage.
- **splenius**: Greek splenion = a bandage. Hence, splenius capitis muscle, with its finely-woven fibres and its quarter-spiral twist from a coronal to a sagittal plane.
- **spongiosum**: adjective, Greek spongia = a sponge.
- **squama**: Latin = a scale (as of fish or reptile); adjective - squamous.
- **squamous**: adjective, Latin squama = a scale (as of fish or reptile), hence scale-like.
- **stapes**: Latin = stirrup; adjective - stapedial, stapedius.
- **stellate**: adjective, Latin stella = star.
- **stereocilia**: Greek stereos = solid, and cilium = eyelash, hence non-motile microvilli.

- **sternebra**: Greek sternon = chest or breast, and -bra = from vertebra, hence the segments of the sternum that fuse in later life.
- **sternum**: Greek sternon = chest or breast; adjective, sternal.
- **stoma**: Greek = a mouth.
- **stomach**: Greek stomachos = gullet or oesophagus, later applied to the wider part of the digestive tract just below the diaphragm; adjective - gastric.
- **strabismus**: Greek strabismos = squinting; hence, inability to focus both eyes on a given point.
- **stratum**: Latin = a covering sheet, or layer.
- **stria**: Latin = furrow, applied to a streak or stripe.
- **striatum**: adjective, Latin striatus = furrowed; hence, corpus striatum, the caudate and lentiform nuclei connected by grey strands which traverse the internal capsule, giving the strands a striated appearance.
- **stroma**: Greek = bed or mattress, deep to the covers; hence, the supporting framework of an organ, as distinct from its special parenchyma.
- **styloid**: adjective, Greek stylos = an instrument for writing, and eidos = shape or form; hence a pen- or pencil-like structure.
- **subclavian**: Latin sub = under or below, and clavis = a key, hence under the clavicle.
- **subiculum**: diminutive of Latin subix = a support.
- **sublimis**: Latin = superficial.
- **substantia**: Latin = a substance.
- **succus**: Latin = juice (succus entericus, the secretion of the small intestine).
- **sudomotor**: Latin sudor = sweat, and movere = to move, hence stimulating the sweat glands.
- **sulcus**: Latin = a groove.
- **superciliary**: adjective, Latin super = above, and cilia = eyelid; hence, pertaining to the eyebrow.
- **superficial**: adjective, Latin super = above, and facies = surface; hence, nearer the surface.
- **superior**: adjective, comparative of Latin superus = above.
- **supination**: the act of turning the back of the hand to face posteriorly; verb - supinate.
- **supine**: adjective, Latin supinus, recumbent on the back. Hence, also, the position of the hand with the dorsum facing posteriorly.
- **supra**: Latin prefix = superior to.
- **suprarenal**: Latin supra = above, over, superior to, and ren = the kidney.
- **sural**: adjective, Latin sura = the calf.
- **sustentaculum**: Latin = a support, which sustains; sustentaculum tali - the ledge on the calcaneus supporting part of the talus.
- **suture**: Latin sutura = a seam; the fibrous joints between cranial bones.
- **sympathetic**: Greek syn = with, and pathos = feeling; hence, the peripheral part of the autonomic nervous system which arises in the thoracolumbar region of the spinal cord and communicates with other nerves.
- **symphysis**: Greek syn = with, and physis = growth; hence a joint where union between the bones is by fibrocartilage - used for median joints. (Symphysis of the mandible is exceptional, the 2 halves fusing before the age of 2).
- **synapse**: Greek syn = with, and aptein = to join; hence, the zone through which an impulse passes from one neuron to another.
- **synchondrosis**: Greek syn = with, and chondros = cartilage; hence, the union of 2 bones by cartilage.
- **syncytium**: Greek syn = with, and kytos = cell, hence a multinucleate mass of protoplasm, formed by the merging of cells.
- **syndesmosis**: Greek syn = with, and desmos = a band; hence, the union of 2 bones by fibrous tissue.

- **syndrome**: Greek syn = with, and dromos = running; hence, a group of signs and symptoms which is characteristic of a certain pathology.
- **synergist**: Greek syn = with, and ergon = work; hence a muscle which cooperates with others in producing a given movement.
- **synovia**: Greek syn = with, and ovum = egg; hence the fluid in freely movable joints resembling egg-white; adjective, synovial.
- **synovial**: adjective, Greek syn = with, and ovum = egg; hence pertaining to the fluid in freely movable joints resembling egg-white.
- **systole**: Greek = contraction; hence the contraction of cardiac muscle.
- **taenia**: Latin = a tape or ribbon.
- **talus**: Latin = ankle-bone; hence, the tortoise-shaped tarsal of the talocrural (ankle) joint.
- **tapetum**: Latin = a carpet or coverlet; hence the roof of the posterior horn of the lateral ventricle.
- **tarsus**: Greek tarsos = a flat surface; hence the flat part of the foot, and later, the bones of the foot behind the metatarsals, adjective, tarsal.
- **tectorial**: adjective, Latin tectorium = an overlying surface like plaster, a covering or roof.
- **tectum**: Latin = roof; hence the roof of the midbrain.
- **tegmen**: Latin = covering (cf. integument = the skin).
- **tegmentum**: Latin = covering.
- **tela**: Latin = a web; e.g., a fold of pia mater containing a choroid plexus.
- **telencephalon**: Greek telos = end, and enkephalos = brain; hence the rostral part of the developing brain. (With the diencephalon, it makes up the prosencephalon).
- **temporal**: Latin tempus = time; hence, the temporal area of the scalp, where grey hair first appears, marking the progress of ageing.
- **tendon**: Latin tendo = I stretch out.
- **tenia**: Latin = a tape or ribbon.
- **tensor**: Latin tensus = stretched; hence a muscle which produces tension.
- **tentorium**: Latin = tent; tentorium cerebelli.
- **teres**: Latin = rounded, cylindrical.
- **testicle**: Latin testiculus = the male gonad (see testis).
- **testis**: Latin testiculus = the male gonad. From Latin testis = a witness. Under Roman law, no man could bear witness (testify) unless he possessed both testes. Plural - testes.
- **tetralogy**: Greek tetra = four, and logos = discourse, hence a combination of four elements e.g., symptoms or defects.
- **tetrology**: Greek tetra = four, and logos = discourse, hence a combination of four elements or symptoms.
- **thalamus**: Greek = bedroom - derivation obscure, though the posterior end of the thalamus is rounded and named pulvinar = cushion.
- **theca**: Greek theka = a capsule, sheath.
- **thenar**: Greek = palm of hand; hence, the ball of the thumb.
- **thorax**: Greek = the chest, adjective, thoracic.
- **thrombus**: Greek = a clot.
- **thymus**: Greek = sweetbread.
- **thyroid**: Greek thyreos = shield, and eidos = shape or form; hence, shaped like a shield (which shields the glottis).
- **tibia**: Latin = the shin-bone, adjective, tibial.
- **tonsil**: Latin tonsilla = tonsil (e.g., palatine tonsil).
- **torus**: Latin = a bulge.
- **trabecula**: diminutive of Latin trabs = a beam; hence the supporting fibres of a structure.
- **trachea**: Greek tracheia = rough, referring to its corrugations.

- **tract**: Latin tractus = an elongated strand of wool or dough; hence a pathway for nerve fibres.
- **tragus**: Latin = goat, because of the beard-like tuft of hair on its internal aspect.
- **transverse**: perpendicular to the long axis.
- **trapezium**: Greek trapezion = a trapezium - a quadrilateral with 2 sides parallel.
- **trapezius**: Greek trapezion = a trapezium - a quadrilateral with 2 sides parallel; hence, trapezius muscle, the diamond-shape of both trapezii muscles together.
- **trapezoid**: Greek trapezion = a trapezium - a quadrilateral with 2 sides parallel, and eidos = shape or form, hence resembling a trapezium.
- **triceps**: Latin tres = 3, and caput = head; hence a 3-headed muscle.
- **trigeminal**: Latin trigeminus = triplets; hence, cranial nerve V, with 3 large divisions.
- **trigone**: Latin trigonum = a triangle.
- **triquetral**: Latin triquetrus = 3-cornered.
- **triticea**: Latin triticum = a grain of wheat; hence, the tiny cartilage in the lateral thyrohyoid ligament.
- **trochanter**: Greek = a runner; hence, the bony landmark, the greater trochanter, which moves so obviously in running.
- **trochlea**: Greek trochilia = a pulley.
- **truncus**: Latin = trunk (of a tree).
- **tuber**: Latin tuber = a swelling or lump.
- **tubercle**: Latin diminutive of tuber, a small prominence, usually bony.
- **tuberculum**: Latin diminutive of tuber, a small prominence, usually bony.
- **tuberosity**: Latin tuber = a swelling or lump, usually large and rough.
- **tunica**: Latin = shirt; hence a covering.
- **turbinate**: Latin turbo = a child's (spinning) top; hence shaped like a top. Old term for nasal conchi.
- **tympanum**: Latin = a drum.
- **ulna**: Latin = elbow or arm; hence, the medial bone of the forearm.
- **umbilicus**: Latin = the navel.
- **umbo**: Latin = the boss on the centre of a shield, umbo of tympanic membrane.
- **uncinate**: Latin uncinatus = hooked.
- **uncus**: Latin = hook; adjective - uncinate.
- **ungual**: pertaining to Latin unguis = finger-nail.
- **urachus**: Greek ouron = urine, and echein = to hold, hence the canal connecting the bladder and umbilicus in the foetus.
- **ureter**: Greek oureter = passage from kidney to bladder.
- **urethra**: Greek ourethra = passage from bladder to exterior.
- **uterus**: Latin = womb.
- **utricle**: diminutive of Latin uterus = womb.
- **uvea**: Latin uva = grape. The pigmented vascular layer of the eyeball (iris, ciliary body and choroid).
- **uvula**: diminutive of Latin uva = grape.
- **agina**: Latin = sheath; hence, invagination is the acquisition of a sheath by pushing inwards into a membrane, and evagination is similar but produced by pushing outwards.
- **vagus**: Latin = wandering; hence, cranial nerve X, which leaves the head and neck to traverse the thorax and upper part of the abdomen.
- **valgus**: Latin = knock-kneed.
- **vallate**: Latin vallatus = walled; hence, the large papillae on the tongue which are depressed below the surface and are surrounded by a groove which is itself bounded by a wall.
- **vallecula**: diminutive of Latin vallis = a fossa.
- **valve**: Latin valva = the segment of a folding-door.

- **valvula**: diminutive of Latin valva.
- **varicocoele**: Latin varix = vein and Greek kele = tumour, hernia, hence a varicose condition of the veins of the pampiniform plexus.
- **varus**: Latin = bow-legged.
- **vas**: Latin = vessel (plural = vasa).
- **vascular**: Latin vasculum, diminutive of vas; hence, pertaining to blood vessels.
- **vastus**: Latin = great, vast, extensive.
- **vein**: Latin vena; adjective - venous.
- **velum**: Latin = curtain; veli = of a curtain.
- **vena cava**: Latin vena = vein + Latin cava, from caves = hollow. It is unclear why the vain was classically termed �hollow�.
- **venter**: Latin = belly; hence, ventral, pertaining to the belly side.
- **ventricle**: diminutive of Latin venter = a small belly.
- **vermiform**: Latin vermis = a worm, and forma = shape; hence, worm-shaped.
- **vermis**: Latin = worm; hence, the segmented median part of the cerebellum.
- **vertebra**: Latin verto = I turn; hence, one of the movable bones of the backbone which seems to be shaped for rotation.
- **vertex**: Latin = summit; hence the highest point on the skull.
- **vertical**: perpendicular (at a right angle) to the horizontal.
- **vesica**: Latin = bladder, adjective - vesical.
- **vesicle**: diminutive of Latin vesica = bladder, hence a little bladder.
- **vesicula**: diminutive of Latin vesica = bladder; seminal vesicle.
- **vestibule**: Latin vestibulum = entrance hall.
- **vibrissa**: Latin vibrare = to vibrate; hence, the hairs in the nasal vestibule which vibrate in the current of air.
- **villus**: Latin a hair; hence, a vascular, hair-like process, usually projecting from a mucous surface.
- **vincula**: Latin = fetters (singular - vinculum); hence, the delicate vascular synovial bands passing to a tendon in the digits.
- **visceral**: adjective, Latin viscus = an internal organ.
- **viscus**: Latin = an internal organ, plural - viscera, adjective - visceral.
- **vital**: Latin vita = life.
- **vitelline**: Latin vitellus = yolk.
- **vitreous**: Latin vitreus = glassy.
- **vocal**: adjective, Latin vox = voice.
- **vomer**: Latin = plough-share; hence, the bone of the nasal septum which is split in two at its upper edge.
- **vorticosae**: Latin vortex = whirl; hence the whirl-like arrangement of the 4 venae vorticosae leaving the eyeball.
- **vulva**: Latin = the external female genitalia.
- **xiphoid**: Greek xiphos = a sword, and eidos = shape or form; hence, sword-shaped.
- **zona**: Latin = a belt; hence, a circular band.
- **zonule**: diminutive of zona.
- **zygapophysis**: Greek zygon = yoke, apo = from, physis = growth; the articular process of a vertebra. The downward "growth" of the vertebra above articulates with the upward "growth" of the vertebra below, forming a zygapophyseal joint.
- **zygoma**: Greek zygon = yoke; hence, the bone joining the maxillary, frontal, temporal and sphenoid bones.
- **zygomatic**: adjective, Greek zygon = yoke; hence, pertaining to the bone joining the maxillary, frontal, temporal and sphenoid bones.

- **zygote**: Greek zygon = yoke; hence the fusion of the male and female gametes.

INDEPENDENT WORK OF STUDENTS

Calendar-themed plan of independent work

№	Theme	Hours
1	The principles of the segmental structure of the skeleton. Age and gender differences of the spinal column.	4
2	Age features of the chest, the impact of sports and work on its formation. Anomalies of development.	4
3	X-ray of skeleton bones. Anomalies in the development of the skeleton.	4
4	Age and gender features of the skull, developmental anomalies.	4
5	Age-related features of the pelvis and bones of the lower extremities, the influence of sports and work on the formation of the pelvis and bones of the lower extremities, their developmental anomalies.	4
6	X-ray of the bones of the skull. Age and gender features of the skull	4
7	X-ray of the bones and joints.	4
8	Joint biomechanics. Joint X-ray.	4
9	History of the study of x-rays on the osteoarticular system.	4
10	New technologies in X-ray anatomy.	4
11	Biomechanics and joint functions.	4
12	Age and gender features of the inguinal canal, the influence of external and internal factors on inguinal hernias and malformations.	4
13	X-ray and malformations of the digestive system. Tooth x-ray.	5
14	Bites and abnormalities of the development of teeth.	5
15	Disorders of GIT (definitions only).	5
16	Age features of malformations of the palate.	5
17	The process of breathing. X-ray and malformations of the respiratory system.	5
18	Mechanism and physiology of respiration and regulation of respiration. Transport of respiratory gases.	5
19	Definition of: Hypoxia, Asphyxia, Dybarism, Oxygen therapy and resuscitation.	5
20	Malformations of the urinary system.	5
21	The process of prolapse of the testicle into the scrotum and genital malformations.	5
22	The influence of social and biological factors on the development and structure of lymphatic vessels.	5
23	The structure, development and function of the thymus.	5

24	Blood vessels and circulation (Pulmonary, coronary and systemic circulation).	5
25	Malformations of the heart. X-ray of blood vessels and heart.	5
26	Electrocardiogram (ECG). Cardiac cycle and heart sounds.	5
27	Blood pressure – its maintenance and regulation.	5
28	Arterial branching rules. Microcirculation concept	5
29	Rules for branching arteries.	5
30	The concept of microcirculation.	5
	TOTAL	138

Regulation on the rating system

I. General rules

The purpose of this system is to control, improve, systematize and deepen the existing knowledge, training highly qualified specialists.

The main objectives of the rating system:

A) the formation of a certain range of knowledge, skills and abilities in accordance with the requirements of the program.

B) assessment of students' knowledge according to the criteria of rating.

C) the promotion of the assimilation of objects by students.

D) the organization of work in the classroom visual, abilities.

E) ensuring the systematization of knowledge by students.

F) assessment of students' knowledge in each semester.

G) ensure the conditions for the computerization of the organization of the educational process

II. Types of control

Assessment of students' knowledge on the subject during the semester is carried out on the basis of the table of rating control and evaluation criteria.

Evaluation should be carried out by the following types of work

1) Initial test.

2) Verification

3) The final test.

4) The total score of students' knowledge for the semester is 100 points, which are distributed as follows:

1) Current control - 45 b

2) Independent work– 5 b

3) Intermediate control - 20 b

4) Final control - 30 b

Types of control	Maximum score	Coefficient	Passing score

Current control	45 b	0,45	24,75
Independent work	5 b	0,05	2,75
Intermediate control	20 b	0,2	11,0
Final control	30 b	0,3	16,5
Итого:	100	1	55,0

Current control

The current control of the subject is determined by the knowledge of each topic and practical skills. Students' skills are determined during the period of practical seminars and practical work.

Current control can be carried out in the form of an oral survey, tests, conversation, test work, colloquium, homework tests and other ways.

Independent work of student (IWS)

1) Independent work of a student is carried out in accordance with the order of the Ministry of Higher and Secondary Education of the Republic of Uzbekistan dated February 21, 2005 No. 34 by 100 point current control system and in accordance with other types of control

2) the topics of independent work of students on the subject “Human Anatomy” are compiled in accordance with the program approved by the Ministry of Health from 2014 and reviewed at the meeting of the department.

3) independent work on the subject is possible by carrying out the following work on relevant topics: writing notes, making test questions, creating crossword puzzles, and presentations.

In the educational journal of a teacher after the last practical lesson of this academic year, there is one column in which the average points of students for independent work are entered.

Intermediate control.

Intermediate control is carried out on several topics of the subject or after passing theoretical lessons on topics. At the same time, the ability to solve problems by a student or by answering certain questions is determined, and given the above, an assessment is derived. Intermediate control is carried out orally 1 time per semester, but given the extensive material on human anatomy, the department decided to carry out intermediate controls in 3-4 sections in each semester. Intermediate control is carried out orally during the year on a 100 point rating system. An interim control pass is given only to those students who have passed all practical work topics and are not in arrears.

Final control.

On the final control assess the knowledge and skills of the student, acquired in all topics of the subject. The final control is carried out at the end of the II and III semester. At the final control on human anatomy, students are allowed to have a positive assessment (at least 55%) for current and intermediate control, as well as CPC. The final control is carried out orally (in writing) and in the form of tests and is assessed on a 100 point rating system. In case of unsatisfactory delivery of the final control, re-retake is possible only with the permission of the dean's office.

Evaluation of responses is carried out according to the following criteria.

№	Performance	Evaluation	Level of students' knowledge.
1	90-100	Excellent "5"	-able to make independent decisions and conclusion -has creative thinking -can independently think

			-can apply interactive games more actively -solves situational problems with a full justified answer -understands the meaning of the question and answered with confidence -has a full understanding
2	70-89	Good "4"	-may apply in practice interactive games more actively -solves situational problems,but completely unable to explain -understands the meaning of the question and answered with confidence -has a full understanding
3	60-69	Satisfactory "3"	-solves situational problems ,but can't justify the answer -knows can answer -on certain issues has an idea
4	0-60	Unsatisfactory "2"	-has no representation on this topic -doesn't know the subject

In surveys, it is recommended to rate the student in whole grades.
Student knowledge of human anatomy is assessed by the following formula: R1 = V * O / 100 where V is the total number of hours allotted for the semester. O- level of achievement in the subject.

The procedure for the certification of students in subjects.

CC (51 lessons) C= 0,45	Average CC (65+73+78+85+86+87) / 6=79 Ball CC = 79 x 0,45= 35,5
IWS (34) C = 0,05	Average IWS (90+85+86) / 3=87 Ball IWS = 87 x 0,05 = 4,35
IC C = 0,2	Orally 76 x 0,2 = 15,2
FC orally or in writing Test	FC (orally or in writing) = 80 x 0,15= 12 FC (test) = 84 x0,15 = 12,6
Total ball	35,5 + 4,35 +15,2 + 12 + 12,6 = 79,6 (good)

Intermediate and final controls are carried out in accordance with the approved calendar and thematic plan based on the rating system. The final control is carried out during the last 2 weeks of the 2 and 3 semesters.

Students who have not received enough points or are absent for a good reason during the intermediate control are given a time limit to re-pass the last current and intermediate control to the final control.

Students who do not pass the current, intermediate and final control before the deadline due to illness, given a 2-week period for delivery with the permission of the dean of the faculty.

A student who has not collected 55% of current or intermediate control and is in arrears is considered an academic debtor and is not allowed to take final control. Academic debtors are given a period of one month for liquidation of debts and re-transfer (with the permission of the dean's office).

If a student does not agree with the results of controls, then after announcing grades over the next day, he may turn to the dean of the faculty with a statement. In this case, after the permission of the dean of the faculty, on the basis of the order of the rector, an appeal commission consisting of at least 3 members is organized. On the same day, the appeal commission reviews the student’s application and summarizes the results.

IV. The procedure for recording rating results

The results of students' test papers are recorded in the rating book in whole numbers. In the rating book in a certain column for the selected hours of the curriculum is recorded the number of hours for the subject. And in the grading graph of the subject is rated on a 100 point system. The score below the passing score is not recorded in the rating book.

The results of examinations on the subject are also recorded in educational journals and announced to students on the same day (if the examinations were carried out in writing, they are announced within 2 days)

The teacher of the subject according to the results of the final control of the students determines the rating and writes in the required column of the rating book.

Students rating points are announced at the end of each semester and school year.

The results of the current, intermediate and final controls are discussed at the department meetings and the corresponding decisions are displayed.

TESTS

What kind of surface has a tooth crown?

+ facies vestibularis,facies lingualis,facies contactus mesialis, facies contactus distalis et facies occlusalis

- facies vestibularis,facies lingualis,facies contactus

- facies vestibularis,facies lingualis,facies occlusalis

- facies lingualis,facies contactus mesialis,facies contactus distalis, facies occlusalis

Specify own muscles of the tongue:

+ mm.longitudinales superior et inferior,m.transversus linguae, m.verticalis

- mm.longitudinales superior et inferior,m.transversus linguae, m.styloglossus

- m.transversus linguae, m.verticalis,m.genioglossus

- mm.longitudinales inferior, m.transversus linguae,m.hyoglossus, mm.longitudinales superior, m.verticalis,m.uvulae

Specify the skeletal muscles of the tongue:

+ m.genioglosus, m.styloglossus, m.hyoglossus

- m.genioglosus, m.styloglossus, m.verticalis

- m.styloglossus, m.hyoglossus, m.transversus

- m.longitudinalis,m.styloglossus, m.hyoglossus

Between tooth enamel and pulp:

+ dentinum

- gingiva

- alveola

- fossa alveolaris

Between the root of the tooth and the alveolus:

+ periodontium

- gingiva

- alveola

- fossa alveolaris

Parodontium consists of:

+ periodont,gingiva,alveola

- enemalum,cementum,dentinum

- pulpa,canalis radicis dentis

- enemalum,cementum,dentinum

Lingua has:

+ papillae filiformes - tonsilla palatini

- m.palatopharingeus

- m.uvulae

Lingua has:

+ papillae foliatae

- tonsilla palatini

- m.palatopharingeus

- m.uvulae

Lingua has:

+ tonsilla lingualis- tonsilla palatini - m.palatopharingeus - m.uvulae

To the caruncula sublingualis opens:+ ductus submandibularis- ductus paratoideus- ductus thyroideus- ductus paratoideus major

To the caruncula sublingualis opens:+ ductus sublingualis major - ductus paratoideus

- ductus thyroideus- ductus choledochus

To the caruncula sublingualis opens:+ ductus sublingualis major

- ductus paratoideus major

- ductus choledochus

- ductus cisticus

Pharynx has:

+ pars nasalis

- pars alaris- pars tubaria

- pars esophagea

Pharynx has:

+ pars oralis

- pars tubaria- pars esophagea

- pars palatina

Pharynx has:

+ fornix pharyngis - gingiva- alveola

- fossa alveolaris

Pharynx has:

+ tonsilla tubaria - gingiva- alveola- fossaalveolaris

Pharynx has:+ m.stylopharyngeus - m.genioglossus

- m.vocalis

- m.levator veli palatini

Pharynx has:+ m.constictor pharyngis medius - m.cricoarythenoideus - m.genioglossus - m.vocalis

Pharynx has:+ pars laryngea- m.genioglossus

- m.vocalis - m.levator velipalatini

Esophagus has:

+ pars cervicalis

- pars ascendens - pars tubaria- pars horizontalis

Esophagus has:+ tunica submucosa

- pars oralis - pars tubaria- pars esophagea

Esophagus has:+ pars thoracica - villi intestinalis - tenia omentalis-. epiploicae

Ventriculus has:+ ostium cardiacum - canalis esophagea- tunica fibrosa- pars laringea

vertebrae differ from other vertebrae in the presence of:

+ foramina processus transversalia- foveae costales

- tuberculum costae - processus accessorius

Thoracic vertebrae differ from other vertebrae in the presence of: + foveae costales- tuberculum anterior et posterior - foramina. processus transversalia. - processus accessorius

Lumbar vertebrae differ from other vertebrae in the presence of: + processus accessorius, processus mamillaris

- tuberculum anterior et posterior -. foveae costales -. foramina processus transversalia.

What are the parts that belong to the first cervical vertebra?

+ arcus anterior

- fovea costalis

- processus spinosus

- dens

What are the parts belonging to the thoracic vertebra? + foveae costales- processus accesorius- tuberculum conoideum

- arcus anterior

Specify the parts belonging to the cervical vertebra II?

+ dens

- incisurae costales- foveae costales- arcus anterior

Where is cavitas glenoidalis located on the shoulder blades? + angulus lateralis

- angulus inferior

- angulus superior

-. angulus medialis

At the proximal end of the humerus are located:

+ collum anatomicum, collum chirurgicum- fossa olecrani, collum anatomicum - capitulum humeri, trochlea, crista tuberculi majoris - fossa olecrani, fossa radialis, fossa coronoidea

At the distal end of the humerus are located: + fossa coronoidea, fossa olecrani

- sulcus intertubercularis, fossa radialis

- collum chirurgicum, capitulum humeri

- collum anatomicum, trochlea humeri

At the distal end of the humerus are located:

+ fossa radialis, trochlea humeri- caput humeri, trochlea humeri - collum anatomicum, capitulum humeri

- fossa olecrani, tuberositas deltoidea

At the proximal end of the ulna are located:

+ olecranon, processus coronoideus

- incisura ulnaris, circumferentia articularis-- incisura radialis, incisura ulnaris

-   incisura trochlearis, incisura ulnaris

At the proximal end of the ulna are located: + incisura trochlearis, incisura radialis

-   incisura radialis, incisura ulnaris- incisura trochlearis, incisura ulnaris- processus styloidens, incisura trochlearis

At the distal end of the ulna are located:

+ processus styloidens, circumferentia articularis- processus coronoideus, olecranon - incisura trochlearis, incisura radialis

- processus styloidens, processus coronoideus

At the distal end of the ulna are located: + caput, processus styloideus- circumferentia articularis, incisura ulnaris

- processus styloidens, processus coronoideus- caput, incisura ulnaris

At the proximal end of the radius are located: + caput, collum

- circumferentia articularis, olecranon

- incisura trochlearis, processus coronoideus

- caput, processus styloideus

At the proximal end of the radius are located:

+ circumferentia articularis, caput- collum, processus styloideus

- caput, processus coronoideus - circumferentia articularis, trochlea

At the distal end of the radius are located: + processus styloideus, incisura ulnaris

- incisura ulnaris, caput-. incisura radialis, processus styloideus

-. incisura radialis, facies articularis carpea

At the distal end of the radius are located:

+ facies articularis carpea, incisura.ulnaris

- incisura radialis, facies articularis carpea-. caput radii, collum radii -. processus styloideus, incisura radialis

In the formation of the neurocranium is involved:+ os frontale

- concha nasalis inferior

- vomer

- mandibula

In the formation of the neurocranium is involved:

+ os temporale

- os palatinum- mandibula- os lacrimale

In the formation of cranium viscerale involved: + maxilla, os lacrimale- os temporale, os palatinum- os parietale-. os frontale

#:What kind of joint is uniaxial? + art.radioulnaris - art.genu

- art.coxae - art.radiocarpea

Which joint is multiaxial?

+ art.coxae

- art.talocruralis - art.cubiti - art.genu

What is inside the temporomandibular joint? + discus articularis- lig.laterale- lig.sphenomandibulare-. lig.caput mandibule

The intra-articular ligament of the hip joint?

+ lig.transversum acetabuli

- lig.transversum genus - lig.cruciatum anterius

- lig.cruciatum posterius

What is inside the knee joint?

+ meniscus lateralis et medialis - labrum glenoidale - labrum acetabularae - lig.capitis femoris

What is inside the knee joint? + ligg.cruciata.genus

- ligg.collaterale tibiale

- lig.popliteum arcuatum -. lig.capitis femoris

What joints form art.tarsi transversa? + art.calcanocuboidea, art.talonaviculare

- art.cuneonavicularis, art.talonaviculare - art.calcanocuboidea, art.cuneonavicularis - art.tarsometatarseae, art.cuneonavicularis

What ligament strengthens the arch of the foot?

+ lig.plantare longum -. lig.bifurcatum- lig.calcanonaviculare -. lig.calcanocuboideum

To linea superior nuchae is attached:

+ m.splenius capitis

- m.splenius cervicis-. mm.rotatores- m.obliquus capitis superior

Lateral wall of the femoral canal:+ v.femoralis- hiatus saphenus-. lig.inguinale and edge fascia lata -. annulus femoralis

The outer ring of the femoral canal: + hiatus saphenus

- annulus femoralis

- lig.inguinale and edge fascia lata

- v.femoralis

Inner ring (opening) of the femoral canal: + annulus femoralis- hiatus saphenus

- lig.inguinale and edge fascia lata -. v.femoralis

The medial wall of the canalis adductorius: + m.adductor magnus - v.femoralis

- lamina vastoadductoria- hiatus tendineus

The contents of the canal canalis adductorius: + a.et v.femoralis-. hiatus tendineus- lamina vastoadductoria - m.adductor magnus

The distal opening of the canalis adductorius:

+ hiatus tendineus- a.et v.femoralis- lamina vastoadductoria- m.adductor magnus

The top wall of the inguinal canal: + mm.obliqus internus abdominis et transversus abdominis - lig.inguinalis - aponeurosis of m.obliqus externus abdominis- fascia transversalis

The bottom wall of the inguinal canal: + gut of the inguinal ligament- mm.obliqus internus abdominis et transversus abdominis

- aponeurosis of m.obliqus externus abdominis

-. fascia transversalis

Muscle derivatives of the first visceral arc: + m.mylohyoideus, front abdomen of m.digastricus, m.stylohyoideus, m.sternohyoideus - m.mylohyoideus, m.sternohyoideus - m.stylohyoideus, m.milohyoideus

-. m.digastricum, m.sternohyoideus

Muscle derivatives of the second visceral arches: + m.stylohyoideus, back abdomen m.digastricus, m.platisma. m.stylohoideus, m.omohyoideus - m.sternohyoideus,m.platysma- m.omochyoideus,m.thyroideus - m.platysma,m.omochyoideus

Where m.quadriceps femoris is attached? + tuberositas tibiae- crista.anterior tibiae- condilus medialis tibiae-. condilus lateralis tibiae

Where m.semitendinosus is attached? + tuberositas tibiae- caput femoris

- caput fibulae

-. epicondilus medialis tibiae

Where m.biceps brachii begins?

+ tuberculum supraglenoidale, processus carocoideus scapulae

- tuberositas humeri - processus coracoideus scapulae - tuberositas supraglenoidalis

Where m.biceps brachii is attached? + tuberositas radii- the middle third of the os radii

- tuberositas ulnae

- membrana interossea# Part m.erector spinae included: + m.iliocostalis,m.spinalis, m.longissimus - m.iliocostalis,m.rectus capitis posterior major - m.spinalis,m.obliquus capitis inferior -. m.transversospinalis,m.rotatores

Parts of m.transversospinalis? + m.semispinalis,mm.rotatores, mm.muitifidi - mm.multifidi,m.iliocostalis - m.rectus capitis posterior major, m.spinalis m.longissimus, - m.iliocostalis,mm.rotatores

The place of attachment m.pectoralis major? + crista tuberculi majoris ossis humeri- tuberositas deltoidea ossis humeri - crista tuberculi minoris ossis humeri - margo medialis scapulae

What muscles are part of the soft palate? + mm.palatopharyngeus,palatoglossus, levator veli palatini,tensor veli palatini,uvulae - m.palatoglossus, tensor veli palatini - m.palatopharyngeus,m.uvulae - m.levator veli palatini,m.depressor veli palatini

What parts does the pharynx consist of? + pars nasalis,pars oralis,pars laryngea

-- pars nasalis,pars oralis- pars oralis,pars laryngea-. pars nasalis,pars oralis,pars pharyngea

What bags are located in the upper floor of the abdomen?

+ bursa hepatica,bursa omentalis,bursa pregastrica

- bursa omentalis,bursa hepatica- bursa omentalis,bursa duodenoejunalis- bursa hepatica,bursa iliocecale

The large intestine differs from small with presence?

+ haustra coli- villi coli

- folliculi lymphatici aggregati

- tunica mucosa

What makes up the front wall of bursa omentalis?

+ ventriculus,omentum minus

- gaster,omentum majus - lig.hepatoduodenale, lig.hepatorenale

-. lien,duodenum,lig.teres hepatis

Where does the common bile duct open? + papilla duodeni major - papilla duodeni minor- pars superior duodeni- pars inferior duodeni

Specify ligaments of the liver? + lig.falciforme,lig.teres - lig.teres,lig.portae hepatis

- lig.falciforme, lig.vesicae felleae - lig.quadratum,lig.coronarium

From the fusion of which ducts ductus choledochus is formed?+ ductus hepaticus communis,ductus cysticus- ductus hepaticus propria,ductus cysticus- ductuli biliferi,ductus hepaticus proprius- ductus lobaris,ductus cysticus

Where does ductus pancreaticus accessorius open?

+ papilla duodeni minor

- papilla duodeni major

- intestinum tenue - jejunum

What ligaments form omentum minus?+ lig.hepatoduodenale, lig.hepatogastricum

- lig.hepatolienale, lig.hepatorenale - lig.hepatoduodenale, lig.hepatorenale - lig.hepatogastricum, lig.gastrocolicum

Which is the border between bursa hepatica and bursa pregastrica? + lig.falciforme hepatis - lig.gastrolienale - lig.phrenicolienale - lig.hepatoduodenale

What is restricted from above foramen epiploicum?+ lobus caudatus hepatis- lobus quadratus hepatis- lobus dexter hepatis - lig.hepatoduodenale

What is restricted foramen epiploicum from front part?+ lig.hepatoduodenale

- lig.hepatogastricum - lig.hepatorenale- lobus sinister hepatis

Specify the ligament of the liver?+ lig.falciforme, lig.hepatogastricum- lig.teres, lig.portae hepatis - lig.falciforme, lig.vesicae felleae - lig.quadratum, lig.coronarium

What tooth has 3 roots?+ I dens molaris superior- III dens molaris inferior- II dens premolaris superior- III dens molaris superior

Which tooth has two canalis radicis dentis?+ I dens molaris inferior

-. I dens molaris superior-. II dens incisivus superior

- III dens molaris superior

What tunica is absent in the wall of the stomach?+ tunica adventitia - tunica mucosa

- tunica muscularis

- tunica submucosa

Part of the stomach connected to the esophagus?+ pars cardiaca- canalis pyloricus - pars pylorica-. fundus

What comes out of the liver's gate?+ ductus hepaticus communis - ductus choledochus - ductus cysticus - ductuli biliferi

Where does ductus choledochus open? + papilla duodeni major-. papilla duodeni minor-. villi intestinales- plica longitudinalis duodeni

Where is the voice gap located?+ between plicae vocales - between plicae vestlbularis

- between plicae vocalis and plicae vestibularis- between m.vocalis and plica vocalis

What parts are distinguished in rima glottidis?+ pars intermembranacea et pars intercartilaginea - pars intermembranacea - pars intercartilaginea

- pars thyroidea et pars intercartilaginea.

What is included in the bronchial tree?

+ bronchus principalis,lobaris, segmentalis,lobularis et terminalis - bronchus terminalis et respiratorius, lobaris,lobularis- bronchus segmentalis,respiratorius, terminalis, ductus alveolaris - bronchus lobaris,principalis,terminalis

What surfaces are distinguished in the lung?+ facies diaphragmatica,facies costalis,facies medialis - facies diaphragmatica et facies anterior

- facies costalis,facies pleuralis, facies diaphragmatica.

- facies pleuralis,facies mediastinalis

What edges are distinguished in the lung? + margo inferior et anterior- margo anterior,posterior et inferior- margo anterior et superior- margo posterior et superior

What are the grooves in the pleural cavity?+ recessus costodiaphragmatis, recessus costomediastinalis,recessus phrenicomediastinalis -. recessus costodiaphragmatis -. recessus costomediastinalis - sinus phrenicomediastinalis, sinus pleuromediastinalis

What is absence in the arytenoid cartilage?+ linea obliqua- basis- apex- processus vocalis

What is absence in the thyroid cartilage?

+ apex- incisura- cornu- laminae

Where is cartilago triticeae located?

+ ligg.thyrohyoidea lateralia - ligg.thyroepiglotticum - ligg.thyrohyoideum medianum -. ligg.hyoepiglotticum

Where is ventriculus laryngis located?

+ between plica vestibularis and plica vocalis - between aditus laryngis and plica vestibularis

- between aditus laryngis and plica vocalis - between aditus laryngis and rima glottidis

Where is cavitas infraglottica located?

+ between plica vocalis and trachea - between aditus laryngis and plica vestibularis - between plica vestibularis and plica vocalis - between plica vestibularis and trachea

Which cartilage is absence in the wall of the bronchi?+ bronchioli terminales- bronchus principalis- bronchioli lobulares-. bronchi segmentales

On the wall of which bronchi appears alveoli pulmonis?+ bronchioli respiratorii- bronchus lobaris- bronchioli terminales- bronchioli lobulares

Where do ductuli alveolares open?+ bronchioli respiratorii- bronchioli lobulares

- bronchioli terminales- bronchus lobaris

What is not included in the acinus?+ bronchioli lobularis - ductuli alveolaris

- sacculi alveolaris - bronchioli respiratoria

What organs are located in the front mediastinum?+ trachea,bronchi principales - trachea,bronchi lobularis - trachea,oesophagus - aorta thoracica, nn.phrenici

What organs are located in the upper part of the front mediastinum?+ nn.phrenici,arcus aortae - n.vagus,arcus aortae

- truncus sympaticus,aorta.ascendens - v.azygos,nn.phrenici

What organs are located in the posterior mediastinum?+ v.cava.inferior,v.azygos - v.hemiazygos,aorta ascendens

- v.cava superior,v.azygos - v.cava inferior,aorta ascendens

What organs are located in the lower part of the front mediastinum?+ cor et pericardium - n.phrenici- thymus- v.cava superior

What organs are located in the posterior mediastinum? + nn.splanchnici,nn.vagi- truncus sympaticus,nn.phrenici - nn.splanchnici,nn.phrenici - nn.vagi,nn.phrenici

On which part of the fallopian tube are fimbriae tubae located?

+ infundibulum- ampulla- isthmus- pars uterina

A narrowed part of the male urethra? + pars membranacea- pars prostatica- bulbus- pars spongiosa

What are the tunicas covered testis and the spermatic cord?+ skin, tunica dartos,fascia spermatica externa, fascia cremasterica, m.cremaster,

- interna, tunica vaginalis testis

- skin, m.cremaster, fascia spermatica interna,tunica vaginalis testis - skin, fascia cremasterica, m.cremaster, fascia spermatica interna - skin, fascia spermatica externa, tunica vaginalis testis

What kind of tunica is the testis parenchyma covered with?+ tunica albuginea- tunica vaginalis testis- fascia cremasterica- fascia spermatica externa

Where does spermatogenesis occur?+ tubuli seminiferi contorti

- rete testis- tubuli seminiferi recti

- tubuli efferentes

What are the fascia in the area of the urogenital diaphragm?+ f.diaphragmatis urogenitalis superior, inferior et f.perinei superficialis - f.diaphragmatis urogenitalis superficialis et profunda- f.diaphragmatis urogenitalis externa.et interna - f.diaphragmatis urogenitalis propria

What parts are distinguished in the ductus deferens?

+ pars testicularis,pars funicularis,pars inguinalis,pars pelvina - pars abdominalis,pars pelvina- pars testicularis,pars inguinalis, pars pelvina- pars funicularis,pars pelvina

What's the duct of the seminal vesicle?+ ductus excretorius

- ductus ejaculatorius - ductus efferens

- ductus epididymidis

What parts does the cricoid cartilage consist of?

+ lamina et arcus

- arcus et cornu

- arcus et facies articularis- lamina et cornu

Specify the larynx joints?+ art.cricothyroidea, art.cricoarytenoidea - art.cricothyroidea, art.hyoepiglottica- art.cricoarytenoidea, art.thyroepiglottica- art.hyoepiglottica, art.thyroepiglottica

What ligaments are there in the larynx?

+ lig.hyoepiglotticum, lig. thyroepiglotticum - lig.hyoepiglotticum, lig.cricoarytenoideae

- lig. thyroepiglotticum, lig.arytenoideus transversus

- lig.cricothyroideum, lig.thyroarytenoideus

What muscles are related to the urogenital diaphragm?+ m.transversus perinei profundus

- m.levator ani - m.coccygeus - m.sphincter ani externus

What does the kidney body consist of?+ glomerulus et capsula glomeruli

- capsulla glomeruli et tubuli renalis- glomerulis, Genle’s loop- et tubuli recti

What is the formation of the lobulus corticalis of the kidney?+ pars radiata,pars convoluta- pars radiata,pars corticalis

- pars convolute, papilla.renalis

- pyramides renales

Where does urine flow from the ductus papillaris?

+ calyces renalis minores- ureter- calyces renalis majores- pelvis renalis

What concerns the renal apparatus of the kidneys?+ m.sphincter fornicis,m.levator fornicis,m.spiralis calycis et m.longitudinalis calycis - m.levator fornicis et m.spiralis calyces - m.sphincter fornicis et m. transversus calycis

- m.spiralis calycis et m.verticalis fornicis

What parts are distinguished in the ureter?+ pars abdominalis, pars pelvina, pars intramuralis- pars thoracica et pars abdominalis

- pars pelvina et pars vesicalis- pars sacralis et pars intramuralis

What layers does the ureter wall have?+ tunica mucosa,tunica muscularis, tunica adventitia- tunica mucosa, tela submucosa et tunica muscularis- tunica mucosa,tunica muscularis, tunica serosa- tunica mucosa,submucosa,tunica adventitia

What layers is in the wall of the bladder?

+ tunica mucosa,tela submucosa, tunica muscularis,tunica serosa- tunica mucosa,tela submucosa, tunica adventitia.- tunica mucosa,tunica muscularis, tunica serosa

- tunica mucosa,tela submucosa, tunica serosa

What parts are different in the male urethra?+ pars prostatica,pars membranacea, pars spongiosa- pars prostatica,pars spongiosa, pars anterior- pars vesicalis,pars spongiosa, pars posterior- pars spongiosa,pars membranacea.

What ligaments does the ovary have?+ lig.ovarii proprium, lig.suspensorium ovarii - lig.suspensorium et lig.teres ovarii- lig.latum ovarii- lig.teres ovarii

What are the parts of the fallopian tube?+ pars uterina, isthmus, ampulla, infundibulum- pars uterina, pars pelvina- ampulla, collum, infundibulum- pars abdominalis, pars pelvina

The position of the uterus?+ anteversio, anteflexio- retroversio, retroflexio- anteversio, retroflexio- retroversio, anteflexio

What ligaments does the uterus have?+ lig.latum, lig.teres,lig.cardinale - lig.latum, lig.suspensorium - lig.ovarii proprium - lig.cardinale, lig.uteri proprium

What kind of tunic does the kidney have?+ capsula adiposa- ductus papillaris- capsula glomeruli- tubulus renalis contortus

What kind of formation is not part of the nephron?+ ductus papillaris- capsula glomeruli- tubulus renalis contortus prima- glomerulus

What part does the bladder have?+ fundus- caput- fascia cremasterica

- tunica dartos

What part is missing in the epididymis?+ cervix epididymidis- sinus epididymidis- corpus epididymidis- cauda epididymidis

Which tunic is absent in the scrotum?+ tunica serosa- fascia cremasterica- tunica dartos- fascia spermatica externa

What part does the fallopian tube have?+ isthmus- corpus- tunica serosa- fascia cremasterica

Branches of the ascending aorta:+ a.coronaria dextra, a. coronaria sinistra - a.subclavia, a. carotis communis dextra- tr. brachiochephalicus, a. subclavia- a.thyroidea superior et a timica

Aortic arch branches:+ tr. brachiocephalicus, a. carotis communis sinistra, a. subclavia sinistra- tr. brachiocephalicus dexter et sinister

- a. subclavia dextra, sinistra et a. coronaria.dextra.- a. carotis communis sinistra et dextra, a. subclavia.sinistra

Parietal branches of the thoracic part of the aorta:+ aa.intercostales posteriores, a.a.phrenicae superiores - aa.intercostales posteriores, bronchiales, esophagei

- aa.intercostales anteriores, diaphragmatis, esophagei - aa.phrenicae et esophagei

Visceral branches of the thoracic aorta:+ aa.bronchiales, esophagei, pericardiaci, mediastinales - aa.bronchiales, phrenicae, esophagei, mediastinales - aa.bronchiales, aa.intercostales posteriores- aa.esophagei, cardiales, mediastinales

Parietal branches of the abdominal part of the aorta: + aa.phrenicae inferiores, lumbales, a. sacralis median

- aa.phrenicae, suprarenales, renales, lumbales

- aa.lumbales, a. sacralis mediana et lateralis- aa.lumbales et intercostales inferiores, a. sacralis

Unpaired visceral branches of the abdominal aorta:+ truncus coeliacus, a. mesenterica superior, a. mesenterica inferior - aa. mesenterica superior et inferior, a. rectalis superior - truncus coeliacus, a. mesenterica superior, a. gastrica sinistra- truncus coeliacus, a. lienalis, a. hepatica communis

Paired visceral branches of the abdominal aorta: + ovarica(testicularis), a. renalis, a. suprarenalis media - a.a.renales, aa.suprarenales, aa.phrenicae inferiores et superiores - a.testicularis (ovarica), a. renalis et aa.lumbales - a.renalis, aa.glandulae suprarenales superiores et aa.lumbales

Anterior branches of the external carotid artery:+ a.thyroidea superior, a. lingualis, et a. facialis - a.thyroidea superior et inferior, a. lingualis- a.thyroidea superior, a. facialis-. a.facialis, a. lingualis, a. occipitalis

Posterior branches of the external carotid artery:+ a.occipitalis, a. auricularis posterior, a. sternocleidomastoidea - a.occipitalis, a. facialis, a. pharyngea- a.occipitalis, a. auricularis posterior, a. thyroidea.- a.auricularis posterior, a. maxilaris, a. temporalis

Middle branches of the external carotid artery:+ a.pharyngea ascendens, a. temporalis superficialis, a. maxillaris - a.temporalis, a. facialis, a. pharyngea- a.maxilaris, a. facialis, a. temporalis- a.facialis, a. thyroidea, a. lingualis

Branches of the first section of the maxillary artery:+ a.meningea.media, a. alveolaris inferior- a.alveolaris superior et a. alveolaris inferior- a.meningea media, a. nasalis posterior- a.muscularis кжевательныммышцам

Branches of the second part of the maxillary artery:+ aa.alveolares superiores posteriores иветвикжевательныммышцам - aalveolaris inferior et a. meningea.media- a.alveolaris superior posterior et a. infraorbitalis- ветвикмимическиммышцамиa. alveolaris superior

Branches of the third section of the maxillary artery:+ a.infraorbitalis, a. palatina descendens, aa.pterygopalatinae - a.infraorbitalis, a. supraorbitalis - a.palatina descendens, a. alveolaris inferior, a. lingualis- a.pterygopalatina, a. alveolaris inferior

Where does the internal carotid artery go? + canalis caroticus, sulcus caroticus- canalis n. hypoglossi- canalis caroticotimpanicus - sulcus sigmoideus

Branches of the internal carotid artery:+ a.ophthalmica, a. cerebri anterior et media, a. communicans posterior, a. chorioidea

- a.ophthalmica, a. vertebralis, a. basilaris - a.cerebri anterior, media.et posterior- a.ophthalmica, a. cerebri anterior, media et posterior

Subclavian artery passes from:+ from left from arcus aortae, from right from truncus brachiocephalicus - from left from truncus brachiocephalicus, from right from arcus aortae - from left from arcus aortae, from right from aorta ascendens- from left from aorta ascendens, from right from arcus aortae

Branches of subclavian artery:

+ a.vertebralis, tr. thyrocervicalis, a. transversa colli, a. thoracica interna, tr. costocervicalis- a.vertebralis, tr. thyrocervicalis, a. axillaris- a.thoracica interna, a. suprascapularis, a. subscapularis, a. dorsalis scapulae- a.vertebralis, tr. thyrocervicalis, a. transversa colli, a. thoracica interna, a. profunda brachii

What arteries formed the arterial circle of the brain?+ a.cerebri anterior, a. communicans anterior, a. carotis interna a. communicans posterior, a. cerebri posterior- a.cerebri anterior, a. cerebri posterior, a. cerebri media.- a.cerebri anterior, a. carotis communis, a. cerebri media.- a.cerebri anterior, posterior, media, a. communicans anterior et posterior

Main artery of the shoulder:+ a.brachialis

- a.axillaris- a.profunda brachii- a.subscapularis

Branches of a. radialis:+ ramus carpeus palmaris, ramus palmaris superficialis - ramus carpeus palmaris, ramus palmaris profundus - a.interossea communis, ramus dorsalis carpeus- a.princeps policis, a. interossea posterior

What vessels form the superficial Palmar arch?+ a.ulnaris et r. palmaris superficialis a. radialis - a.ulnaris et r. palmaris profundus a. radialis- a.radialis et r. palmaris superficialis a. ulnaris

- a.radialis et r. palmaris profundus a. ulnaris

What vessels form the deep Palmar arch?+ a.radialis et r. palmaris profundus a. ulnaris- a.ulnaris et a. radialis

- a.ulnaris et r. palmaris profundus a. radialis

- a.ulnaris et r. palmaris superficialis a. radialis

What branch of the superficial Palmar arch gives?

+ aa.digitales communes- aa.interossei- rr. metacarpei palmares- aa.digitales proprei

What branches gives deep Palmar arch?+ rr. metacarpei palmares

- rr. carpei dorsales- aa.interossei

- aa.interdigitales

What are the surface veins of the upper limb:

+ v. basilica, v. cephalica, v. mediana antebrachii- v. axillaris, v. brachialis, v. profunda brachii- v. ulnaris, v. radialis, vv. interdigitales superficiales

- vv. dorsales manus, v. radialis, v. ulnaris, v. interossea

Name the deep veins of the hand:

+ vv. radiales, ulnares brachiales- v. profunda.brachii, vv. interossei anterior et posterior- v. axillaris, v. subclavia, truncus brachiocephalicus

- v. axillaris, v. subscapularis, v. suprascapularis

From the confluence of which veins is the inferior vena cava formed?+ v. iliaca communis dextra et v. iliaca communis sinistra- v. iliaca interna et v. iliaca externa- v. iliaca externa et v. sacralis mediana

- vv. gluteae, vv. sacrales laterales, vv. iliolumbales

Specify the main visceral tributaries of the inferior vena cava:+ vv. hepaticae, renales, suprarenales, v. ovarica(testicularis) dextra

- vv. hepaticae, gastricae, lienales

- vv. hepaticae, gastricae, intestinales- vv. renales, suprarenales, gastricae, pancreaticae

Specify the parietal tributaries of the inferior vena cava:

+ vv. phrenicae inferiores et vv. lumbales- vv. intercostales et vv. phrenicae superiores- v. azygos et v. hemiazygos- vv. lumbales, iliolumbales, sacrales

From which veins are common iliac veins formed?+ v. iliaca.externa et v. iliaca.interna- rr. parietales et viscerales- v. mesenterica inferior et vv. gluteae- vv. uterinae, rectales, vesicales

What are the tributaries of the internal iliac vein: +vv. gluteae, obturatoria, vesicalis, rectales (media et inferior), veins of the internal genitals- vv. mesentericae superior et inferior, vv. rectales- v. circumflexa.ilei profunda, v. sacralis lateralis, vv. gluteae - v. iliolumbalis, v. sacralis lateralis, v.vesicalis

List the surface veins of the free lower limb:

+ v. saphena magna et parva- v. saphena lateralis et medialis- v. saphena anterior et posterior- v. saphena superior et inferior

List the deep veins of the leg:

+ v. femoralis, v. profunda femoris, v. poplitea, v. tibialis anterior, v. tibialis posterior, vv. pedis

- v. iliaca externa, interna.- vv. dorsales pedis, v. tibialis magna.et parva- v. plantaris lateralis, v. plantaris medialis, vv. genu

What are the roots of portal vein: + v. lienalis, v. mesenterica superior, v. mesenterica inferior- v. gastrica, v. hepatica, v. lienalis- v. gastrica, v. lienalis, v. pancreatica- v. hepatica, v. mesenterica superior et inferior

Where to join the venae pulmonales?+ atrium sinister - atrium dexter- vena cava superior- v. azygos

Where does the venous blood flow from the external nose?+ v. facialis, v. opthalmica- v. sphenopalatina, v. frontalis- v. jugularis externa, v. emissaria.parietalis- v. retromandibularis, v. facialis

Where does the venous blood flow from the nasal mucosa? + v. sphenopalatina- v. facialis- v. retromandibularis- v. angularis

Where does the venous blood flow from upper-abdominal cavity?+ v. lienalis- v. mesenterica superior- v. mesenterica inferior- v. cava superior

From the confluence of which trunks formed ductus thoracicus?+ truncus lumbalis dexter et sinister- truncus subclavia dexter et sinister

- truncus jugularis dexter et sinister- truncus intestinalis dexter et sinister

In ductus thoracicus is poured:+ truncus bronchomediastinalis sinister- truncus bronchomediastinalis dexter

- truncus subclavius anterior- truncus jugularis pasterior

In ductus thoracicus is poured:+ truncus intestinalis - truncus bronchomediastinalis dexter - truncus popliteus - truncus brachialis

In ductus lymphaticus dexter is poured:+ truncus jugularis dexter- truncus jugularis sinister- truncus intestinalis

- truncus subclavius sinister

In ductus lymphaticus dexter is poured:

+ truncus subclavius dexter - truncus lumbalis dexter- truncus intestinalis- truncus subclavius sinister

In ductus lymphaticus dexter is poured:+ truncus bronchomediastinalis dexter- truncus bronchomediastinalis sinister- truncus lumbalis dexter

- truncus lumbalis sinister

Where flows ductus lymphaticus dexter?

+ v. subclavia dextra

- v. subclavia sinistra

- v. jugularis interna

- v. portae

Where does ductus thoracicus flow?

+ v. jugularis interna sinistra- v. jugularis interna dextra- v. subclavia dextra

- v. portae

Name the roots of the superior vena cava:+ v. brachiocephalica dextra et v. brachiocephalica sinistra- v. jugularis et v. subclavia- vv. jugulares externa et interna- v. brachiocephalica dextra.et v. jugularis

Name the main inflow of the superior vena cava:

+ v. azygos

- v. hemiazygos et v. accessoria

- v. jugularis- v. subclavia

Name the main tributaries of brachiocephalic veins:

+ v. jugularis interna et v. subclavia- v. jugularis externa et v. subclavia - vv. jugulares externa et interna- v. axillaris et v. subclavia# List extracranial inflows of the internal jugular vein:

+ v. retromandibularis, v. facialis, vv. pharingei, v. lingualis, v. thyroidea superior

- vv. jugulares externa.et anterior

- v. maxillaris, v. mandibularis, v. ophthalmica

- v. axillaris et v. subclavia

Lymph from the upper half of the abdomen flows off:+ nodi lymphatici axillares

- nodi lymphatici inguinales

- nodi lymphatici lumbales- nodi lymphatici mesenterici superiores

Lymph from the lower half of the abdomen flows off:+ nodi lymphatici inguinales

- nodi lymphatici axillares

- nodi lymphatici lumbales

- nodi lymphatici mesenterici superiores

Lymphatic vessels along v. saphena magna flow:

+ nodi lymphatici inguinales superficialis

- nodi lymphatici inguinales profundus

- nodi lymphatici popliteales

- nodi lymphatici iliaci externi

Lymph from the outer integument of the anterior and lateral walls of the thoracic cavity flows out:

+ nodi lymphatici axillares

- nodi lymphatici mediastinalis anteriores- nodi lymphatici mediastinalis posteriores

- nodi lymphatici parasternales

Lymph from the lateral parts of the breast is given:

+ nodi lymphatici axillares- nodi lymphatici mediastinalis anteriores

- nodi lymphatici mediastinalis posteriores

- nodi lymphatici parasternales

Lymphatic vessels along the v. basilica flow off:

+ nodi lymphatici cubitales

- nodi lymphatici axillaries superficiales

- nodi lymphatici axillaris profundi

- nodi lymphatici bronchomediastinales

Lymphatic vessels along the v. cephalica flow off:

+ nodi lymphatici axillaris superficiales - nodi lymphatici axillaris profundi

- nodi lymphatici cubitales

- nodi lymphatici bronchomediastinales # Lymph from the upper lip flows off:

+ nodi lymphatici submandibulares

- nodi lymphatici parotidei- nodi lymphatici mastoidei

- nodi lymphatici occipitales

Lymph from the lower lip flows off:+ nodi lymphatici submandibulares

- nodi lymphatici parotidei- nodi lymphatici mastoidei

- nodi lymphatici occipitales

Lymph from the body of the tongue flows off:

+ nodi lymphatici submandibulares

- nodi lymphatici parotidei

- nodi lymphatici mastoidei- nodi lymphatici occipitales

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