O’ZBEKISTON RESPUBLIKASI OLIY VA O’RTA TA’LIM VAZIRLIGI

Farg’ona Politexnika Instituti

“Tillarni o’rgatish” kafedrasi

“English for chemists”

nomli ingliz tili fanidan kimyo texnologiya yo’nalishidagi talabalarning og’zaki va yozma nutqlarini shakllantirish uchun mavzular to’plami bo’yicha

USLUBIY QO’LLANMA

Farg’ona 2018

«Tasdiqlangan»

“Ishlab chiqarishda boshqaruv”

uslubiy kengash raisi

_______________E. Muminova

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«Tasdiqlangan»

Farg’ona politexnika institut Fakulteti

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Kirish

O’zbekiston Respublikasining mustaqilikni qo’lga kiritishi horijiy mamlakatlar bilan bevosita aloqalar o’rnatish imkoniyatini yaratdi. Bu esa talabalarimizning chet tillarini chuqurroq egallashlarini taqazo etadi, chunki xorijiy mamlakatlar bilan respublikamizda qo’shma korxonalar ish boshladi. Yoshlar chet ellarga o’qish va ishlash uchun yuborilmoqda, respublikamizni tanigan davlatlar bilan diplomatik aloqalar o’rnatilmoqda.

Tabiiyki, chet tillarini o’zlashtirish har bir kishidan vaqt, qunt, sabr – toqat, izlanish, qiziqish, o’z ustida ko’proq ishlashni talab qiladi. Mazkur qo’llanma texnik sohalarga yo’naltirilgan o’quv yurtlarining amaldagi dasturi va zamonaviy usullari, hozirgi metodikasi, talablari ni inobatga olgan holda yaratildi.

Mazkur uslubiy qo’llanma respublikadagi texnika sohalariga yo’naltirilgan oliy o’quv yurtlarining talabalari hamda kasb-hunar kollejlari o’quvchilari uchun ham mo’ljallangan.

Uslubiy qo’llanmaning yaratilishiga asosiy sabab respublikamizdagi texnika sohalariga yo’naltirilgan oliy o’quv yurtlari talabalari uchun uslubiy qo’llanma va darsliklarning kamligi va ularga hozirgi kunda bo’lgan katta ehtiyojdir.

Uslubiy qo’llanma dastur asosida tuzilgan bo’lib, bunda to’g’ri o’qish va yozish, ularda og’zaki nutq ko’nikmalarini o’stirish bo’yicha matnlar berilgan.

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Text 1

AGRICULTURE IN UZBEKISTAN

Mike Edwards wrote in National Geographic, “Agriculture is Uzbekistan's biggest employer, and cotton is king, as it was in Soviet days, when irrigation canals were stitched across the arid landscape and ground-water became polluted with agrochemicals. State farms, also Soviet relics, have not been abolished, and the government still tells farmers what to plant: cotton. The system enriches the state at the expense of the peasants, for the crop must be sold to the state at a fraction of its value. [Source: Mike Edwards, National Geographic, February 2002]

Land use: agricultural land: 62.6 percent; arable land 10.1 percent; permanent crops 0.8; percent; permanent pasture 51.7 percent; forest: 7.7 percent; other: 29.7 percent (2011 est.). Irrigated land: 41,980 square kilometers (2005); Total renewable water resources: 48.87 cubic kilometers (2011). Freshwater withdrawal (domestic/industrial/agricultural) total: 56 cubic kilometers a year(7 percent/3 percent/90 percent); per capita: 2,113 cubic meters a year (2005). [Source: CIA World Factbook]

Agriculture and industries processing agricultural products (primarily those related to cotton and foods) have consistently contributed about 35 percent of Uzbekistan's gross domestic product. However, expansion of the sector has been hindered by state control of agricultural markets, equipment shortages, and the ban on private land ownership. Privately worked plots contribute an estimated 75 percent of non-wheat food output. **

Uzbekistan is the world's fourth-largest producer and second-largest exporter of cotton, which in 2005 accounted for approximately 20 percent of the country's exports after reaching 39 percent in the late 1990s. In recent years, Uzbekistan has switched some farmland from cotton to grains (mainly rice and wheat) in an effort to reduce food imports. Officially reported wheat harvests have increased every year since 1998, while the rice harvest decreased substantially in 2005. Other significant agricultural products are silk, fruits and vegetables, cow’s milk, and beef. Virtually all agriculture requires intensive irrigation. Cattle, goats, and sheep are the most frequently raised livestock. **

Under the Soviet system, agricultural land was held by the state in the form of collective and state farms. Farmers were allowed cultivate small private farm plots. These accounted for a disproportionate share of agricultural production—up to 30 percent of the total agricultural output in some places.

Uzbekistan has the advantages of a warm climate, a long growing season, and plentiful sources of water for irrigation. In the Soviet period, those conditions offered high and reliable yields of crops with specialized requirements. Soviet agricultural policy applied Uzbekistan's favorable conditions mainly to cotton cultivation. As Uzbekistan became a net exporter of cotton and a narrow range of other agricultural products, however, it required large-scale imports of grain and other foods that were not grown in sufficient quantities in domestic fields.

Text 2

Food technology

Food technology is a branch of food science that deals with the production processes that make foods.

Early scientific research into food technology concentrated on food preservation. Nicolas Appert’s development in 1810 of the canning process was a decisive event. The process wasn’t called canning then and Appert did not really know the principle on which his process worked, but canning has had a major impact on food preservation techniques.

Louis Pasteur's research on the spoilage of wine and his description of how to avoid spoilage in 1864 was an early attempt to apply scientific knowledge to food handling. Besides research into wine spoilage, Pasteur researched the production of alcohol, vinegar, wines and beer, and the souring of milk. He developed pasteurization—the process of heating milk and milk products to destroy food spoilage and disease-producing organisms. In his research into food technology, Pasteur became the pioneer into bacteriology and of modern preventive medicine.

Developments

Freeze-dried coffee, a form of instant coffee

Developments in food technology have contributed greatly to the food supply and have changed our world. Some of these developments are:

Instantized Milk Powder - D.D. Peebles (U.S. patent 2,835,586) developed the first instant milk powder, which has become the basis for a variety of new products that are rehydratable. This process increases the surface area of the powdered product by partially rehydrating spray-dried milk powder.

Freeze-drying - The first application of freeze drying was most likely in the pharmaceutical industry; however, a successful large-scale industrial application of the process was the development of continuous freeze drying of coffee.

High-Temperature Short Time Processing - These processes for the most part are characterized by rapid heating and cooling, holding for a short time at a relatively high temperature and filling aseptically into sterile containers.

Decaffeination of Coffee and Tea - Decaffeinated coffee and tea was first developed on a commercial basis in Europe around 1900. The process is described in U.S. patent 897,763. Green coffee beans are treated with water, heat and solvents to remove the caffeine from the beans.

Process optimization - Food Technology now allows production of foods to be more efficient, Oil saving technologies are now available on different forms. Production methods and methodology have also become increasingly sophisticated.

Consumer acceptance

In the past, consumer attitude towards food technologies was not common talk and was not important in food development. Nowadays the food chain is long and complicated, foods and food technologies are diverse; consequently the consumers are uncertain about the food quality and safety and find it difficult to orient themselves to the subject. That is why consumer acceptance of food technologies is an important question. However, in these days acceptance of food products very often depends on potential benefits and risks associated with the food. This also includes the technology the food is processed with. Attributes like “uncertain”, “unknown” or “unfamiliar” are associated with consumers’ risk perception and consumer very likely will reject products linked to these attributes. Especially innovative food processing technologies are connected to these characteristics and are perceived as risky by consumers .

Acceptance of the different food technologies is very different. Whereas pasteurisation is well recognised, high pressure treatment or even microwaves are perceived as risky very often. In studies done within Hightech Europe project, it was found that traditional technologies were well accepted in contrast to innovative technologies.

Consumers form their attitude towards innovative food technologies by three main factors mechanisms. First, knowledge or beliefs about risks and benefits which are correlated with the technology. Second, attitudes are based on their own experience and third, based on higher order values and beliefs.

Acceptance of innovative technologies can be improved by providing non-emotional and concise information about these new technological processes methods. According to a study made by HighTech project also written information seems to have higher impact than audio-visual information on the consumer in case of sensory acceptance of products processed with innovative food technologies.

Food science is the applied science devoted to the study of food. The Institute of Food Technologists defines food science as "the discipline in which the engineering, biological, and physical sciences are used to study the nature of foods, the causes of deterioration, the principles underlying food processing, and the improvement of foods for the consuming public".. The textbook *Food Science* defines food science in simpler terms as "the application of basic sciences and engineering to study the physical, chemical, and biochemical nature of foods and the principles of food processing"

Food chemistry

Main article: Food chemistry

Food chemistry is the study of chemical processes and interactions of all biological and non-biological components of foods.. The biological substances include such items as meat, poultry, lettuce, beer, and milkas examples. It is similar to biochemistry in its main components such as carbohydrates, lipids, and protein, but it also includes areas such as water, vitamins, minerals, enzymes, food additives, flavors, and colors. This discipline also encompasses how products change under certain food processing techniques and ways either to enhance or to prevent them from happening.

Food physical chemistry

Main article: Food physical chemistry

Food physical chemistry is the study of both physical and chemical interactions in foods in terms of physical and chemical principles applied to food systems, as well as the application of physicochemical techniques and instrumentation for the study and analysis of foods.

Food engineering

Main article: Food engineering

A pizza factory in Germany, an example of food engineering

Food engineering is the industrial processes used to manufacture food.

Food microbiology

Food microbiology laboratory at theFaculty of Food Technology, Latvia University of Agriculture.

Main article: Food microbiology

Food microbiology is the study of the microorganisms that inhabit, create, or contaminate food, including the study of microorganisms causing food spoilage. "Good" bacteria, however, such as probiotics, are becoming increasingly important in food science. In addition, microorganisms are essential for the production of foods such as cheese, yogurt, bread, beer, wine and, other fermented foods.

Food packaging

Food packaging in progress

Food preservation

Main article: Food preservation

Food preservation involves the causes and prevention of quality spoilage

Food substitution

Food substitution refers to the replacement of fat, sugar, or calories from a product while maintaining similar shape, texture, color, or taste.

Food technology

Main article: Food technology

Food technology is the technological aspects. Early scientific research into food technology concentrated on food preservation. Nicolas Appert's development in 1810 of the canning process was a decisive event. The process wasn't called canning then and Appert did not really know the principle on which his process worked, but canning has had a major impact on food preservation techniques.

Molecular gastronomy

Main article: Molecular gastronomy

Molecular gastronomy is the scientific investigation of processes in cooking, social and artistic gastronomical phenomena. Molecular gastronomy is a subdiscipline of food science that seeks to investigate the physical and chemical transformations of ingredients that occur in cooking. Its program includes three axis, as cooking was recognized to have three components, which are social, artistic and technical.

Text 3

General Classification of Food & Food Products

Specific conditions and requirements apply when importing and exporting food and food products.

Food businesses, traders, consumers and travellers are advised to check AVA's classification below.

Food Group	What's Included
Meat	Whole carcasses or parts of any animal or bird*. These can be chilled, frozen, processed or in canned form. Some examples of processed meat products include: beef, pizza, bak kwa, rendang.
Fish	Any of the following varieties of marine, brackish water or fresh water: fishes crustacean molluscs marine sponges trepang or marine invertebrates (e.g. sea cucumber) any other form of aquatic life including their young and eggs These can be live, chilled, frozen, processed or in canned form. Some examples of processed fish products include: belacan (shrimp paste), rojak sauce, canned tuna. Excluded: Ornamental varieties of fishes

Food Group	What's Included
Fresh Fruits and Vegetables	Raw and unprocessed fruits and vegetables. Excluded: Fruits and vegetables which have undergone some processing such as cutting, peeling, canning and freezing. These are regulated as processed food.
Fresh Eggs	Table eggs
Processed Eggs	salted and preserved eggs liquid and powdered egg cooked eggs (e.g. hard-boiled eggs and omelette)
Processed Food	All food products and supplements of food nature that are not grouped as meat products, fish products or fresh fruits and fresh vegetables. Some examples include: mineral water wine infant formula milk and milk products such as cheese, milk powder and yoghurt biscuits cooking oil beverages nuts

Food Group	What's Included
Food Appliances	Food ware such as: bowls cups plates pans pots water bottles Food utensils such as: chopsticks spoons

Food-Health Products

Before checking the general classification of food products, traders and manufacturers of food-health products need to determine which competent authority regulates their products. Food-health products could fall under the regulation of either:

- Agri-Food and Veterinary Authority (AVA), or
- Health Sciences Authority (HSA).

The import and sale of food and supplements of food nature are governed by the Sale of Food Act and the Food Regulations under AVA.

Importers must ensure that their products comply with AVA’s regulations and labelling requirements.

Meanwhile, medicinal and other health-related products are regulated under HSA's regulations. Some products include western medicinal products, Chinese proprietary medicines and cosmetic products.

In general, food-health products are regulated by AVA if they are taken as:

- part of a daily diet, or
- supplementation to a diet, with no defined dosage.

Text 4

Carbohydrate

A carbohydrate is a biological molecule consisting of carbon (C), hydrogen (H) and oxygen (O) atoms, usually with a hydrogen–oxygen atom ratio of 2:1 (as in water); in other words, with the empirical formula $C_m(H_2O)_n$ (where *m* could be different from *n*). This formula holds true for monosaccharides. Some exceptions exist; for example, deoxyribose, a sugar component of DNA, has the empirical formula $C_5H_{10}O_4$. Carbohydrates are technically hydrates of carbon; structurally it is more accurate to view them as polyhydroxy aldehydes and ketones.

The term is most common in biochemistry, where it is a synonym of 'saccharide', a group that includes sugars, starch, and cellulose. The saccharides are divided into four chemical groups: monosaccharides, disaccharides, oligosaccharides, and polysaccharides. Monosaccharides and disaccharides, the smallest (lowermolecular weight) carbohydrates, are commonly referred to as sugars. The word *saccharide* comes from the Greek word *σάκχαρον* (*sákkharon*), meaning "sugar". While the scientific nomenclature of carbohydrates is complex, the names of the monosaccharides and disaccharides very often end in the suffix -ose. For example, grape sugar is the monosaccharide glucose, cane sugar is the disaccharide sucrose, and milk sugar is the disaccharide lactose.

Carbohydrates perform numerous roles in living organisms. Polysaccharides serve for the storage of energy (e.g. starch and glycogen) and as structural components (e.g. cellulose in plants and chitin in arthropods). The 5-carbon onosaccharide ribose is an important component of coenzymes (e.g. ATP, FAD andNAD) and the backbone of the genetic molecule known as RNA. The related deoxyribose is a component of DNA. Saccharides and their derivatives include many other important biomolecules that play key roles in the immune system, fertilization, preventing pathogenesis, blood clotting, and development.

In food science and in many informal contexts, the term carbohydrate often means any food that is particularly rich in the complex carbohydrate starch (such as cereals, bread and pasta) or simple carbohydrates, such as sugar (found in candy, jams, and desserts).

Often in lists of nutritional information, such as the USDA National Nutrient Database, the term "carbohydrate" (or "carbohydrate by difference") is used for everything other than water, protein, fat, ash, and ethanol. This will include chemical compounds such as acetic or lactic acid, which are not normally considered carbohydrates. It also includes "dietary fiber" which is a carbohydrate but which does not contribute much in the way of food energy (calories), even though it is often included in the calculation of total food energy just as though it were a sugar.

Carbohydrates are found in a wide variety of foods. The important sources are cereals (wheat, maize, rice), potatoes, sugarcane, fruits, table sugar(sucrose), bread, milk, etc. Starch and sugar are the important carbohydrates in our diet. Starch is abundant in potatoes, maize, rice and other cereals. Sugar appears in our diet mainly as sucrose(table sugar) which is added to drinks and many prepared foods such as jam, biscuits and cakes. Glucose and fructose are found naturally in many fruits and some vegetables. Glycogen is carbohydrate found in the liver and muscles (as animal source). Cellulose in the cell wall of all plant tissue is a carbohydrate. It is important in our diet as fibre which helps to maintain a healthy digestive system.

Structure

Formerly the name "carbohydrate" was used in chemistry for any compound with the formula $C_m(H_2O)_n$. Following this definition, some chemists considered formaldehyde (CH_2O) to be the simplest carbohydrate, while others claimed that title for glycolaldehyde. Today, the term is generally understood in the biochemistry sense, which excludes compounds with only one or two carbons and includes many biological carbohydrates which deviate from this formula. For example, while the above representative formulas would seem to capture the commonly known carbohydrates, ubiquitous and abundant carbohydrates often deviate from this. For example, carbohydrates often display chemical groups such as: *N*-acetyl (e.g. chitin), sulphate (e.g. glycosaminoglycans), carboxylic acid (e.g. sialic acid) and deoxy modifications (e.g. fucose and sialic acid).

Natural saccharides are generally built of simple carbohydrates called monosaccharides with general formula $(CH_2O)_n$ where n is three or more. A typical monosaccharide has the structure H–$(CHOH)_x$(C=O)–$(CHOH)_y$–H, that is, an aldehyde or ketone with many hydroxyl groups added, usually one on each carbon atom that is not part of the aldehyde or ketone functional group. Examples of monosaccharides are glucose,fructose, and glyceraldehydes. However, some biological substances commonly called "monosaccharides" do not conform to this formula (e.g. uronic acids and deoxy-sugars such as fucose) and there are many chemicals that do conform to this formula but are not considered to be monosaccharides (e.g. formaldehyde CH_2O and inositol $(CH_2O)_6$).

The open-chain form of a monosaccharide often coexists with a closed ring form where the aldehyde/ketone carbonyl group carbon (C=O) and hydroxyl group (–OH) react forming a hemiacetal with a new C–O–C bridge.

Monosaccharides can be linked together into what are called polysaccharides (or oligosaccharides) in a large variety of ways. Many carbohydrates contain one or more modified monosaccharide units that have had one or more groups replaced or removed. For example, deoxyribose, a component of DNA, is a modified version of ribose; chitin is composed of repeating units of N-acetyl glucosamine, a nitrogen-containing form of glucose.

Text 5

Canning

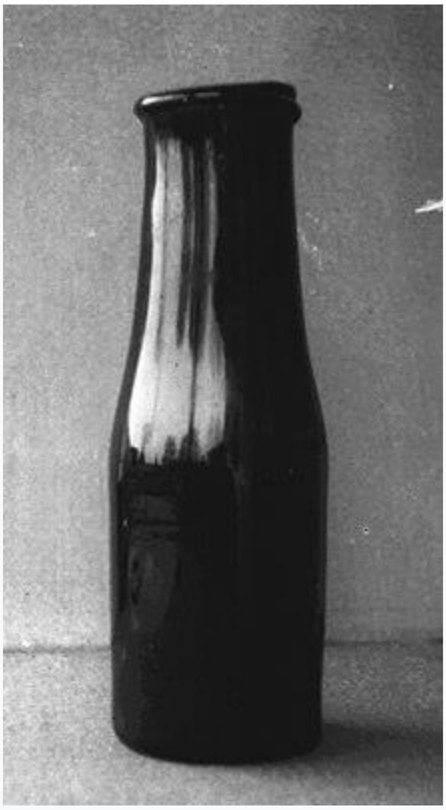
Canning is a method of preserving food in which the food contents are processed and sealed in an airtight container. Canning provides a shelf life typically ranging from one to five years, although under specific circumstances it can be much longer. A freeze-dried canned product, such as canned dried lentils, could last as long as 30 years in an edible state. In 1974, samples of canned food from the wreck of the *Bertrand*, a steamboat that sank in the Missouri River in 1865, were tested by the National Food Processors Association. Although appearance, smell and vitamin content had deteriorated, there was no trace of microbial growth and the 109-year-old food was determined to be still safe to eat.

History and development of canning

French Origins

During the first years of the Napoleonic Wars, the French government offered a hefty cash award of 12,000 francs to any inventor who could devise a cheap and effective method of preserving large amounts of food. The larger armies of the period required increased and regular supplies of quality food. Limited food availability was among the factors limiting military campaigns to the summer and autumn months. In 1809, Nicolas Appert, a French confectioner and brewer, observed that food cooked inside a jar did not spoil unless the seals leaked, and developed a method of sealing food in glass jars. Appert was awarded the prize in

1810 by Count Montelivert, a French minister of the interior. The reason for lack of spoilage was unknown at the time, since it would be another 50 years before Louis Pasteur demonstrated the role of microbes in food spoilage.



Appert canning jar

Nicolas Appert, developer of the canning process

The French Army began experimenting with issuing canned foods to its soldiers, but the slow process of canning foods and the even slower development and transport stages prevented the army from shipping large amounts across the French Empire, and the war ended before the process was perfected. Unfortunately for Appert, the factory which he had built with his prize money was razed in 1814 by Allied soldiers when they entered France.

Following the end of the Napoleonic Wars, the canning process was gradually employed in other European countries and in the US.

In the United Kingdom

A Dixie Can Sealer for home use. Now in Thinktank, Birmingham Science Museum.

Based on Appert's methods of food preservation, the tin can process was allegedly developed by Frenchman Philippe de Girard, who came to London and used British merchant Peter Durand as an agent to patent his own idea in 1810. Durand did not pursue food canning himself, selling his patent in 1811 to Bryan Donkin and John Hall, who were in business as Donkin Hall and Gamble, ofBermondsey. Bryan Donkin developed the process of packaging food in sealed airtight cans, made of tinned wrought iron. Initially, the canning process was slow and labour-intensive, as each large can had to be hand-made, and took up to six hours to cook, making canned food too expensive for ordinary people.

The main market for the food at this stage was the British Army and Royal Navy. By 1817 Donkin recorded that he had sold £3000 worth of canned meat in six months. In 1824 Sir William Edward Parry took canned beef and pea soup with him on his voyage to the Arctic in HMS Fury, during his search for a northwestern passage to India. In 1829, Admiral Sir James Ross also took canned food to the Arctic, as did Sir John Franklin in 1845. Some of his stores were found by the search exp.ion led by Captain (later Admiral Sir) Leopold McLintock in 1857. One of these cans was opened in 1939, and was edible and nutritious, though it was not analysed for contamination by the lead solder used in its manufacture.

In Europe

During the mid-19th century, canned food became a status symbol amongst middle-class households in Europe, being something of a frivolous novelty. Early methods of manufacture employed poisonous lead solder for sealing the cans, which may have worsened the disastrous outcome of the 1845 Franklin exp.ion to chart and navigate theNorthwest Passage.

Increasing mechanization of the canning process, coupled with a huge increase in urban populations across Europe, resulted in a rising demand for canned food. A number of inventions and improvements followed, and by the 1860s smaller machine-made steel cans were possible, and the time to cook food in sealed cans had been reduced from around six hours to thirty minutes.

In the United States

1914 magazine advertisement forcookware with instructions for home canning

Canned food also began to spread beyond Europe — Robert Ayars established the first American canning factory in New York City in 1812, using improved tin-plated wrought-iron cans for preserving oysters, meats, fruits and vegetables. Demand for canned food greatly increased during wars. Large-scale wars in the nineteenth century, such as theCrimean War, American Civil War, and Franco-Prussian War introduced increasing numbers of working-class men to canned food, and allowed canning companies to expand their businesses to meet military demands for non-perishable food, allowing companies to manufacture in bulk and sell to wider civilian markets after wars ended. Urban populations in Victorian Britain demanded ever-increasing quantities of cheap, varied, quality food that they could keep at home without having to go shopping daily. In response, companies such as Underwood, Nestlé, Heinz, and others provided quality canned food for sale to working class city-dwellers. In particular, Crosse and Blackwell took over the concern of Donkin Hall and Gamble. The late 19th century saw the range of canned food available to urban populations greatly increase, as canners competed with each other using novel foodstuffs, highly decorated printed labels, and lower prices.

World War I

Demand for canned food skyrocketed during World War I, as military commanders sought vast quantities of cheap, high-calorie food to feed their millions of soldiers, which could be transported safely, survive trench conditions, and not spoil in transport. Throughout the war, soldiers generally subsisted on low-quality canned foodstuffs, such as the British "Bully Beef" (cheap corned beef), pork and beans, canned sausages, and Maconochies Irish Stew, but by 1916 widespread boredom with cheap canned food amongst soldiers resulted in militaries purchasing better-quality food to improve morale, and the complete meals in a can began to appear. In 1917 the French Army began issuing canned French cuisine, such as coq au vin, Beef Bourguignon and Vichyssoise while the Italian Army experimented with canned ravioli, spaghetti bolognese, Minestrone andPasta e fagioli. Shortages of canned food in the British Army in 1917 led to the government issuing cigarettes and amphetamines to soldiers to suppress their appetites. After the war, companies that had supplied military canned food improved the quality of their goods for civilian sale.

Methods

The original fragile and heavy glass containers presented challenges for transportation, and glass jars were largely replaced in commercial canneries with cylindrical tin or wrought-iron canisters (later shortened to "cans") following the work of Peter Durand (1810). Cans are cheaper and quicker to make, and much less fragile than glass jars. Glass jars have remained popular for some high-value products and in home canning. Can openers were not invented for another thirty years — at first, soldiers had to cut the cans open with bayonets or smash them open with rocks. Today, tin-coated steel is the material most commonly used. Laminate vacuum pouches are also used for canning, such as used in MREs and Capri Sundrinks.

To prevent the food from being spoiled before and during containment, a number of methods are used: pasteurisation, boiling (and other applications of high temperature over a period of time), refrigeration, freezing, drying, vacuum treatment, antimicrobial agents that are natural to the recipe of the foods being preserved, a sufficient dose of ionizing radiation, submersion in a strong saline solution, acid, base, osmotically extreme (for example very sugary) or other microbially-challenging environments.

Other than sterilization, no method is perfectly dependable as a preservative. For example, the microorganism *Clostridium botulinum* (which causes botulism) can only be eliminated at temperatures above the boiling point of water.

From a public safety point of view, foods with low acidity (a pH more than 4.6) need sterilization under high temperature (116-130 °C). To achieve temperatures above the boiling point requires the use of a pressure canner. Foods that must be pressure canned include most vegetables, meat, seafood, poultry, and dairy products. The only foods that may be safely canned in an ordinary boiling water bath are highly acidic ones with a pH below 4.6, such as fruits, pickled vegetables, or other foods to which acidic additives have been added.

Double seams

Invented in 1888 by Max Ams, modern double seams provide an airtight seal to the tin can. This airtight nature is crucial to keeping micro-organisms out of the can and keeping its contents sealed inside. Thus, double seamed cans are also known as Sanitary Cans. Developed in 1900 in Europe, this sort of can was made of the traditional cylindrical body made with tin plate. The two ends (lids) were attached using what is now called a double seam. A can thus sealed is impervious to contamination by creating two tight continuous folds between the can's cylindrical body and the lids. This eliminated the need for solder and allowed improvements in manufacturing speed, reducing cost.

Double seaming uses rollers to shape the can, lid and the final double seam. To make a sanitary can and lid suitable for double seaming, manufacture begins with a sheet of coated tin plate. To create the can body, rectangles are cut and curled around a die, and welded together creating a cylinder with a side seam.

Rollers are then used to flare out one or both ends of the cylinder to create a quarter circle flange around the circumference. Precision is required to ensure that the welded sides are perfectly aligned, as any misalignment will cause inconsistent flange shape, compromising its integrity.

A circle is then cut from the sheet using a die cutter. The circle is shaped in a stamping press to create a downward countersink to fit snugly into the can body. The result can be compared to an upside down and very flat top hat. The outer edge is then curled down and around about 140 degrees using rollers to create the end curl.

The result is a steel tube with a flanged edge, and a countersunk steel disc with a curled edge. A rubber compound is put inside the curl.

Seaming

Opened can

The body and end are brought together in a seamer and held in place by the base plate and chuck, respectively. The base plate provides a sure footing for the can body during the seaming operation and the chuck fits snugly into the end (lid). The result is the countersink of the end sits inside the top of the can body just below the flange. The end curl protrudes slightly beyond the flange.

First operation

Once brought together in the seamer, the seaming head presses a first operation roller against the end curl. The end curl is pressed against the flange curling it in toward the body and under the flange. The flange is also bent downward, and the end and body are now loosely joined together. The first operation roller is then retracted. At this point five thicknesses of steel exist in the seam. From the outside in they are:

- End
- Flange
- End Curl
- Body
- Countersink

Second operation

The seaming head then engages the second operation roller against the partly formed seam. The second operation presses all five steel components together tightly to form the final seal. The five layers in the final seam are then called; a) End, b) Body Hook, c) Cover Hook, d) Body, e) Countersink. All sanitary cans require a filling medium within the seam because otherwise the metal-to-metal contact will not maintain a hermetic seal. In most cases, a rubberized compound is placed inside the end curl radius, forming the critical seal between the end and the body.

Probably the most important innovation since the introduction of double seams is the welded side seam. Prior to the welded side seam, the can body was folded and/or soldered together, leaving a relatively thick side seam. The thick side seam required that the side seam end juncture at the end curl to have more metal to curl around before closing in behind the Body Hook or flange, with a greater opportunity for error.

Seamer setup and quality assurance

Many different parts during the seaming process are critical in ensuring that a can is airtight and vacuum sealed. The dangers of a can that is not hermetically sealed are contamination by foreign objects (bacteria or fungicide sprays), or that the can could leak or spoil.

One important part is the seamer setup. This process is usually performed by an experienced technician. Amongst the parts that need setup are seamer rolls and chucks which have to be set in their exact position (using a feeler gauge or a clearance gauge). The lifter pressure and position, roll and chuck designs, tooling wear, and bearing wear all contribute to a good double seam.

Incorrect setups can be non-intuitive. For example, due to the springback effect, a seam can appear loose, when in reality it was closed too tight and has opened up like a spring. For this reason, experienced operators and good seamer setup are critical to ensure that double seams are properly closed.

Quality control usually involves taking full cans from the line - one per seamer head, at least once or twice per shift, and performing a teardown operation (wrinkle/tightness), mechanical tests (external thickness, seamer length/height and countersink) as well as cutting the seam open with a twin blade saw and measuring with a double seam inspection system. The combination of these measurements will determine the seam's quality.

Use of a Statistical Process Control (SPC) software in conjunction with a manual double-seam monitor, computerized double seam scanner, or even a fully automatic double seam inspection system makes the laborious process of double seam inspection faster and much more accurate. Statistically tracking the performance of each head or seaming station of the can seamer allows for better prediction of can seamer issues, and may be used to plan maintenance when convenient, rather than to simply react after bad or unsafe cans have been produced.

Nutritional value

Canning is a way of processing food to extend its shelf life. The idea is to make food available and edible long after the processing time. A 1997 study found that canned fruits and vegetables are as rich with dietary fiber and vitamins as the same corresponding fresh or frozen foods, and in some cases the canned products are richer than their fresh or frozen counterparts. The heating process during canning appears to make dietary fiber more soluble, and therefore more readily fermented in the colon into gases and physiologically active byproducts. Canned tomatoes have a higher available lycopene content. Consequently, canned meat and vegetables are often among the list of food items that are stocked during emergencies. In 2013, the Can Manufacturers Institute launched the Cans Get You Cooking Campaign with the support of Crown Holdings, Inc., Ball Corporation, and Silgan Containers. The goal of the campaign is to get consumers to use more canned goods in their daily meals.

Text 6

Enzyme

Enzymes /ˈɛnzaɪmz/ are macromolecular biological catalysts. Enzymes accelerate chemical reactions. The molecules upon which enzymes may act are called substrates and the enzyme converts the substrates into different molecules known as products. Almost all metabolic processes in the cell need enzymes in order to occur at rates fast enough to sustain life. The set of enzymes made in a cell determines which metabolic path ways occur in that cell. The study of enzymes is called *enzymology* and a new field of pseudoenzyme analysis has recently grown up, recognising that during evolution, some enzymes have lost the ability to carry out biological catalysis, which is often reflected in their amino acid sequences and unusual 'pseudocatalytic' properties.

Enzymes are known to catalyze more than 5,000 biochemical reaction types. Most enzymes are proteins, although a few are catalytic RNA molecules. The latter are called ribozymes. Enzymes' specificity comes from their unique three-dimensional structures.

Like all catalysts, enzymes increase the reaction rate by lowering its activation energy. Some enzymes can make their conversion of substrate to product occur many millions of times faster. An extreme example is orotidine 5'-phosphate decarboxylase, which allows a reaction that would otherwise take millions of years to occur in milliseconds. Chemically, enzymes are like any catalyst and are not consumed in chemical reactions, nor do they alter the equilibrium of a reaction. Enzymes differ from most other catalysts by being much more specific. Enzyme activity can be affected by other molecules: inhibitors are molecules that decrease enzyme activity, and activators are molecules that increase activity. Many therapeutic drugs and poisons are enzyme inhibitors. An enzyme's activity decreases markedly outside its optimal temperature and pH.

Some enzymes are used commercially, for example, in the synthesis of antibiotics. Some household products use enzymes to speed up chemical reactions: enzymes in biological washing powders break down protein, starch or fat stains on clothes, and enzymes in meat tenderizer break down proteins into smaller molecules, making the meat easier to chew.

Etymology and history

Eduard Buchner

By the late 17th and early 18th centuries, the digestion of meat by stomach secretions and the conversion of starch to sugars by plant extracts and saliva were known but the mechanisms by which these occurred had not been identified.

French chemist Anselme Payen was the first to discover an enzyme, diastase, in 1833. A few decades later, when studying the fermentation of sugar to alcohol by yeast, Louis Pasteur concluded that this fermentation was caused by a vital force contained within the yeast cells called "ferments", which were thought to function only within living organisms. He wrote that "alcoholic fermentation is an act correlated with the life and organization of the yeast cells, not with the death or putrefaction of the cells."

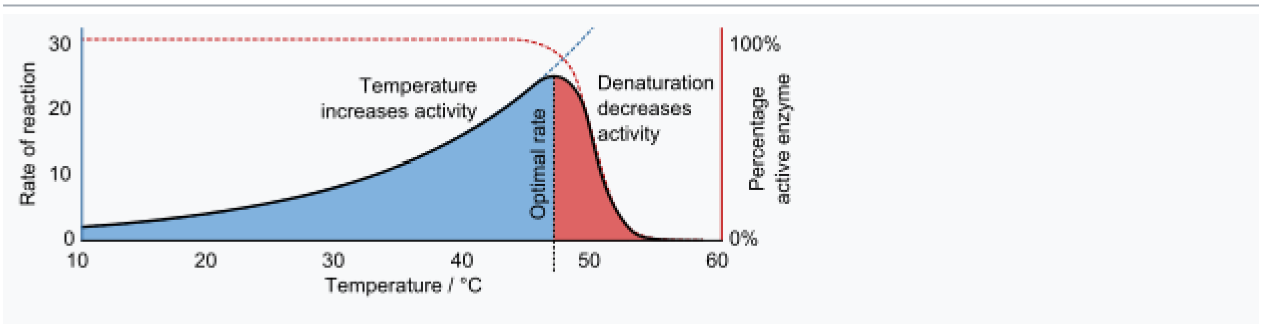
In 1877, German physiologist Wilhelm Kühne (1837–1900) first used the term *enzyme*, which comes from Greek ἔνζυμον, "leavened" or "in yeast", to describe this process. The word *enzyme* was used later to refer to nonliving substances such as pepsin, and the word *ferment* was used to refer to chemical activity produced by living organisms.

Eduard Buchner submitted his first paper on the study of yeast extracts in 1897. In a series of experiments at the University of Berlin, he found that sugar was fermented by yeast extracts even when there were no living yeast cells in the mixture. He named the enzyme that brought about the fermentation of sucrose "zymase". In 1907, he received theNobel Prize in Chemistry for "his discovery of cell-free fermentation". Following Buchner's example, enzymes are usually named according to the reaction they carry out: the suffix -*ase*is combined with the name of the substrate (e.g., lactase is the enzyme that cleaves lactose) or to the type of reaction (e.g., DNA polymerase forms DNA polymers).

The biochemical identity of enzymes was still unknown in the early 1900s. Many scientists observed that enzymatic activity was associated with proteins, but others (such as Nobel laureate Richard Willstätter) argued that proteins were merely carriers for the true enzymes and that proteins *per se* were incapable of catalysis. In 1926, James B. Sumner showed that the enzyme urease was a pure protein and crystallized it; he did likewise for the enzyme catalase in 1937. The conclusion that pure proteins can be enzymes was definitively demonstrated by John Howard Northrop and Wendell Mer.h Stanley, who worked on the digestive enzymes pepsin (1930), trypsin and chymotrypsin. These three scientists were awarded the 1946 Nobel Prize in Chemistry.

The discovery that enzymes could be crystallized eventually allowed their structures to be solved by x-ray crystallography. This was first done for lysozyme, an enzyme found in tears, saliva and egg whites that digests the coating of some bacteria; the structure was solved by a group led by David Chilton Phillips and published in 1965. This high-resolution structure of lysozyme marked the beginning of the field of structural biology and the effort to understand how enzymes work at an atomic level of detail.

Structure



Enzyme activity initially increases with temperature (Q10 coefficient) until the enzyme's structure unfolds (denaturation), leading to an optimalrate of reaction at an intermediate temperature.

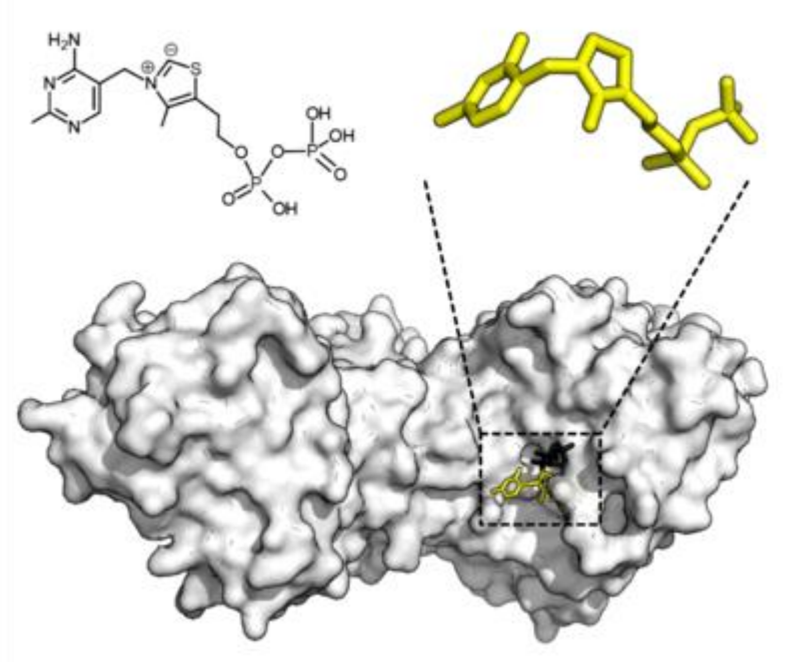
Protein structure

Enzymes are generally globular proteins, acting alone or in larger complexes. The sequence of the amino acids specifies the structure which in turn determines the catalytic activity of the enzyme. Although structure determines function, a novel enzymatic activity cannot yet be predicted from structure alone. Enzyme structures unfold (denature) when heated or exposed to chemical denaturants and this disruption to the structure typically causes a loss of activity. Enzyme denaturation is normally linked to temperatures above a species' normal level; as a result, enzymes from bacteria living in volcanic environments such as hot springs are prized by industrial users for their ability to function at high temperatures, allowing enzyme-catalysed reactions to be operated at a very high rate.

Enzymes are usually much larger than their substrates. Sizes range from just 62 amino acid residues, for the monomer of 4-oxalocrotonate tautomerase, to over 2,500 residues in the animal fatty acid synthase. Only a small portion of their structure (around 2–4 amino acids) is directly involved in catalysis: the catalytic site. This catalytic site is located next to one or more binding sites where residues orient the substrates. The catalytic site and binding site together comprise the enzyme's active site. The remaining majority of the enzyme structure serves to maintain the precise orientation and dynamics of the active site.

In some enzymes, no amino acids are directly involved in catalysis; instead, the enzyme contains sites to bind and orient catalytic cofactors. Enzyme structures may also contain allosteric sites where the binding of a small molecule causes a conformational change that increases or decreases activity.

Cofactors



Chemical structure for thiamine pyrophosphate and protein structure of transketolase. Thiamine pyrophosphate cofactor in yellow andxylulose 5-phosphate substrate in black. (PDB: 4KXV)

Main article: Cofactor (biochemistry)

Some enzymes do not need additional components to show full activity. Others require non-protein molecules called cofactors to be bound for activity. Cofactors can be either inorganic (e.g., metal ions and iron-sulfur clusters) or organic compounds (e.g., flavin and heme). These cofactors serve many purposes; for instance, metal ions can help in stabilizing nucleophilic species within the active site. Organic cofactors can be either coenzymes, which are released from the enzyme's active site during the reaction, or prosthetic groups, which are tightly bound to an enzyme. Organic prosthetic groups can be covalently bound (e.g., biotin in enzymes such as pyruvate carboxylase).

An example of an enzyme that contains a cofactor is carbonic anhydrase, which is shown in the ribbon diagram above with a zinc cofactor bound as part of its active site. These tightly bound ions or molecules are usually found in the active site and are involved in catalysis. For example, flavin and heme cofactors are often involved in redox reactions.

Enzymes that require a cofactor but do not have one bound are called *apoenzymes* or *apoproteins*. An enzyme together with the cofactor(s) required for activity is called a *holoenzyme* (or haloenzyme). The term *holoenzyme* can also be applied to enzymes that contain multiple protein subunits, such as the DNA polymerases; here the holoenzyme is the complete complex containing all the subunits needed for activity.

Text 7

Vitamin A

Vitamin A is a group of unsaturated nutritional organic compounds that includes retinol, retinal, retinoic acid, and several provitamin A carotenoids (most notably beta-carotene).¨ Vitamin A has multiple functions: it is important for growth and development, for the maintenance of the immune system and good vision.¨ Vitamin A is needed by the retina of the eye in the form of retinal, which combines with protein opsin to form rhodopsin, the light-absorbing molecule necessary for both low-light (scotopic vision) and color vision. Vitamin A also functions in a very different role as retinoic acid (an irreversibly oxidized form of retinol), which is an important hormone-like growth factor forepithelial and other cells.

In foods of animal origin, the major form of vitamin A is an ester, primarily retinyl palmitate, which is converted to retinol (chemically an alcohol) in the small intestine. The retinol form functions as a storage form of the vitamin, and can be converted to and from its visually active aldehyde form, retinal.

All forms of vitamin A have a beta-ionone ring to which an isoprenoid chain is attached, called a *retinyl group*. Both structural features are essential for vitamin activity. Theorange pigment of carrots (beta-carotene) can be represented as two connected retinyl groups, which are used in the body to contribute to vitamin A levels. Alpha-carotene andgamma-carotene also have a single retinyl group, which give them some vitamin activity. None of the other carotenes have vitamin activity. The carotenoid beta-cryptoxanthinpossesses an ionone group and has vitamin activity in humans.

Vitamin A can be found in two principal forms in foods:

- Retinol, the form of vitamin A absorbed when eating animal food sources, is a yellow, fat-soluble substance. Since the pure alcohol form is unstable, the vitamin is found in tissues in a form of retinyl ester. It is also commercially produced and administered as esters such as retinyl acetate or palmitate.
- The carotenes alpha-carotene, beta-carotene, gamma-carotene; and the xanthophyll beta-cryptoxanthin (all of which contain beta-ionone rings), but no other carotenoids, function as provitamin A in herbivores and omnivore animals, which possess the enzyme beta-carotene 15,15'-dioxygenase which cleaves beta-carotene in the intestinal mucosa and converts it to retinol. In general, carnivores are poor converters of ionone-containing carotenoids, and pure carnivores such as cats and ferrets lack beta-carotene 15,15'-dioxygenase

and cannot convert any carotenoids to retinal (resulting in *none* of the carotenoids being forms of vitamin A for these species).

Deficiency

Main article: Vitamin A deficiency

Vitamin A deficiency is estimated to affect approximately one third of children under the age of five around the world. It is estimated to claim the lives of 670,000 children under five annually. Approximately 250,000–500,000 children in developing countries become blind each year owing to vitamin A deficiency, with the highest prevalence in Southeast Asia and Africa. Vitamin A deficiency is "the leading cause of preventable childhood blindness," according to UNICEF. It also increases the risk of death from common childhood conditions such as diarrhea. UNICEF regards addressing vitamin A deficiency as critical to reducing child mortality, the fourth of the United Nations' Millennium Development Goals.

Vitamin A deficiency can occur as either a primary or a secondary deficiency. A primary vitamin A deficiency occurs among children and adults who do not consume an adequate intake of provitamin A carotenoids from fruits and vegetables or preformed vitamin A from animal and dairy products. Early weaning from breastmilk can also increase the risk of vitamin A deficiency.

Secondary vitamin A deficiency is associated with chronic malabsorption of lipids, impaired bile production and release, and chronic exposure to oxidants, such as cigarette smoke, and chronic alcoholism. Vitamin A is a fat-soluble vitamin and depends on micellar solubilization for dispersion into the small intestine, which results in poor use of vitamin A from low-fat diets. Zinc deficiency can also impair absorption, transport, and metabolism of vitamin A because it is essential for the synthesis of the vitamin A transport proteins and as the cofactor in conversion of retinol to retinal. In malnourished populations, common low intakes of vitamin A and zinc increase the severity of vitamin A deficiency and lead physiological signs and symptoms of deficiency. A study in Burkina Faso showed major reduction of malaria morbidity with combined vitamin A and zincsupplementation in young children.

Due to the unique function of retinal as a visual chromophore, one of the earliest and specific manifestations of vitamin A deficiency is impaired vision, particularly in reduced light – night blindness. Persistent deficiency gives rise to a series of changes, the most devastating of which occur in the eyes. Some other ocular changes are referred to as xerophthalmia. First there is dryness of the conjunctiva (xerosis) as the normal lacrimal and mucus-secreting epithelium is replaced by a keratinized epithelium. This is followed by the build-up of keratin debris in small opaque plaques (Bitot's spots) and, eventually, erosion of the roughened corneal surface with softening and destruction of the cornea (keratomalacia) and leading to total blindness. Other changes include impaired immunity (increased risk of ear infections, urinary tract infections, Meningococcal disease), hyperkeratosis (white lumps at hair follicles), keratosis pilaris and squamous metaplasia of the epithelium lining the upper respiratory passages and urinary bladder to a keratinized epithelium. In relation to dentistry, a deficiency in vitamin A may lead to enamel hypoplasia.

Adequate supply, but not excess vitamin A, is especially important for pregnant and breastfeeding women for normal fetal development and in breastmilk. Deficiencies cannot be compensated by postnatalsupplementation. Excess vitamin A, which is most common with high dose vitamin supplements, can cause birth defects and therefore should not exceed recommended daily values.[21]

Vitamin A metabolic inhibition as a result of alcohol consumption during pregnancy is the elucidated mechanism for fetal alcohol syndrome and is characterized by teratogenicity closely matching maternal vitamin A deficiency.

Vitamin A supplementation

Global efforts to support national governments in addressing vitamin A deficiency are led by the Global Alliance for Vitamin A (GAVA), which is an informal partnership between A2Z, the Canadian International Development Agency, Helen Keller International, the Micronutrient Initiative, UNICEF, USAID, and the World Bank. Joint GAVA activity is coordinated by the Micronutrient Initiative.

While strategies include intake of vitamin A through a combination of breast feeding and dietary intake, delivery of oral high-dose supplements remain the principal strategy for minimizing deficiency. A meta-analysis of 43 studies showed that vitamin A supplementation of children under five who are at risk of deficiency reduces mortality by up to 24%. About 75% of the vitamin A required for supplementation activity by developing countries is supplied by the Micronutrient Initiative with support from the Canadian International Development Agency. Food fortification approaches are becoming increasingly feasible but cannot yet ensure coverage levels.

The World Health Organization estimates that Vitamin A supplementation has averted 1.25 million deaths due to vitamin A deficiency in 40 countries since 1998. In 2008 it was estimated that an annual investment of US$60 million in vitamin A and zinc supplementation combined would yield benefits of more than US$1 billion per year, with every dollar spent generating benefits of more than US$17. These combined interventions were ranked by the Copenhagen Consensus 2008 as the world's best development investment.

Observational studies of pregnant women in sub-Saharan Africa have shown that low serum vitamin A levels are associated with an increased risk of mother-to-child transmission (MTCT) of HIV. Vitamin A is cheap and easily provided through existing health services in low-income settings. It is thus important to determine the effect of routine supplementation of H levels, and because low blood vitamin A levels have been associated with rapid HIV infection and deaths, To identify randomised controlled trials comparing vitamin A supplementation with placebo in known HIV-infected pregnant women, authors searched the Cochrane Library, PubMed, EMBASE, AIDSearch and GATEWAY; checked reference lis,. Authoritative reviews of more recent and better-designed studies have found no relationship between the level of serum maternal and/or infant vitamin A and the likelihood of vertical (MTCT) HIV transmission. of HIV, our trials which enrolled 3033 HIV-infected pregnant women met inclusion criteria. Authors found significant statistical heterogeneity between the three trials with information on MTCT of HIV. Overall, there was no evidence of an effect of antenatal vitamin A supplementation on the risk of MTCT of HIV. However, antenatal vitamin A supplementation significantly improved birth weight, but there was no evidence of an effect on preterm births, stillbirths, deaths by 24 months. Evidence is also lacking on whether vitamin A supplementation for infants up to six months of age reduces infant mortality or morbidity in low- and middle-income countries.

A 2012 systematic review found no evidence that beta-carotene or vitamin A supplements increase longevity in healthy people or in people with various diseases (gastrointestinal, cardiovascular, neurological, ocular, dermatological, rheumatoid, endocrinological, and others).

Side effects

Main article: Hypervitaminosis A

Since vitamin A is fat-soluble, disposing of any excesses taken in through diet takes much longer than with water-soluble B vitamins and vitamin C. This allows for toxic levels of vitamin A to accumulate. These toxicities only occur with preformed (retinoid) vitamin A (such as from liver). The carotenoid forms (such as beta-carotene as found in carrots), give no such symptoms, but excessive dietary intake of beta-carotene can lead tocarotenodermia, a harmless but cosmetically displeasing orange-yellow discoloration of the skin.

In general, acute toxicity occurs at doses of 25,000 IU/kg of body weight, with chronic toxicity occurring at 4,000 IU/kg of body weight daily for 6–15 months. However, liver toxicities can occur at levels as low as 15,000 IU (4500 micrograms) per day to 1.4 million IU per day, with an average daily toxic dose of 120,000 IU, particularly with excessive consumption of alcohol. In people with renal failure, 4000 IU can cause substantial damage. Signs of toxicity may occur with long-term consumption of vitamin A at doses of 25,000-33,000 IU per day.

Excessive vitamin A consumption can lead to nausea, irritability, anorexia (reduced appetite), vomiting, blurry vision, headaches, hair loss, muscle and abdominal pain and weakness, drowsiness, and altered mental status. In chronic cases, hair loss, dry skin, drying of the mucous membranes, fever, insomnia, fatigue, weight loss, bone fractures, anemia, and diarrhea can all be evident on top of the symptoms associated with less serious toxicity. Some of these symptoms are also common to acne treatment with Isotretinoin. Chronically high doses of vitamin A, and also pharmaceutical retinoids such as 13-cis retinoic acid, can produce the syndrome of pseudotumor cerebri. This syndrome includes headache, blurring of vision and confusion, associated with increased intracerebral pressure. Symptoms begin to resolve when intake of the offending substance is stopped.

Chronic intake of 1500 RAE of preformed vitamin A may be associated with osteoporosis and hip fractures because it suppresses bone building while simultaneously stimulating bone breakdown, although other reviews have disputed this effect, indicating further evidence is needed.

A 2012 systematic review found that beta-carotene and higher doses of supplemental vitamin A increased mortality in health people and people with various diseases. The findings of the review extend evidence that antioxidants may not have long-term benefits.

History

The discovery of vitamin A may have stemmed fro**m research dating back to 1816,** when physiologist François Magendie observed that dogs deprived of nutrition developed corneal ulcers and had a high mortality rate. In 1912, Frederick Gowland Hopkins demonstrated that unknown accessory factors found in milk, other than carbohydrates, proteins, and fats were necessary for growth in rats. Hopkins received a Nobel Prize for this discovery in 1929. By 1913, one of these substances was independently discovered by Elmer McCollum and Marguerite Davis at the University of Wisconsin–Madison, and Lafayette Mendel and Thomas Burr Osborne at Yale University who studied the role of fats in the diet. McCollum and Davis ultimately received cr. because they submitted their paper three weeks before Mendel and Osborne. Both papers appeared in the same issue of the *Journal of Biological Chemistry* in 1913. The "accessory factors" were termed "fat soluble" in 1918 and later "vitamin A" in 1920. In 1919, Harry Steenbock (University of Wisconsin–Madison) proposed a relationship between yellow plant pigments (beta-carotene) and vitamin A. In 1931, Swiss chemist Paul Karrer described the chemical structure of vitamin A. Vitamin A was first s**ynthesized in 1947 by two Dutch**chemists, David Adriaan van Dorp and Jozef Ferdinand Arens.

Text 8

B vitamins

B vitamins are a class of water-soluble vitamins that play important roles in cell metabolism. Though these vitamins share similar names, research shows that they are chemically distinct vitamins that often coexist in the same foods. In general, dietary supplements containing all eight are referred to as a vitamin B complex. Individual B vitamin supplements are referred to by the specific number or name of each vitamin: B_1 = thiamine, B_2 = riboflavin, B_3 = niacin, etc. Some are better known by name than number: niacin, pantothenic acid, biotin and folate.

Each B vitamin is either a cofactor (generally a coenzyme) for key metabolic processes or is a precursor needed to make one.

List of B vitamins

B number	Name	Thumbnail description

Vitamin B_1	thiamine	A coenzyme in the catabolism of sugars and amino acids.
Vitamin B_2	riboflavin	A precursor of cofactors called FAD and FMN, which are needed for flavoprotein enzyme reactions, including activation of other vitamins

Vitamin B_3	niacin (nicotinic acid), nicotinamide riboside	A precursor of coenzymes called NAD and NADP, which are needed in many metabolic processes.
Vitamin B_5	pantothenic acid	A precursor of coenzyme A and therefore needed to metabolize many molecules.
Vitamin B_6	pyridoxine, pyridoxal, pyridoxamine	A coenzyme in many

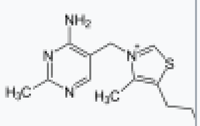
		enzymatic reactions in metabolism.
Vitamin B_7	biotin	A coenzyme for carboxylase enzymes, needed for synthesis of fatty acids and in gluconeogenesis.
Vitamin B_9	folate	A precursor needed to make, repair, and methylate DNA;

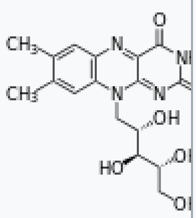
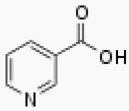
		a cofactor in various reactions; especially important in aiding rapid cell division and growth, such as in infancy and pregnancy. Synthetic folate is known as folic acid.
Vitamin B_{12}	various cobalamins; commonly cyanocobalamin ormethylcobalamin in vitamin supplements	A coenzyme involved in the metabolism of every cell of the human body, especially affecting DNA synthesis and regulation, but also fatty acid

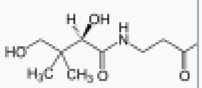
		metabolism and amino acid metabolism.

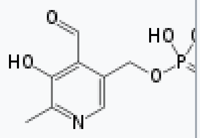
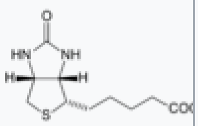
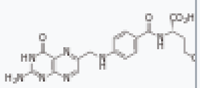
Note: other substances once thought to be vitamins were given numbers in the B-vitamin numbering scheme, but were subsequently discovered to be either not essential for life or manufactured by the body, thus not meeting the two essential qualifiers for a vitamin. See section #Related compounds for numbers 4, 8, 10, 11, and others.

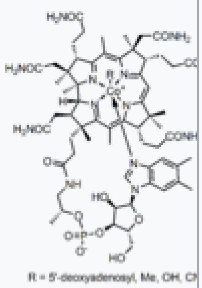
B vitamin molecular functions

Vitamin	Name	Structure	Molecular Function
Vitamin B_1	thiamine		Thiamine plays a central role in the release of energy from carbohydrates. It is involved in RNA and DNA production, as well as nerve function. Its active form is a coenzyme called thiamine

			pyrophosphate (TPP), which takes part in the conversion of pyruvate to acetyl coenzyme A (CoA) in metabolism.
Vitamin B2	riboflavin		Riboflavin is involved in release of energy in the electron transport chain, the citric acid cycle, as well as the catabolism of fatty acids (beta oxidation)..
Vitamin B3	niacin		Niacin is composed of two structures: nicotinic acid and nicotinamide. There are two co-enzyme forms of niacin: nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP). Both

			play an important role in energy transfer reactions in the metabolism of glucose, fat and alcohol.. NAD carries hydrogens and their electrons during metabolic reactions, including the pathway from the citric acid cycle to the electron transport chain. NADP is a coenzyme in lipid and nucleic acid synthesis..
Vitamin B5	pantothenic acid		Pantothenic acid is involved in the oxidation of fatty acids and carbohydrates. Coenzyme A, which can be synthesised from pantothenic acid, is involved in the synthesis of amino acids, fatty acids, ketone bodies, cholesterol,. phospholipids, steroid hormones, neurotransmitters (such as acetylcholine), and antibodies..

Vitamin B6	pyridoxine,pyridoxal,pyridoxamine		The active form pyridoxal 5'-phosphate (PLP) (depicted) serves as a cofactor in many enzyme reactions mainly in amino acid metabolism including biosynthesis ofneurotransmitters.
Vitamin B7	biotin		Biotin plays a key role in the metabolism of lipids, proteins and carbohydrates. It is a critical co-enzyme of four carboxylases: acetyl CoA carboxylase, which is involved in the synthesis of fatty acids from acetate; pyruvate CoA carboxylase, involved in gluconeogenesis; β-methylcrotonyl CoA carboxylase, involved in the metabolism ofleucine; and propionyl CoA carboxylase, which is involved in the metabolism of energy, amino acids and cholesterol..
Vitamin B9	folate		Folate acts as a co-enzyme in the form

			of tetrahydrofolate (THF), which is involved in the transfer of single-carbon units in the metabolism of nucleic acids and amino acids. THF is involved in pyrimidine nucleotide synthesis, so is needed for normal cell division, especially during pregnancy and infancy, which are times of rapid growth. Folate also aids in erythropoiesis, the production of red blood cells..
Vitamin B12	cobalamin		Vitamin B12 is involved in the cellular metabolism of carbohydrates, proteins an d lipids. It is essential in the production of blood cells in bone marrow, and for nerve sheaths and proteins.. Vitamin B12 functions as a co-enzyme in intermediary metabolism for the methionine synthase reaction with methylcobalamin, and

			the methylmalonyl CoA mutase reaction with adenosylcobalamin..[not in citation given]

B vitamin deficiency

Several named vitamin deficiency diseases may result from the lack of sufficient B vitamins. Deficiencies of other B vitamins result in symptoms that are not part of a named deficiency disease.

Vitamin	Name	Deficiency effects
Vitamin B_1	thiamine	Deficiency causes beriberi. Symptoms of this disease of the nervous system include weight loss, emotional disturbances, Wernicke's

		encephalopathy (impaired sensory perception), weakness and pain in the limbs, periods of irregular heartbeat, and edema (swelling of bodily tissues). Heart failure and death may occur in advanced cases. Chronic thiamin deficiency can also cause Korsakoff's syndrome, an irreversible dementia characterized

		by amnesia and compensatory confabulation.
Vitamin B_2	riboflavin	*Main article: Riboflavin § Deficiency* Deficiency causes ariboflavinosis. Symptoms may include cheilosis (cracks in the lips), high sensitivity to sunlight, angular cheilitis, glossitis (inflammation of

		the tongue), seborrheic dermatitis or pseudo-syphilis (particularly affecting the scrotum or labia majora and the mouth), pharyngitis (sore throat), hyperemia, and edema of the pharyngeal and oral mucosa.
Vitamin B3	niacin	*Deficiency, along with a deficiency of tryptophan causes pellagra. Symptoms include aggression, dermatitis, insomnia, weakness, mental confusion, and diarrhea. In advanced cases, pellagra may lead to dementia and death (the 3(+1) D's: dermatitis, diarrhea, dementia, and*

		death).
Vitamin B5	pantothenic acid	*Deficiency can result in acne and paresthesia, although it is uncommon.*
Vitamin B6	pyridoxine,pyridoxal,pyridoxamine	*Main article: Vitamin B6 § Deficiency* *seborrhoeic dermatitis-like eruptions, pink eye, neurological symptoms (e.g. epilepsy)*
Vitamin B7	biotin	*Deficiency does not typically cause symptoms in adults but may lead to impaired growth and neurological disorders in infants. Multiple carboxylase deficiency, an inborn error of metabolism, can lead to biotin deficiency even when dietary biotin intake is normal.*
Vitamin B_9	folic acid	Deficiency results in a macrocytic anemia, and elevated levels of homocysteine. Deficiency in

		pregnant women can lead to birth defects.
Vitamin B_{12}	cobalamin	Deficiency results in a macrocytic anemia, elevated methylmalonic acid and homocysteine, peripheral neuropathy, memory loss and other cognitive deficits. It is most likely to occur among elderly people, as absorption through the gut declines with age; the autoimmune disease pernicious anemia is another common cause. It can also cause symptoms of mania and psychosis. In rare extreme cases, paralysis can result.

Text 9

Wheat, wheat processing

Processing and Eating Wheat

While only the heads of wheat plants contain enriching human foods, farmers usually harvest the dried stems and leaves for use as hay, which provides livestock with food and a comfortable place to sleep.

IMAGEMORE/GETTY IMAGES

Farmers grow wheat as either a winter or spring crop, depending on how severe winters are in the region. In milder climates, planting takes place in the fall with harvest following between June and August, depending on the duration of winter. Where winters are a little more intense, farmers plant as soon as the soil has thawed and harvest in early fall.

Modern farmers typically use a combine harvester to collect their wheat, but the scythe, sickle and flail still see significant use in developing countries. The first task is pretty simple: cut the heads from the top of the wheat plants and then thresh them to remove the grains from the rest of the head, called chaff. The grains are divided from additional plant fragments, cleaned and taken to a mill, where any separation of bran, endosperm and germ takes place.

To separate the three elements, farmers either crush the wheat with grinding stones or pass them through automated steel cylinders. Mill operators usually add a small amount of water to the grains, as this toughens the outer bran and softens the inner endosperm, making it easier to split the two. Rollers typically flatten the wheat germ, allowing it to be sifted out from the rest of the flour. In modern mills, the type of flour produced depends on what stage operators remove it from the milling cycle.

Wheat grain contains several key nutrients. The outer bran covering contains three major B vitamins, trace minerals and dietary fiber. The endosperm, however, takes up most of the room and contains protein, carbohydrates, iron, riboflavin and thiamine. Not to be outdone, the germ (or wheat plant embryo) contains a small portion of B vitamins and trace minerals as well.

While early humans consumed these grains raw, they eventually began using tools to pound the grain and then adding water to the crushed kernels to form a wholesome gruel. The uses and properties of wheat foods vary depending on what combination of bran, endosperm and germ harvesters use. Take white bread and bleached white flour, for instance. In these products, both the bran and the endosperm have been removed to ensure smoother texture and longevity. The germ contains fat, which can turn rancid in flour if not properly stored. But wheat germ still contains a number of key nutrients, including protein, and is used separately in many products.

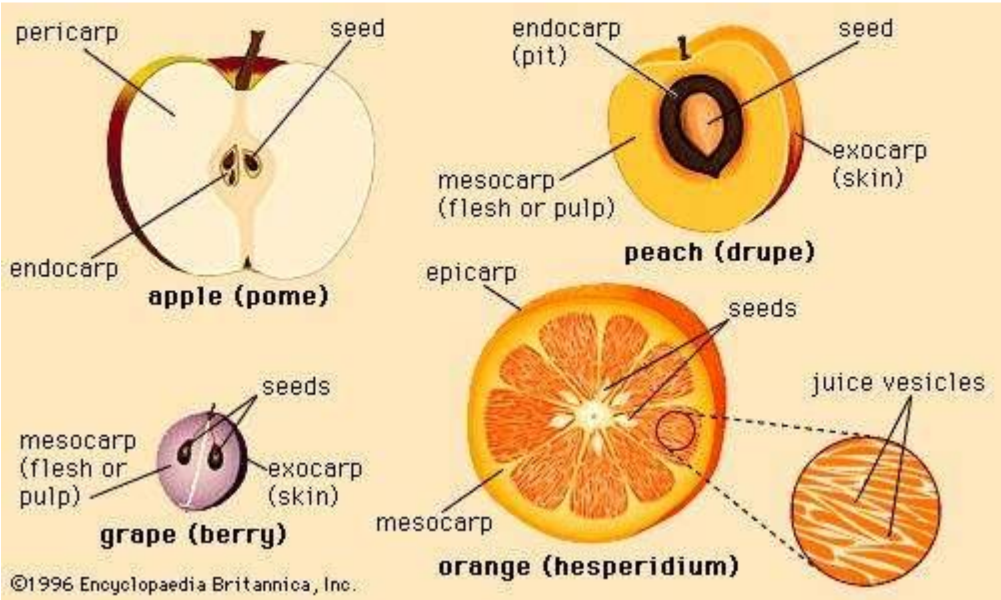
Whole wheat products contain all three parts of the wheat grain, offering the largest array of nutrients. When separated from the rest of the grain, bran also goes it alone for use in animal feed and foods such as bran muffins and breakfast cereals.

Before you grab a bowl of cereal or a bottle of wheat beer, explore the links below to learn even more about agriculture.

Text 10

Fruit processing, preparation of fruit for human consumption.

Fruit is sometimes defined as the product of growth from an angiosperm, or flowering plant. From a purely botanical point of view, the fruit may be only the fleshy growth that arises from the ovary of a flower and may not necessarily include any other structures. From the consumer's or food processor's point of view, however, fruit is generally characterized as the edible product of a plant or tree that includes the seed and its envelope and can typically be described as juicy, sweet, and pulpy. Typical fruit structures are illustrated in Figure 1.



Four representative types of fruit.*Encyclopædia Britannica, Inc.*

Fruits are a high-moisture, generally acidic food that is relatively easy to process and that offers a variety of flavour, aroma, colour, and texture to the diet. They are usually low in calories but are an excellent source of dietary fibre and essential vitamins. Owing to the presence of cellulose, pectin, and various organic acids, fruits can also act as natural laxatives. Fruits are therefore a valuable part of the diet.

Nutrient composition

Moisture content, acidity, and vitamin content

As shown in the table, fresh fruit is typically between 75 and 95 percent water, a fact that helps to explain the refreshing character of the food. In general, fruits are acidic, with pH ranging from 2.5 to 4.5. The most common acids in fruits are citric acid, malic acid, and tartaric acid.

Nutrient composition of selected fruits and fruit products (per 100 g)*

fruit or fruit product	energy (kcal)	water (g)	carbohydrate (g)	vitamin C (mg)	thiamin (mg)	riboflavin (mg)	niacin (mg)	vitamin A (IU)	fat (g)	protein (g)
apple, juice	47	87.93	11.68	0.9	0.021	0.017	0.100	1	0.11	0.06
apple, whole	59	83.90	15.25	5.7	0.017	0.014	0.077	53	0.36	0.19
Apricot	48	86.35	11.12	10.0	0.030	0.040	0.600	2,612	0.39	1.40
Avocado	161	74.27	2.11	7.9	0.108	0.122	1.921	61	15.32	1.98

*Values shown are approximations; actual nutrient composition can vary greatly depending on such factors as growing conditions, time of harvest, and storage.

Source: U.S. Department of Agriculture, Composition of Foods, Agriculture Handbook no. 8–9.

fruit or fruit product	energy (kcal)	water (g)	carbohydrate (g)	vitamin C (mg)	thiamin (mg)	riboflavin (mg)	niacin (mg)	vitamin A (IU)	fat (g)	protein (g)
Banana	92	74.26	23.43	9.1	0.045	0.100	0.540	81	0.48	1.03
Grape	63	81.30	17.15	4.0	0.092	0.057	0.300	100	0.35	0.63
Grapefruit	32	90.89	8.08	34.4	0.036	0.020	0.250	124	0.10	0.63
Orange	47	86.75	11.75	53.2	0.087	0.040	0.282	205	0.12	0.94
Peach	43	87.66	11.10	6.6	0.017	0.041	0.990	535	0.09	0.70
Pear	59	83.81	15.11	4.0	0.020	0.040	0.100	20	0.40	0.39
Plum	55	85.20	13.01	9.5	0.043	0.096	0.500	323	0.62	0.79
Watermelon	32	91.51	7.18	9.6	0.080	0.020	0.200	366	0.43	0.62

Of all the vitamins present in fruits, the most noted is vitamin C, or ascorbic acid. Actual quantities of vitamin C in fruits are not especially large, but the vitamin is particularly important in the diet because of its role in the prevention of disease and in the general promotion of good health. Citrus fruits, such as oranges, lemons, and grapefruits, are well known for their vitamin C content. Other sources include most berries and melons. Carotene, a chemical common to fruit, is easily converted in the body to vitamin A; cantaloupes, peaches, and apricots are significant sources of this nutrient.

Carbohydrates

Typically, fruits are high in carbohydrates, although a large range is possible—between 2 and 40 percent, depending on the type of fruit and its maturity. Free sugars usually include fructose, glucose, and sucrose; other sugars may be present in smaller quantities.

A large portion of the carbohydrates present in fruits is fibre, which is not digested and passes through the digestive system. Fibre is usually made up of cellulose, hemicellulose, and pectic substances. A small amount of starch may also be present in fruit, but starches are typically converted to sugars during the ripening process.

Protein and fat content

A negligible quantity of protein is found in fruits, and they usually contain less than 1 percent fat. Fats are most typically associated with the waxy cuticle surface of the fruit skin. Exceptions to this rule are avocados and olives, the flesh of which may contain as much as 20 percent oil.

Text 11

Making tomatos

Homemade tomato paste—or if you're feeling fancy you can call it tomato *conserva*—is remarkable. It is thick, sticky, gooey, and sweet, and transmits complete tomato essence to whatever recipe you add it to. Plus, it's a great way to store a bumper crop of tomatoes in a compact, useful fashion.

To make tomato paste you'll need:

- 5 pounds tomatoes
- 1 teaspoon fine sea salt
- 1/2 to 1 cup extra-virgin olive oil
- Large pot
- Food mill or large sieve
- Large rimmed baking pan
- 2 or 3 half-pint jars with lids or similar containers

Use only the ripest (a bit too ripe is okay), sweetest, more delicious tomatoes you can find. Look for dry-farmed, vine-ripened tomatoes. Concentrated tomatoes like Roma or Early Girl tomatoes work extremely well in this recipe. If you use juicier tomatoes, be sure to follow the note on de-seeding and de-juicing them in the next step.

If you want to reduce the paste in the oven, preheat an oven to 300 F (see Step 5 for more details).

Remove and discard stems and any damaged parts from the tomatoes. Roughly chop the tomatoes and put them in a large pot. This can be a *very* rough chop—you just want to get the tomatoes started so they break down faster.

Note: If you're working with tomatoes that contain a lot of juice, you might want to halve them and squeeze out and discard the seeds and watery juice in the center to help speed up the concentration process that will turn tomato purée into tomato paste.

Bring the tomatoes to a boil over high heat. Cook, stirring, just until tomatoes soften, about 2 minutes. This brief cooking helps break the tomatoes down a bit and makes them easier to run through a food mill or sieve. Add about 1/2 cup of the olive oil and that teaspoon fine sea salt to the tomatoes.

Note: If you have a tomato mill or food mill and a strong arm, you can skip this initial cooking step, if you like.

Run the cooked tomatoes through a food mill or push them through a large sieve with a flexible spatula. Why are you doing this? To turn the tomatoes into a pulp while also removing the skins and seeds.

At this point, you can proceed in one of three ways:

8. Oven Method: If you started with not-too-juicy tomatoes and you have a few large sheet pans, you can directly pour the tomato pulp onto one or two large rimmed baking sheet(s) and bake in a preheated 300 F oven for about 3 hours.
9. Combination Method: If your tomatoes were juicier or you don't have a large enough rimmed baking sheet, feel free to boil down the tomato purée on the stove first. Reduce it by up to 1/3 (or even 1/2 if your tomatoes were super juicy) by bringing it to a simmer and maintaining a steady simmer until the tomatoes have reduced. *Then*, you can pour this more concentrated tomato mixture onto a rimmed baking sheet or smaller roasting pan to finish reducing it in the oven.
10. Stovetop Method: Reduce the tomatoes to a paste completely on the stove. While this is completely possible, it's a tricky business to get it to the right consistency without burning it. Better to make it in an oven, but if for whatever reason you want to just simmer it down, see Step 9 for a few tips.

Whichever method you choose to reduce your puréed tomatoes, be sure to stir them frequently (every 30 minutes or so if they're in the oven; every 15 minutes or so if they're on the stove), taking care to scrape up any caramelized bits along the edges of the pan or bottom or sides of the pot and re-incorporating them into the mixture.

After the tomatoes have reduced significantly (between 1/3 and 1/2), reduce the oven heat to 250 F degrees. Continue baking (and stirring and scraping at regular intervals) until the mixture is thick, shiny, and the color of bricks, up to 2 or 3 more hours.

If you don't have an oven or are simply willing to be around to monitor and stir the pot *very regularly* for a few hours, reducing tomato paste on the stove isn't a big deal.

At Step 5, above, simply keep simmering the tomatoes. You want a very low and steady simmer and you need to check on the tomatoes and stir them every 20 minutes or so, being sure to scrape down the sides of the pot as the mixture goes lower and lower.

Checking it regularly is key to keeping it from scorching, as is cooking it in as heavy a pot as you can find. An enameled cast iron pot and a set timer to remind you to stir are ideal.

The whole process will take several hours—it really depends on how juicy the tomatoes are. Feel free to turn off the stove if you need to leave and do an errand and turn the stove back on when you come home.

Once you have cooked the tomatoes into a thick, delicious paste, transfer it into several half-pint jars. You can keep it in the refrigerator *or* process the jars in a hot-water bath for keeping them shelf-stable.

To Store the Jars In the Refrigerator

11. Use a flexible rubber or silicone spatula to transfer the tomato paste into jars. You will have 2 to 3 cups.

12. Leave room at the top of each jar to pour a thick layer of olive oil to protect the paste.
13. Cover with lids and store for up to several months in the refrigerator. Each time you use some, make sure the surface of the tomato paste is again covered with oil.
14. To reduce the chance of mold developing, make sure to use scrupulously clean utensils every time you remove a dab of tomato paste from the jar.

To Hot-Water Process the Jars

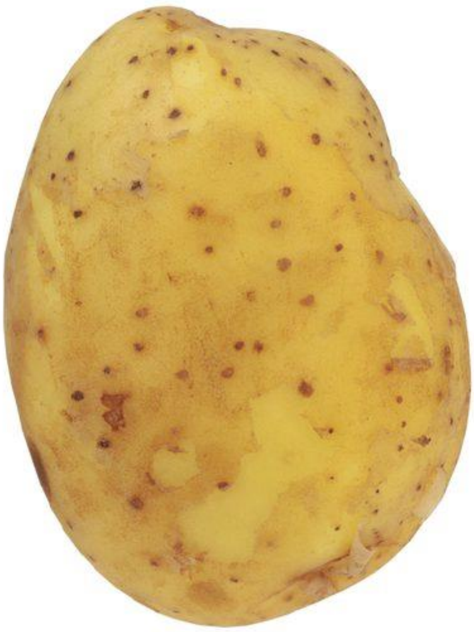
15. Bring a canning kettle of water to a boil. Use a flexible rubber or silicone spatula to transfer the mixture into sterilized, hot, pint- or half-pint jars, leaving 1/2-inch head space in each jar and running a thin knife along the sides of each jar to release as many air bubbles as possible. Pounding the jars on a counter a few times to try and get inevitable air bubbles out of the thick mixture works well.
16. Put sterile lids that have been softened for a few minutes in hot water and patted dry on the jars.
17. Set the jars in a canning rack and submerge in the boiling water of the canning kettle (making sure the boiling water covers the jars by at least an inch) for 30 minutes.
18. Remove and let cool to room temperature.
19. Store in a cool, dark place (a pantry or cupboard is fine) for up to 1 year. Once opened, store in the fridge and, as with the unprocessed jars, use clean utensils for removing tomato paste from the jar to reduce the risk of mold developing.

Text 12

Potatoes, carrots. Juice production

The Benefits of Juicing a Potato

Marie Dannie has been a professional journalist since 1991, specializing in nutrition and health topics. She has written for "Woman's Own," the "Daily Mail," the "Daily Mirror" and the "Telegraph." She is a registered nutritionist and holds a Bachelor of Science degree with honors in food science from the University of Nottingham.



Potato juice tastes mild and blends well with other juices. Photo Credit: Stockbyte/Stockbyte/Getty Images

Because the potato is most often associated with baking, boiling or roasting for side dishes, juicing one may not have occurred to you. But, potato juice is nutrient-rich. While the taste of potato juice alone is unappetizing -- too vegetal and starchy with little natural sweetness -- its mild flavor means it can be mixed with other fruit and vegetable juices without affecting the taste. It takes 2 cups of diced, peel-on, raw potato to produce a 1/2-cup serving of fresh potato juice.

Essential Potassium

Photo Credit: Digital Vision./Photodisc/Getty Images

An electrolyte and essential mineral, potassium helps maintain the electrical activity in your heart. It also helps with the production of protein and muscle and regulates the acid-base balance in your body's cells. Potassium also helps with maintaining healthy body growth and aids breakdown and use of carbohydrates. A 1/2-cup serving of potato juice has 1,263 milligrams of

potassium, which is almost 27 percent of the daily recommended dietary intake for all adults.

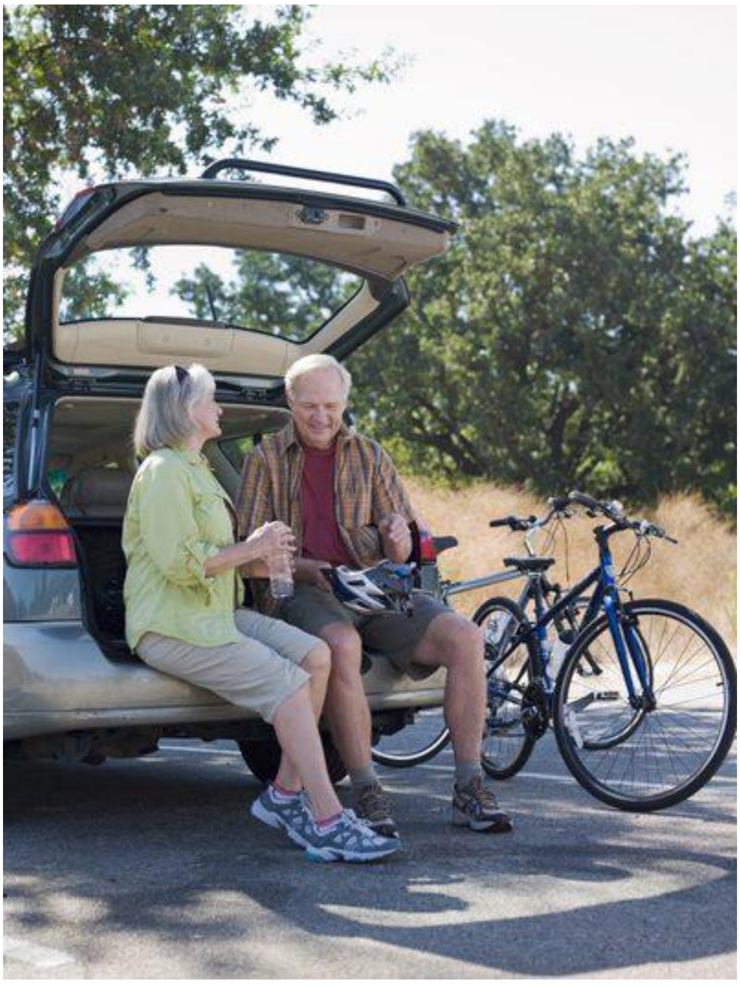
Immune-Boosting Vitamin C

Vitamin C helps produce collagen, which is used to make tendons, ligaments, blood vessels and skin. Consequently, it helps with the maintenance of cartilage. Vitamin C is also important for the production of scar tissue, promoting wound healing. As a natural antioxidant, vitamin C helps your body defend itself from free radicals and environmental toxins such as smog and radiation, which can lead to premature aging and increase the risk of heart disease and cancer. A 1/2-cup serving of potato juice contains just over 59 milligrams of vitamin C. This is more than 50 percent of the dietary reference intake for all adults, with the exception of breastfeeding women, for whom it provides only 49 percent of the DRI.

Thiamine for Energy

A member of the B vitamin group, thiamine -- vitamin B-1 -- helps with maintaining healthy skin, eyes and teeth. It also provides support to your nervous system and helps your body break down carbohydrates into usable energy. A 1/2-cup serving of potato juice contains 0.24 milligrams of thiamine. This provides 20 percent of the recommended dietary allowance for adult men, almost 22 percent for adult women and 17 percent for women who are pregnant or breastfeeding.

Natural Niacin



Also a member of the B vitamin group, niacin, also known as vitamin B-3, provides support to your nervous system, aids in the breakdown and use of carbohydrates and maintains healthy skin, teeth and eyes. Niacin is also known for helping improve circulation and for helping make a range of sex and stress hormones in your body. With just over 3 milligrams of niacin per 1/2-cup serving, potato juice provides almost 20 percent of the recommended dietary allowance for adult men, 22.5 percent for adult women, 17.6 percent for pregnant women and 18.6 percent for breastfeeding women.

Text 13

Fat

Fat is one of the three main macronutrients, along with carbohydrate and protein. Fats, also known as triglycerides, are esters of three fatty acid chains and the alcoholglycerol. The terms "oil", "fat", and "lipid" are often confused. "Oil" normally refers to a fat with short or unsaturated fatty acid chains that is liquid at room temperature, while "fat" may specifically refer to fats that are solids at room temperature. "Lipid" is the general term, though a lipid is not necessarily a triglyceride. Fats, like other lipids, are generallyhydrophobic, and are soluble in organic solvents and insoluble in water.

Fat is an important foodstuff for many forms of life, and fats serve both structural and metabolic functions. They are a necessary part of the diet of most heterotrophs (including humans). Some fatty acids that are set free by the digestion of fats are called essential because they cannot be synthesized in the body from simpler constituents. There are two essential fatty acids (EFAs) in human nutrition: alpha-linolenic acid (an omega-3 fatty acid) and linoleic acid (an omega-6 fatty acid). Other lipids needed by the body can be synthesized from these and other fats. Fats and other lipids are broken down in the body by enzymes called lipases produced in the pancreas.

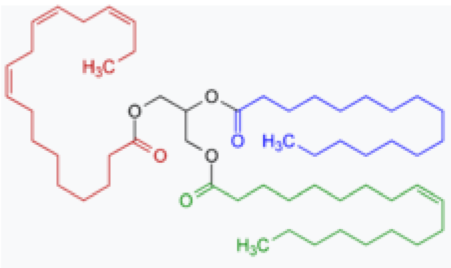
Fats and oils are categorized according to the number and bonding of the carbon atoms in the aliphatic chain. Fats that are saturated fats have no double bonds between the carbons in the chain. Unsaturated fats have one or more double bonded carbons in the chain. The nomenclature is based on the non-acid (non-carbonyl) end of the chain. This end is called the omega end or the n-end. Thus alpha-linolenic acid is called an omega-3 fatty acid because the 3rd carbon from that end is the first double bonded carbon in the chain counting from that end. Some oils and fats have multiple double bonds and are therefore called polyunsaturated fats. Unsaturated fats can be further divided into cis fats, which are the most common in nature, and trans fats, which are rare in nature.

Unsaturated fats can be altered by reaction with hydrogen effected by a catalyst. This action, called hydrogenation, tends to break all the double bonds and makes a fully saturated fat. To make vegetable shortening, then, liquid *cis*-unsaturated fats such as vegetable oils are hydrogenated to produce saturated fats, which have more desirable physical properties e.g., they melt at a desirable temperature (30–40 °C), and store well, whereas polyunsaturated oils go rancid when they react with oxygen in the air. However, trans fats are generated during hydrogenation as contaminants created by an unwanted side reaction on the catalyst during partial hydrogenation.

Saturated fats can stack themselves in a closely packed arrangement, so they can solidify easily and are typically solid at room temperature. For example, animal fats tallow and lardare high in saturated fatty acid content and are solids. Olive and linseed oils on the other hand are unsaturated and liquid. Fats serve both as energy sources for the body, and as stores for energy in excess of what the body needs immediately. Each gram of fat when burned or metabolized releases about 9 food calories (37 kJ = 8.8 kcal).· Fats are broken down in the healthy body to release their constituents, glycerol and fatty acids. Glycerol itself can be converted to glucose by the liver and so become a source of energy.

Chemical structure

Main article: Triglyceride

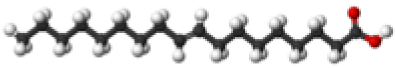
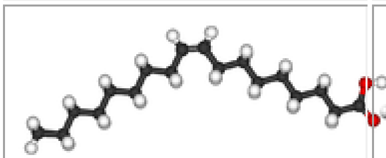


Example of a natural triglyceride with three different fatty acids. One fatty acid is saturated (blue highlighted), another contains one double bondwithin the carbon chain (greenhighlighted). The third fatty acid (a polyunsaturated fatty acid, highlighted in red) contains three double bondswithin the carbon chain. All carbon-carbon double bonds shown are *cis*isomers.

There are many different kinds of fats, but each is a variation on the same chemical structure. All fats are derivatives of fatty acids and glycerol. Most fats are glycerides, particularly triglycerides (triesters of glycerol). One chain of fatty acid is bonded to each of the three -OH groups of the glycerol by the reaction of the carboxyl end of the fatty acid (-COOH) with the alcohol; I.e. three chains per molecule. Water is eliminated and the carbons are linked by an -O- bond through dehydration synthesis. This process is called esterification and fats are therefore esters. As a simple visual illustration, if the kinks and angles of these chains were straightened out, the molecule would have the shape of a capital letter E. The fatty acids would each be a horizontal line; the glycerol "backbone" would be the vertical line that joins the horizontal lines. Fats therefore have "ester" bonds.

The properties of any specific fat molecule depend on the particular fatty acids that constitute it. Fatty acids form a family of compounds that are composed of increasing numbers of carbon atoms linked into a zig-zag chain (hydrogen atoms to the side). The more carbon atoms there are in any fatty acid, the longer its chain will be. Long chains are more susceptible to intermolecular forces of attraction (in this case, van der Waals forces), and so the longer ones melt at a higher temperature (melting point).

Examples of fatty acids.

trans Unsaturated (Example shown: Elaidic acid)	*cis* Unsaturated (Example shown: Oleic acid)	Saturated (Example shown: Stearic acid)
		
Elaidic acid is the principal *trans* unsaturated fatty acid often found in partially hydrogenated vegetable oils.	Oleic acid is a *cis* unsaturated fatty acid making up 55–80% of olive oil.	Stearic acid is a saturated fatty acid found in animal fats and is the intended product in full hydrogenation. Stearic acid is neither *cis* nor *trans* because it has no carbon-carbon double bonds.

Fatty acid chains may also differ by length, often categorized as short to very long.

- Short-chain fatty acids (SCFA) are fatty acids with aliphatic tails of fewer than six carbons (i.e. butyric acid).
- Medium-chain fatty acids (MCFA) are fatty acids with aliphatic tails of 6–12 carbons, which can form medium-chain triglycerides.
- Long-chain fatty acids (LCFA) are fatty acids with aliphatic tails of 13 to 21 carbons.
- Very long chain fatty acids (VLCFA) are fatty acids with aliphatic tails of 22 or more carbons.

Any of these aliphatic fatty acid chains may be glycerated and the resultant fats may have tails of different lengths from very short triformin to very long, e.g., cerotic acid, or*hexacosanoic acid*, a 26-carbon long-chain saturated fatty acid. Long chain fats are exemplified by tallow (lard) whose chains are 17 carbons long. Most fats found in food, whether vegetable or animal, are made up of medium to long-chain fatty acids, usually of equal or nearly equal length. Many cell types can use either glucose or fatty acids for this energy. In particular, heart and skeletal muscle prefer fatty acids. Despite long-standing assertions to the contrary, fatty acids can also be used as a source of fuel for brain cells.

Importance for living organisms

Fats are also sources of essential fatty acids, an important dietary requirement. They provide energy as noted above. Vitamins A, D, E, and K are fat-soluble, meaning they can only be digested, absorbed, and transported in conjunction with fats. Fats play a vital role in maintaining healthy skin and hair, insulating body organs against shock, maintaining body temperature, and promoting healthy cell function. Fat also serves as a useful buffer against a host of diseases. When a particular substance, whether chemical or biotic, reaches unsafe levels in the bloodstream, the body can effectively dilute—or at least maintain equilibrium of—the offending substances by storing it in new fat tissue. This helps to protect vital organs, until such time as the offending substances can be metabolized or removed from the body by such means as excretion, urination, accidental or intentional bloodletting, sebum excretion, and hair growth.

Adipose tissue

The obese mouse on the left has large stores of adipose tissue. For comparison, a mouse with a normal amount of adipose tissue is shown on the right.

Main article: Adipose tissue

In animals, adipose, or fatty tissue is the body's means of storing metabolic energy over extended periods of time. Adipocytes (fat cells) store fat derived from the diet and from liver metabolism. Under energy stress these cells may degrade their stored fat to supply fatty acids and also glycerol to the circulation. These metabolic activities are regulated by several hormones (e.g., insulin, glucagon and epinephrine).

The location of the tissue determines its metabolic profile: visceral fat is located within the abdominal wall (i.e., beneath the wall of abdominal muscle) whereas "subcutaneous fat" is located beneath the skin (and includes fat that is located in the abdominal area beneath the skin but *above* the abdominal muscle wall). Visceral fat was recently discovered to be a significant producer of signaling chemicals (i.e., hormones), among which several are involved in inflammatory tissue responses. One of these is resistinwhich has been linked to obesity, insulin resistance, and Type 2 diabetes. This latter result is currently controversial, and there have been reputable studies supporting all sides on the issue.

Fatty acids and human health

Dietary consumption of fatty acids has effects on human health. Studies have found that replacing saturated fats with *cis* unsaturated fats in the diet reduces risk of cardiovascular disease. For example, a 2015 systematic review of randomized control trials by the Cochrane Library concluded: "Lifestyle advice to all those at risk of cardiovascular disease and to lower risk population groups should continue to include permanent reduction of dietary saturated fat and partial replacement by unsaturated fats.".

Numerous studies have also found that consumption of *trans* fats increases risk of cardiovascular disease.. The Harvard School of Public Health advises that replacing *trans*fats and saturated fats with *cis* monounsaturated and polyunsaturated fats is beneficial for health.

Text 14

Mineral

A mineral is a naturally occurring chemical compound,. usually of crystalline form and abiogenic in origin (not produced by life processes). A mineral has one specificchemical composition, whereas a rock can be an aggregate of different minerals or mineraloids. The study of minerals is called mineralogy.

There are over 5,300 known mineral species; as of March 2017, over 5,230 of these have been approved by the International Mineralogical Association (IMA).. Thesilicate minerals compose over 90% of the Earth's crust. The diversity and abundance of mineral species is controlled by the Earth's chemistry. Silicon and oxygenconstitute approximately 75% of the Earth's crust, which translates directly into the predominance of silicate minerals.

Minerals are distinguished by various chemical and physical properties. Differences in chemical composition and crystal structure distinguish the various species, which were determined by the mineral's geological environment when formed. Changes in the temperature, pressure, or bulk composition of a rock mass cause changes in its minerals.

Minerals can be described by their various physical properties, which are related to their chemical structure and composition. Common distinguishing characteristics include crystal structure and habit, hardness, lustre, diaphaneity, colour, streak, tenacity, cleavage, fracture, parting, and specific gravity. More specific tests for describing minerals include magnetism, taste or smell, radioactivity and reaction to acid.

Minerals are classified by key chemical constituents; the two dominant systems are the Dana classification and the Strunz classification. The silicate class of minerals is subdivided into six subclasses by the degree of polymerization in the chemical structure. All silicate minerals have a base unit of a $[SiO_4]^{4-}$ silica tetrahedron—that is, a silicon cation coordinated by four oxygen anions, which gives the shape of a tetrahedron. These tetrahedra can be polymerized to give the subclasses: orthosilicates (no polymerization, thus single tetrahedra), disilicates (two tetrahedra bonded together), cyclosilicates (rings of tetrahedra), inosilicates (chains of tetrahedra), phyllosilicates (sheets of tetrahedra), and tectosilicates (three-dimensional network of tetrahedra). Other important mineral groups include thenative elements, sulfides, oxides, halides, carbonates, sulfates, and phosphates.

Basic definition

One definition of a mineral encompasses the following criteria:

1. Naturally occurring
2. Stable at room temperature
3. Represented by a chemical formula
4. Usually abiogenic (not resulting from the activity of living organisms)

5. Ordered atomic arrangement

The first three general characteristics are less debated than the last two. The first criterion means that a mineral has to form by a natural process, which excludes anthropogenic compounds. Stability at room temperature, in the simplest sense, is synonymous to the mineral being solid. More specifically, a compound has to be stable or metastable at 25 °C. Classical examples of exceptions to this rule include nativemercury, which crystallizes at −39 °C, and water ice, which is solid only below 0 °C; as these two minerals were described prior to 1959, they were grandfathered by the International Mineralogical Association(IMA). Modern advances have included extensive study of liquid crystals, which also extensively involve mineralogy. Minerals are chemical compounds, and as such they can be described by fixed or a variable formula. Many mineral groups and species are composed of a solid solution; pure substances are not usually found because of contamination or chemical substitution. For example, the olivine group is described by the variable formula $(Mg, Fe)_2SiO_4$, which is a solid solution of two end-member species, magnesium-rich forsterite and iron-rich fayalite, which are described by a fixed chemical formula. Mineral species themselves could have a variable compositions, such as the sulfide mackinawite, $(Fe, Ni)_9S_8$, which is mostly a ferrous sulfide, but has a very significant nickel impurity that is reflected in its formula.

Finally, the requirement of an ordered atomic arrangement is usually synonymous with crystallinity; however, crystals are also periodic, so the broader criterion is used instead. An ordered atomic arrangement gives rise to a variety of macroscopic physical properties, such as crystal form, hardness, and cleavage. There have been several recent proposals to amend the definition to consider biogenic or amorphous substances as minerals. The formal definition of a mineral approved by the IMA in 1995:

A mineral is an element or chemical compound that is normally crystalline and that has been formed as a result of geological processes.

In addition, biogenic substances were explicitly excluded:

Biogenic substances are chemical compounds produced entirely by biological processes without a geological component (e.g., urinary calculi, oxalate crystals in plant tissues, shells of marine molluscs, etc.) and are not regarded as minerals. However, if geological processes were involved in the genesis of the compound, then the product can be accepted as a mineral.

Recent advances

Mineral classification schemes and their definitions are evolving to match recent advances in mineral science. Recent changes have included the addition of an organic class, in both the new Dana and the Strunz classification schemes. The organic class includes a very rare group of minerals with hydrocarbons. The IMA Commission on New Minerals and Mineral Names adopted in 2009 a hierarchical scheme for the naming and classification of mineral groups and group names and established seven commissions and four working groups to review and classify minerals into an official listing of their published names. According to these new rules, "mineral species can be grouped in a number of different ways, on the basis of chemistry, crystal structure, occurrence, association, genetic history, or resource, for example, depending on the purpose to be served by the classification."

The Nickel (1995) exclusion of biogenic substances was not universally adhered to. For example, Lowenstam (1981) stated that "organisms are capable of forming a diverse array of minerals, some of which cannot be formed inorganically in the biosphere." The distinction is a matter of classification and less to do with the constituents of the minerals themselves. Skinner (2005) views all solids as potential minerals and includesbiominerals in the mineral kingdom, which are those that are created by the metabolic activities of organisms. Skinner expanded the previous definition of a mineral to classify "element or compound, amorphous or crystalline, formed through *biogeochemical* processes," as a mineral.

Recent advances in high-resolution genetics and X-ray absorption spectroscopy are providing revelations on the biogeochemical relations between microorganisms and minerals that may make Nickel's (1995) biogenic mineral exclusion obsolete and Skinner's (2005) biogenic mineral inclusion a necessity. For example, the IMA commissioned "Environmental Mineralogy and Geochemistry Working Group" deals with minerals in the hydrosphere, atmosphere, and biosphere. The group's scope includes mineral-forming microorganisms, which exist on nearly every rock, soil, and particle surface spanning the globe to depths of at least 1600 metres below the sea floor and 70 kilometres into the stratosphere (possibly entering the mesosphere). Biogeochemical cycles have contributed to the formation of minerals for billions of years. Microorganisms can precipitate metals from solution, contributing to the formation of ore deposits. They can also catalyze the dissolution of minerals.

Prior to the International Mineralogical Association's listing, over 60 biominerals had been discovered, named, and published. These minerals (a sub-set tabulated in Lowenstam (1981)) are considered minerals proper according to the Skinner (2005) definition. These biominerals are not listed in the International Mineral Association official list of mineral names, however, many of these biomineral representatives are distributed amongst the 78 mineral classes listed in the Dana classification scheme. Another rare class of minerals (primarily biological in origin) include the mineral liquid crystals that have properties of both liquids and crystals. To date over 80,000 liquid crystalline compounds have been identified.

The Skinner (2005) definition of a mineral takes this matter into account by stating that a mineral can be crystalline or amorphous, the latter group including liquid crystals. Although biominerals and liquid mineral crystals, are not the most common form of minerals, they help to define the limits of what constitutes a mineral proper. The formal Nickel (1995) definition explicitly mentioned crystallinity as a key to defining a substance as a mineral. A 2011 article defined icosahedrite, an aluminium-iron-copper alloy as mineral; named for its unique natural icosahedral symmetry, it is a quasicrystal. Unlike a true crystal, quasicrystals are ordered but not periodic.

Rocks, ores, and gems

Schist is a metamorphic rock characterized by an abundance of platy minerals.

In this example, the rock has prominent sillimaniteporphyroblasts as large as

3 cm (1.2 in).

Minerals are not equivalent to rocks. A rock is either an aggregate of one or more minerals or mineraloids. Some rocks, such as limestone or quartzite, are composed primarily of one mineral—calcite or aragonite in the case of limestone, and quartz in the latter case. Other rocks can be defined by relative abundances of key (essential) minerals; a granite is defined by proportions of quartz, alkali feldspar, and plagioclase feldspar. The other minerals in the rock are termed accessory, and do not greatly affect the bulk composition of the rock. Rocks can also be composed entirely of non-mineral material; coal is a sedimentary rock composed primarily of organically derived carbon.

In rocks, some mineral species and groups are much more abundant than others; these are termed the rock-forming minerals. The major examples of these are quartz, the feldspars, the micas, the amphiboles, the pyroxenes, the olivines, and calcite; except the last one, all of the minerals are silicates. Overall, around 150 minerals are considered particularly important, whether in terms of their abundance or aesthetic value in terms of collecting.

Commercially valuable minerals and rocks are referred to as industrial minerals. For example, muscovite, a white mica, can be used for windows (sometimes referred to as isinglass), as a filler, or as an insulator. Ores are minerals that have a high concentration of a certain element, typically a metal. Examples are cinnabar (HgS), an ore of mercury, sphalerite (ZnS), an ore of zinc, or cassiterite (SnO_2), an ore of tin. Gems are minerals with an ornamental value, and are distinguished from non-gems by their beauty, durability, and usually, rarity. There are about 20 mineral species that qualify as gem minerals, which constitute about 35 of the most common gemstones. Gem minerals are often present in several varieties, and so one mineral can account for several different gemstones; for example, ruby and sapphire are both corundum, Al_2O_3.

Nomenclature and classification

Minerals are classified by variety, species, series and group, in order of increasing generality. The basic level of definition is that of mineral species, which is distinguished from other species by specific and unique chemical and physical properties. For example, quartz is defined by its formula, SiO_2, and a specific crystalline structure that distinguishes it from other minerals with the same chemical formula (termed polymorphs). When there exists a range of composition between two minerals species, a mineral series is defined. For example, thebiotite series is represented by variable amounts of the endmembers phlogopite, siderophyllite, annite, and eastonite. In contrast, a mineral group is a grouping of mineral species with some common chemical properties that share a crystal structure. The pyroxene group has a common formula of $XY(Si,Al)_2O_6$, where X and Y are both cations, with X typically bigger than Y; the pyroxenes are single-chain silicates that crystallize in either the orthorhombic or monoclinic crystal systems. Finally, a mineral variety is a specific type of mineral species that differs by some physical characteristic, such as colour or crystal habit. An example is amethyst, which is a purple variety of quartz.

Two common classifications, Dana and Strunz, are used for minerals; both rely on composition, specifically with regards to important chemical groups, and structure. James Dwight Dana, a leading geologist of his time, first published his *System of Mineralogy* in 1837; as of 1997, it is in its eighth .ion. The Dana classification assigns a four-part number to a mineral species. Its class number is based on important compositional groups; the type gives the ratio of cations to anions in the mineral; and the last two numbers group minerals by structural similarity within a given type or class. The less commonly used Strunz classification, named for German mineralogist Karl Hugo Strunz, is based on the Dana system, but combines both chemical and structural criteria, the latter with regards to distribution of chemical bonds.

As of March 2017, 5,237 mineral species are approved by the IMA. They are most commonly named after a person (45%), followed by discovery location (23%); names based on chemical composition (14%) and physical properties (8%) are the two other major groups of mineral name etymologies. The common suffix -*ite* of mineral names descends from the ancient Greek suffix -ί τ η ς (-ites), meaning "connected with or belonging to".

Hübnerite, the manganese-rich end-member of the wolframite series, with minor quartz in the background

The abundance and diversity of minerals is controlled directly by their chemistry, in turn dependent on elemental abundances in the Earth. The majority of minerals observed are derived from the Earth's crust. Eight elements account for most of the key components of minerals, due to their abundance in the crust. These eight elements, summing to over 98% of the crust by weight, are, in order of decreasing abundance: oxygen, silicon, aluminium, iron, magnesium, calcium, sodium and pot assium. Oxygen and silicon are by far the two most important – oxygen composes 47% of the crust by weight, and silicon accounts for 28%.

The minerals that form are directly controlled by the bulk chemistry of the parent body. For example, a magma rich in iron and magnesium will form mafic minerals, such as olivine and the pyroxenes; in contrast, a more silica-rich magma will crystallize to form minerals that incorporate more SiO_2, such as the feldspars and quartz. In a limestone, calcite or aragonite(both $CaCO_3$) form because the rock is rich in calcium and carbonate. A corollary is that a mineral will not be found in a rock whose bulk chemistry does not resemble the bulk chemistry of a given mineral with the exception of trace minerals. For example, kyanite,

Al_2SiO_5 forms from the metamorphism of aluminium-rich shales; it would not likely occur in aluminium-poor rock, such quartzite.

The chemical composition may vary between end member species of a solid solution series. For example, the plagioclase feldspars comprise a continuous series from sodium-rich end member albite ($NaAlSi_3O_8$) to calcium- rich anorthite ($CaAl_2Si_2O_8$) with four recognized intermediate varieties between them (given in order from sodium- to calcium-rich): oligoclase,andesine, labradorite, and bytownite. Other examples of series include the olivine series of magnesium-rich forsterite and iron-rich fayalite, and the wolframite series of manganese-rich hübnerite and iron-rich ferberite.

Chemical substitution and coordination polyhedra explain this common feature of minerals. In nature, minerals are not pure substances, and are contaminated by whatever other elements are present in the given chemical system. As a result, it is possible for one element to be substituted for another. Chemical substitution will occur between ions of a similar size and charge; for example, K^+will not substitute for Si^{4+} because of chemical and structural incompatibilities caused by a big difference in size and charge. A common example of chemical substitution is that of Si^{4+} by Al^{3+}, which are close in charge, size, and abundance in the crust. In the example of plagioclase, there are three cases of substitution. Feldspars are all framework silicates, which have a silicon-oxygen ratio of 2:1, and the space for other elements is given by the substitution of Si^{4+} by Al^{3+} to give a base unit of $[AlSi_3O_8]^-$; without the substitution, the formula would be charge-balanced as SiO_2, giving quartz.[45] The significance of this structural property will be explained further by coordination polyhedra. The second substitution occurs between Na^+ and Ca^{2+}; however, the difference in charge has to accounted for by making a second substitution of Si^{4+} by Al^{3+}.

Coordination polyhedra are geometric representation of how a cation is surrounded by an anion. In mineralogy, coordination polyhedra are usually considered in terms of oxygen, due its abundance in the crust. The base unit of silicate minerals is the silica tetrahedron – one Si^{4+} surrounded by four O^{2-}. An alternate way of describing the coordination of the silicate is by a number: in the case of the silica tetrahedron, the silicon is said to have a coordination number of 4. Various cations have a specific range of possible coordination numbers; for silicon, it is almost always 4, except for very high-pressure minerals where compound is compressed such that silicon is in six-fold (octahedral) coordination by oxygen. Bigger cations have a bigger coordination number because of the increase in relative size as compared to oxygen (the last orbital subshell of heavier atoms is different too). Changes in coordination numbers between leads to physical and mineralogical differences; for example, at high pressure such as in the mantle, many minerals, especially silicates such as olivine and garnet will change to a perovskite structure, where silicon is in octahedral coordination. Another example are the aluminosilicates kyanite, andalusite, and sillimanite (polymorphs, as they share the formula Al_2SiO_5), which differ by the coordination number of the Al^{3+}; these minerals transition from one another as a response to changes in pressure and temperature. In the case of silicate materials, the substitution of Si^{4+} by Al^{3+} allows for a variety of minerals because of the need to balance charges.

When minerals react, the products will sometimes assume the shape of the reagent; the product mineral is termed a pseudomorph of (or after) the reagent.

Illustrated here is a pseudomorph of kaolinite afterorthoclase. Here, the

pseudomorph preserved the Carlsbad twinningcommon in orthoclase.

Changes in temperature and pressure, and composition alter the mineralogy of a rock sample. Changes in composition can be caused by processes such as weathering ormetasomatism (hydrothermal alteration). Changes in temperature and pressure occur when the host rock undergoes tectonic or magmatic movement into differing physical regimes. Changes in thermodynamic conditions make it favourable for mineral assemblages to react with each other to produce new minerals; as such, it is possible for two rocks to have an identical or a very similar bulk rock chemistry without having a similar mineralogy. This process of mineralogical alteration is related to the rock cycle. An example of a series of mineral reactions is illustrated as follows.

Orthoclase feldspar ($KAlSi_3O_8$) is a mineral commonly found in granite, a plutonic igneous rock. When exposed to weathering, it reacts to form kaolinite ($Al_2Si_2O_5(OH)_4$, a sedimentary mineral, and silicic acid):

$$2\ KAlSi_3O_8 + 5\ H_2O + 2\ H^+ \rightarrow Al_2Si_2O_5(OH)_4 + 4\ H_2SiO_3 + 2\ K^+$$

Under low-grade metamorphic conditions, kaolinite reacts with quartz to form pyrophyllite ($Al_2Si_4O_{10}(OH)_2$):

$$Al_2Si_2O_5(OH)_4 + SiO_2 \rightarrow Al_2Si_4O_{10}(OH)_2 + H_2O$$

As metamorphic grade increases, the pyrophyllite reacts to form kyanite and quartz:

$$Al_2Si_4O_{10}(OH)_2 \rightarrow Al_2SiO_5 + 3\ SiO_2 + H_2O$$

Alternatively, a mineral may change its crystal structure as a consequence of changes in temperature and pressure without reacting. For example, quartz will change into a variety of its SiO_2 polymorphs, such as tridymite and cristobalite at high temperatures, and coesite at high pressures.

Text 15

Water

Water is a transparent and nearly colorless chemical substance that is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. Itschemical formula is H_2O, meaning that its molecule contains one oxygen and two hydrogen atoms, that are connected by covalent bonds. Water strictly refers to the liquid state of that substance, that prevails at standard ambient temperature and pressure; but it often refers also to its solid state (ice) or its gaseous state (steam or water vapor). It also occurs in nature as snow, glaciers, ice packs and icebergs, clouds, fog, dew, aquifers, and atmospheric humidity.

Water covers 71% of the Earth's surface. It is vital for all known forms of life. On Earth, 96.5% of the planet's crust water is found in seas and oceans, 1.7% in groundwater, 1.7% in glaciers and the ice caps of Antarctica and Greenland, a small fraction in other large water bodies, and 0.001% in the air as vapor, clouds (formed of ice and liquid water suspended in air), and precipitation. Only 2.5% of this water is freshwater, and 98.8% of that water is in ice (excepting ice in clouds) and groundwater. Less than 0.3% of all freshwater is in rivers, lakes, and the atmosphere, and an even smaller amount of the Earth's freshwater (0.003%) is contained within biological bodies and manufactured products. A greater quantity of water is found in the earth's interior.

Water on Earth moves continually through the water cycle of evaporation and transpiration (evapotranspiration), condensation, precipitation, and runoff, usually reaching the sea. Evaporation and transpiration contribute to the precipitation over land. Large amounts of water are also chemically combined or adsorbed in hydrated minerals.

Safe drinking water is essential to humans and other lifeforms even though it provides no calories or organic nutrients. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation. There is a clear correlation between access to safe water and gross domestic product per capita. However, some observers have estimated that by 2025 more than half of the world population will be facing water-based vulnerability. A report, issued in November 2009, suggests that by 2030, in some developing regions of the world, water demand will exceed supply by 50%.

Water plays an important role in the world economy. Approximately 70% of the freshwater used by humans goes to agriculture. Fishing in salt and fresh water bodies is a major source of food for many parts of the world. Much of long-distance trade of commodities (such as oil and natural gas) and manufactured products is transported by boatsthrough seas, rivers, lakes, and canals. Large quantities of water, ice, and steam are used for cooling and heating, in industry and homes. Water is an excellent solvent for a wide variety of chemical substances; as such it is widely used in industrial processes, and in cooking and washing. Water is also central to many sports and other forms of entertainment, such as swimming, pleasure boating, boat racing, surfing, sport fishing, and diving.

Etymology

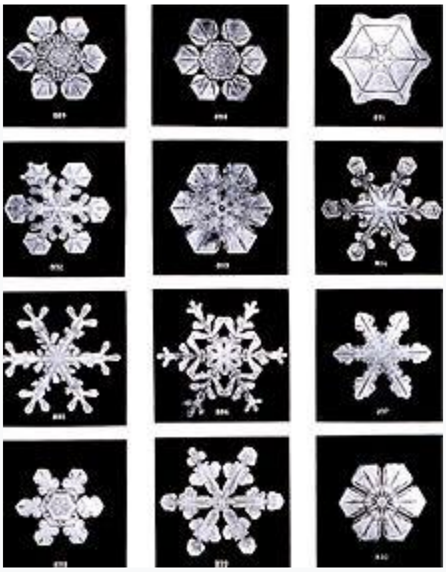
The word "water" comes from "Old English wæter, from Proto-Germanic *watar (source also of Old Saxon watar, Old Frisian wetir, Dutch water, Old High German wazzar, German Wasser, Old Norse vatn, Gothic wato "water"), from PIE *wod-or, suffixed form of root *wed-... "water; wet."

Chemical and physical properties

Main articles: Properties of water, Water (data page), and Water model

Water (H_2O) is a polar inorganic compound that is at room temperature a tasteless and odorless liquid, nearly colorless with a hint of blue. This simplest hydrogen chalcogenide is by far the most studied chemical compound and is described as the "universal solvent" for its ability to dissolve many substances. This allows it to be the "solvent of life". It is the only common substance to exist as a solid, liquid, and gas in normal terrestrial conditions.

States



Snowflakes by Wilson Bentley, 1902.

Liquid water, showing droplets and air bubbles caused by the drops

Water is a liquid at the temperatures and pressures that are most adequate for life. Specifically, at a standard pressure of 1 atm(1.01325 bar, 101.325 kPa, 14.69595 psi), water is a liquid between the temperatures of 273.15 K (0 °C, 32 °F) and 373.15 K (100 °C, 212 °F). Increasing the pressure slightly lowers the melting point, which is about −5 °C at 600 atm, −22 °C at 2100 atm. This effect is relevant, for example, to ice skating, to the buried lakes of Antartica, and to the movement of glaciers. (At pressures higher than 2100 atm the melting point rapidly increases again, and ice takes several exotic forms that do not exist at lower pressures.)

Increasing the pressure has a more dramatic effect on the boiling point, that is about 374 °C at 220 atm. This effect is important in, among other things, deep-sea hydrothermal vents and geysers, pressure cooking, and steam engine design. At the top of Mount Everest, where the atmospheric pressure is about 0.34 atm, water boils at 68 °C (154 °F).

At very low pressures (below about 0.006 atm), water cannot exist in the liquid state and passes directly from solid to gas bysublimation—a phenomenon exploited in the freeze drying of food. At very high pressures (above 221 atm), the liquid and gas states are no longer distinguishable, a state called supercritical steam.

Water also differs from most liquids in that it becomes less dense as it freezes. The maximum density of water in its liquid form (at 1atm) is 1,000 kg/m^3 (62.43 lb/cu ft); that occurs at 3.98 °C (39.16 °F). The density of ice is 917 kg/m^3

(57.25 lb/cu ft).·· Thus, water expands 9% in volume as it freezes, which accounts for the fact that ice floats on liquid water.

The details of the exact chemical nature of liquid water are not well understood; some theories suggest that water's unusual behaviour is as a result of it having 2 liquid states.

Taste and odor

Pure water is usually described as tasteless and odorless, although humans have specific sensors that can feel the presence of water in their mouths, and frogs are known to be able to smell it. However, water from ordinary sources (including bottled mineral water) usually has many dissolved substances, that may give it varying tastes and odors. Humans and other animals have developed senses that enable them to evaluate the potability of water by avoiding water that is too salty or putrid.

Color and appearance

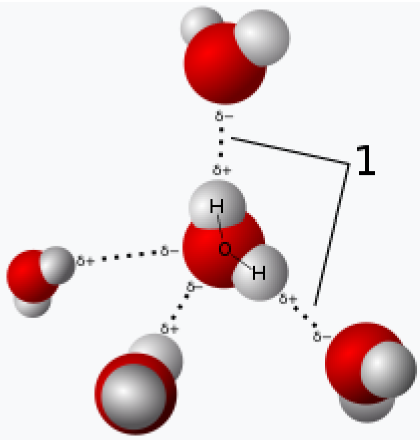
The apparent color of natural bodies of water (and swimming pools) is often determined more by dissolved and suspended solids, or by reflection of the sky, than by water itself.

Light in the visible electromagnetic spectrum can traverse a couple meters of pure water (or ice) without significant absorption, so that it looks transparent and colorless.· Thus aquatic plants, algae, and otherphotosynthetic organisms can live in water up to hundreds of meters deep, because sunlight can reach them. Water vapour is essentially invisible as a gas.

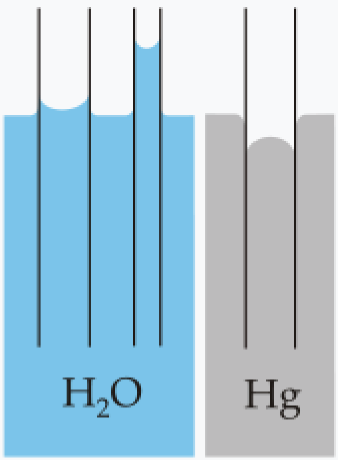
Through a thickness of 10 meters or more, however, the intrinsic color of water (or ice) is visibly turquoise (greenish blue), as its absorption spectrum has a sharp minimum at the corresponding color of light (1/227 m^{-1} at 418 nm). The color becomes increasingly stronger and darker with increasing thickness. (Practically no sunlight reaches the parts of the oceans below 1000 meters of depth.) Infrared and ultraviolet light, on the other hand, is strongly absorbed by water.

The refraction index of liquid water (1.333 at 20 °C) is much higher than that of air (1.0), similar to those of alkanes and ethanol, but lower than those of glycerol (1.473), benzene (1.501), carbon disulfide (1.627), and common types of glass (1.4 to 1.6). The refraction index of ice (1.31) is lower than that of liquid water.

Polarity and hydrogen bonding



Model of hydrogen bonds (1) between molecules of water.



Capillary action of water compared to mercury.

Impact from a water drop causes an upward "rebound" jet surrounded by circular capillary waves.

Since the water molecule is not linear and the oxygen atom has a higher electronegativity than hydrogen atoms, it is a polar molecule, with anelectrical dipole moment: the oxygen atom carries a slight negative charge, whereas the hydrogen atoms are slightly positive. Water is a good polar solvent, that dissolves many salts and hydrophilic organic molecules such as sugars and simple alcohols such as ethanol. Most acidsdissolve in water to yield the corresponding anions. Many substances in living organisms, such as proteins, DNA and polysaccharides, are dissolved in water. Water also dissolves many gases, such as oxygen and carbon dioxide—the latter giving the fizz of carbonated beverages,sparkling wines and beers.

On the other hand, many organic substances (such as fats and oils and alkanes) are hydrophobic, that is, insoluble in water. Many inorganic substances are insoluble too, including most metal oxides, sulfides, and silicates.

Because of its polarity, a molecule of water in the liquid or solid state can form up to four hydrogen bonds with neighboring molecules. These bonds are the cause of water's high surface tension and capillary forces. The capillary action refers to the tendency of water to move up a narrow tube against the force of gravity. This property is relied upon by all vascular plants, such as trees.

The hydrogen bonds are also the reason why the melting and boiling points of water are much higher than those of other analogous compoundslike hydrogen sulfide (H_2S). They also explain its exceptionally high specific heat capacity (about 4.2 J/g/K), heat of fusion (about 333 J/g), heat of vaporization (2257 J/g), and thermal conductivity (between 0.561 and 0.679 W/m/K). These properties make water more effective at moderating Earth's climate, by storing heat and transporting it between the oceans and the atmosphere.

Electrical conductivity and electrolysis

P ure water has a low electrical conductivity, which increases with the dissolution of a small amount of ionic material such as common salt.

Liquid water can be split into the elements hydrogen and oxygen by passing an electric current through it—a process called electrolysis. The decomposition requires moreenergy input than the heat released by the inverse process (285.8 kJ/mol, or 15.9 MJ/kg).

Text 16

Energy requirements

The energy requirement of an individual corresponds to the minimum amount of energy the body needs to function. The energy needs are only supplied by diet. Energy requirements are different depending on age, daily activity, or overall state of health. Infants and adolescents have higher energy needs than children and adults. Adult men have, on average, higher daily energy needs (about 2600 kcal) than women (2100 kcal). In nutrition, energy inputs are provided by carbohydrates, proteins, and lipids. The recommended percentage for humans is about 60% carbohydrates, 25% fat, and 15% protein.

Daily estimated energy requirements to maintain body weight are calculated using a formula to account for four factors: gender, age, activity level and current weight. Modest energy-deficit diets, which would achieve about 0.5 kg (1 lb) a week weight loss, are based on daily dietary intake of 600 calories less than the person's daily energy requirement. Work out the patient's 'Estimated energy requirements for a 600-calorie energy-deficit diet' using the information below. This information uses the Schofield and WHO energy-requirement equations, but we recognise that there are alternative equations that you may prefer to use.

Based on the patient's age, gender and current weight (in kg) as listed in the chart below, predict their Basal Metabolic Rate (BMR). This is based on modified Schofield equations (see the Department of Health's Dietary Reference Values, 1991).

Age range for men and women Basal metabolic rate equals:

Age Men Women

18–29 years 15.1 × weight (kg) + 692 14.8 × weight (kg) + 487

30–59 years 11.5 × weight (kg) + 873 8.3 × weight (kg) + 846

60+ years 11.9 × weight (kg) + 700 9.2 × weight (kg) + 687

Incorporate the patient's Physical Activity Level (PAL) based on the gender and activity levels shown in the chart below. Do this by multiplying the patient's estimated BMR with the appropriate figure from the table. Few patients are likely to have activity levels above 'inactive'.

Activity level Description Men Women Inactive Assume sitting most of the day with less than 2 hours on their feet.

1.4 1.4

Light Assume some daily exercise – at work or tasks about the house or garden – with at least 2 hours on their feet.

1.5 1.5

Moderate Assume 6 hours on their feet or regular strenuous exercise.

1.78 1.64

Heavy Those in heavy labouring jobs or serious athletes in training.

2.1 1.82

Text 17

Preservation of foods

Food preservation is to prevent the growth of microorganisms (such as yeasts), or other micro-organisms (although some methods work by introducing benign bacteria or fungi to the food), as well as slowing theoxidation of fats that cause rancidity. Food preservation may also include processes that inhibit visual deterioration, such as the enzymatic browning reaction in apples after they are cut during food preparation.

Many processes designed to preserve food involve more than one food preservation method. Preserving fruit by turning it into jam, for example, involves boiling (to reduce the fruit’s moisture content and to kill bacteria, etc.), sugaring (to prevent their re-growth) and sealing within an airtight jar (to prevent recontamination). Some traditional methods of preserving food have been shown to have a lower energy input andcarbon footprint, when compared to modern methods.

Some methods of food preservation are known to create carcinogens. In 2015, the International Agency for Research on Cancer of the World Health Organization classified processed meat, i.e. meat that has undergone salting, curing, fermenting, and smoking, as "carcinogenic to humans".

Maintaining or creating nutritional value, texture and flavor is an important aspect of food preservation.

Curing

Bag of Prague powder #1, also known as "curing salt" or "pink salt". It is typically a combination of salt and sodium nitrite, with the pink color added to distinguish it from ordinary salt.

Main article: Curing (food preservation)

The earliest form of curing was dehydration or drying, used as early as 12,000 BC. Smoking and salting techniques improve on the drying process and add antimicrobial agents that aid in preservation. Smoke deposits a number of pyrolysis products onto the food, including the phenols syringol, guaiacol and catechol. Salt accelerates the drying process using osmosis and also inhibits the growth of several common strains of bacteria. More recently nitrites have been used to cure meat, contributing a characteristic pink colour.

Cooling

Main article: Refrigeration

Cooling preserves food by slowing down the growth and reproduction of microorganisms and the action of enzymes that causes the food to rot. The introduction of commercial and domestic refrigerators drastically improved the diets of many in the Western world by allowing foods such as fresh fruit, salads and dairy products to be stored safely for longer periods, particularly during warm weather.

Before the era of mechanical refrigeration, cooling for food storage occurred in the forms of root cellars and iceboxes. Rural people often did their own ice cutting, whereas town and city dwellers often relied on the ice trade. Today, root cellaring remains popular among people who value various goals, including local food, heirloom crops, traditional home cooking techniques, family farming,frugality, self-sufficiency, organic farming, and others.

Freezing

Main article: Frozen food

Freezing is also one of the most commonly used processes, both commercially and domestically, for preserving a very wide range of foods, including prepared foods that would not have required freezing in their unprepared state. For example, potato waffles are stored in the freezer, but potatoes themselves require only a cool dark place to ensure many months' storage. Cold stores provide large-volume, long-term storage for strategic food stocks held in case of national emergency in many countries.

Boiling

Main article: Boiling

Boiling liquid food items can kill any existing microbes. Milk and water are often boiled to kill any harmful microbes that may be present in them.

Heating

Heating to temperatures which are sufficient to kill microorganisms inside the food is a method used with perpetual stews. Milk is also boiled before storing to kill many microorganisms.

Sugaring

See also: Sugaring

The earliest cultures have used sugar as a preservative, and it was commonplace to store fruit in honey. Similar to pickled foods, sugar cane was brought to Europe through the trade routes. In northern climates without sufficient sun to dry foods, preserves are made by heating the fruit with sugar. "Sugar tends to draw water from the microbes (plasmolysis). This process leaves the microbial cells dehydrated, thus killing them. In this way, the food will remain safe from microbial spoilage." Sugar is used to preserve fruits, either in an antimicrobial syrup with fruit such as apples, pears, peaches, apricots, and plums, or in crystallized form where the preserved material is cooked in sugar to the point of crystallization and the resultant product is then stored dry. This method is used for the skins of citrus fruit (candied peel), angelica, and ginger. Also, sugaring can be used in the production of jam and jelly.

Pickling

Main article: Pickling

Pickling is a method of preserving food in an edible, antimicrobial liquid. Pickling can be broadly classified into two categories: chemical pickling and fermentation pickling.

In chemical pickling, the food is placed in an edible liquid that inhibits or kills bacteria and other microorganisms. Typical pickling agents include brine (high in salt), vinegar, alcohol, and vegetable oil. Many chemical pickling processes also involve heating or boiling so that the food being preserved becomes saturated with the pickling agent. Common chemically pickled foods include cucumbers, peppers, corned beef, herring, and eggs, as well as mixed vegetables such as piccalilli.

In fermentation pickling, bacteria in the liquid produce organic acids as preservation agents, typically by a process that produces lactic acid through the presence of lactobacillales. Fermented pickles includesauerkraut, nukazuke, kimchi, and surströmming.

Text 18

Sunflower oil

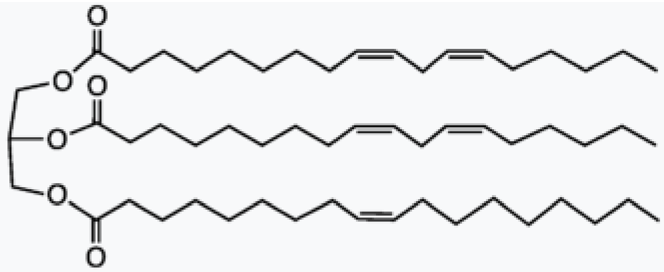
High-oleic sunflower oil

Sunflower oil is the non-volatile oil pressed from the seeds of sunflower(*Helianthus annuus*). Sunflower oil is commonly used in food as a frying oil, and in cosmetic formulations as an emollient. The world's total production of sunflower oil in 2014 was nearly 16 million tonnes, with Ukraine and Russia as the largest producers.

Sunflower oil is a monounsaturated (MUFA)/polyunsaturated (PUFA) mixture of mostly oleic acid (omega-9)-linoleic acid (omega-6) group of oils. The oil content of the seed ranges from 22% to 36% (average, 28%): the kernel contains 45–55% oil. The expressed oil is of light amber color with a mild and pleasant flavor; refined oil is pale yellow. Refining losses are low and the oil has good keeping qualities with light tendency for flavor reversion. The oil contains appreciable quantities of vitamin E, sterols, squalene, and other aliphatic hydrocarbons.

Genome analysis and development of hybrid sunflowers to increase oil production are occurring to meet increased demand for sunflower oil.

Composition



Sunflower oil is mainly triglycerides (fats), typically derived from the fatty acids linoleic acid (which is doubly unsaturated) and oleic acid

Sunflower oil is mainly a triglyceride; a typical constituent is shown. The British Pharmacopoeia lists the following profile:

- Palmitic acid (saturated): 5%
- Stearic acid (saturated): 6%
- Oleic acid (monounsaturated omega-9): 30%
- Linoleic acid (polyunsaturated omega-6): 59%

Several types of sunflower oils are produced, such as high linoleic, high oleic and mid oleic. Mid-oleic sunflower oil typically has at least 69% oleic acid. High oleic sunflower oil has at least 82% oleic acid. Variation in unsaturated fatty acids profile is strongly influenced by both genetics and climate. In the last decade, high stearic sunflower lines have been developed in Spain to avoid the use of partially hydrogenated vegetable oils in the food industry.

Sunflower oil is high in the essential vitamin E and low in saturated fat. The two most common types of sunflower oil are linoleic and high oleic. Linoleic sunflower oil is a common cooking oil that has high levels of polyunsaturated fat. It is also known for having a clean taste and low levels of trans fat. High oleic sunflower oils are classified as having monounsaturated levels of 80% and above. Newer versions of sunflower oil have been developed as a hybrid containing linoleic acid. They have monounsaturated levels lower than other oleic sunflower oils. The hybrid oil also has lower saturated fat levels than linoleic sunflower oil.

The phosphatides (0.1–0.2%) present in the oil are lecithin (38.5%) and cephalin (61.5%); they occur in combination with protein and carbohydrates.

Sunflower oil also contains lecithin, tocopherols, carotenoids and waxes. Sunflower oil's properties are typical of a vegetable triglyceride oil.

Production and trade

In 2014, world production of sunflower oil was 15.8 million tonnes. Leading 2014 producers and volumes were Ukraine (4.4 million tonnes), Russia (4.1 million tonnes), Argentina (0.9 million tonnes), and Turkey (0.7 million tonnes).

Nutrition

Sunflower oil, high oleic (70% and over)	
Nutritional value per 100 g (3.5 oz)	
Energy	3,699 kJ (884 kcal)
Carbohydrates	0 g
Fat	100 g
Saturated	9.748 g
Monounsaturated	83.594 g

Polyunsaturated	3.798 g
Protein	0 g
Vitamins	Quantity%DV†
Vitamin E	274% 41.08 mg
Vitamin K	5% 5.4 μg

- Units

μg = micrograms • mg = milligrams

- IU = International units

†Percentages are roughly approximated using US recommendations for adults.
Source: USDA Nutrient Database

Sunflower oil, standard	
Nutritional value per 100 g (3.5 oz)	
Energy	3,699 kJ (884 kcal)

Carbohydrates	0 g
Fat	100 g
Saturated	10.3 g
Monounsaturated	19.5 g
Polyunsaturated	65.7 g
Protein	0 g
Vitamins	Quantity%DV†
Vitamin E	274% 41.08 mg
Vitamin K	5% 5.4 μg

- Units

μg = micrograms • mg = milligrams

- IU = International units

†Percentages are roughly approximated using US recommendations for adults.

Source: USDA Nutrient Database	
Sunflower oil (NuSun), mid oleic	
Nutritional value per 100 g (3.5 oz)	
Energy	3,699 kJ (884 kcal)
Carbohydrates	0 g
Fat	100 g
Saturated	9.009 g
Monounsaturated	57.344 g
Polyunsaturated	28.962 g
Protein	0 g
Vitamins	Quantity%DV†
Vitamin E	274% 41.08 mg

Vitamin K	5% 5.4 μg

- Units

μg = micrograms • mg = milligrams

- IU = International units

†Percentages are roughly approximated using US recommendations for adults.
Source: USDA Nutrient Database

Several varieties of sunflower oilseeds have been developed by standard plant breeding methods, mainly to vary the amount of oleic acid and linoleic acidwhich, respectively, are the predominant monounsaturated and polyunsaturatedfats in sunflower oil.

While the original oilseed was high in linoleic acid, a polyunsaturated ω-6 fatty acid, a premium high oleic acid strain was developed in the late twentieth century. Early in the 21st century, a mid-oleic strain marketed as Nu-Sun was introduced as an improved frying oil that would have a low level of saturated fat, but would not require hydrogenation. These three major strains have been purposely bred to differ in their levels of monounsaturated and polyunsaturated fats, saturated fat and tocopherols. All seed hybrids and the resulting different sunflower oils are mostly devoid of essential nutrients, with the notable exception of vitamin E which is high in content in all varieties (nutrient tables).

Physical properties

Sunflower oil is liquid at room temperature. The refined oil is clear and slightly amber-colored with a slightly fatty odor.

Smoke point (refined)	232 °C	450 °F

Smoke point (unrefined)	107 °C	225 °F
Density (25 °C)	918.8 kg/m	
Refractive index (25 °C	≈1.473	
Saponification value	188-19	
Iodine value	120-15	
Unsaponifiable matter	1.5-2.%	
Viscosity (25 °C), unrefined	0.04914 kg/(m*s)	

Preparation and storage

Because sunflower oil is primarily composed of less-stable polyunsaturated and monounsaturated fatty acids, it can be particularly susceptible to degradation by heat, air, and light, which trigger and accelerate oxidation. Keeping sunflower oil at low temperatures during manufacture and storage can help minimize rancidity and nutrient loss—as can storage in bottles that are made of either darkly-colored glass, or, plastic that has been treated with an ultraviolet light protectant.

Methods of extraction

Sunflower oil can be extracted using chemical solvents (e.g., hexane), or expeller pressing (i.e., squeezed directly from sunflower seeds by crushing them). "Cold-pressing" (or expeller pressing) sunflower seeds under low-temperature conditions is a method that does not use chemical solvents to derive sunflower seed oil.

Refined versus unrefined

Refining sunflower oil through solvent extraction, de-gumming, neutralization, and bleaching can make it more stable and suitable for high-temperature cooking; but, will also remove some of the oil's nutrients; flavor; color (resulting in a pale-yellow); free fatty acids; phospholipids; polyphenols; and, phytosterols. Unrefined sunflower oil is less heat-stable (and therefore well-suited to dishes that are either raw or cooked at low temperatures); but, will retain more of its original nutrient content, flavor, and color (light-amber).

Uses

In food preparation

Refined sunflower oil is used for low-to-extremely-high-temperature cooking. As a frying oil, it behaves as a typical vegetable triglyceride. Unrefined sunflower oil is a traditional salad dressing in Eastern European cuisines. Sunflower oil is also an ingredient in sunflower butter.

Methods for cooking snack foods, such as potato chips or French fries, may use sunflower oil.

Seed meal

Extraction of sunflower oil leaves behind the crushed seeds, typically referred to as seed meal, which is rich in protein and dietary fiber and used as an animal feed, fertilizer or fuel.

Supplements

Taking sunflower oil dietary supplements is not an effective treatment for eczema.

As fuel

Sunflower oil can be used to run diesel engines when mixed with diesel in the tank. Due to the high levels of unsaturated fats, there is higher viscosity in cold temperatures.

Text 19

CEREALS AND CEREAL PRODUCTS

CEREALS are generally of the gramineous family and, in the FAO concept, refer tocrops harvested for dry grain only. Crops harvested green for forage, silage or grazingare classified as fodder crops. Also excluded are industrial crops, e.g. broom sorghum (Crude organic materials nes) and sweet sorghum when grown for syrup (Sugar crops nes). For international trade classifications, fresh cereals (other than sweet corn), whether or not suitable for use as fresh vegetables, are classified as cereals. Cereals are identified according to their genus. However, when two or more genera are sown and harvested as a mixture they should be classified and reported as "mixed grains". Production data are reported in terms of clean, dry weight of grains (12-14 percent moisture) in the form usually marketed. Rice, however, is reported in terms of paddy. Apart from moisture content and inedible substances such as cellulose, cereal grains contain, along with traces of minerals and vitamins, carbohydrates - mainly starches - (comprising 65-75 percent of their total weight), as well as proteins (6-12 percent) and fat (1-5 percent). The FAO definitions cover 17 primary cereals, of which one - white maize - is a component of maize. Each definition is listed along with its code, botanical name or names, and a short description. Cereal products derive either from the processing of grain through one or more mechanical or chemical operations, or from the processing of flour, meal or starch. Each cereal product is listed after the cereal from which it is derived.

Cereals and Products

Wheat

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
	WHEAT *Triticum spp.:*	
0015	common *(T. aestivum)* durum *(T. durum)* spelt *(T. spelta)*	Common and durum wheat are the main types. Among common wheat, the main varieties are spring and winter, hard and soft, and red and white. At the national level, different varieties should be reported separately, reflecting their different uses. Used mainly for human food.
0016	Flour of Wheat	Defined broadly to include meal, groats and pellets. Strong flours from hard wheat are used for bread, while durum wheat flour is used primarily for pasta. Weaker flours from soft wheat are mainly used in cakes, pastries, biscuits and certain noodles.
0017	Bran of Wheat	See Chapter 11.
0018	Macaroni	Pasta made from semolina, or flour, that is mixed with water and kneaded into a dough. Other

		ingredients may be included as well. The dough is then shaped into various forms. This heading is limited to macaroni that is not cooked, stuffed or otherwise prepared.
0019	Germ of Wheat	The seed embryo. Whole or rolled germ is used for oil extraction by solvents. Flaked or ground germ is used in bakers' wares, dietetic preparations, feed supplements and in pharmaceutical preparations.
0020	Bread	A baked product of flour or meal of cereals, especially wheat. Includes ordinary, unleavened, crackers, rusks, etc.
0021	Bulgur	Whole wheat grains that are boiled, dried and cracked, either between stones or in a hand mill. Very popular in the Near East.
0022	Pastry	All baked products excluding those listed under bread. Pastry products may contain ingredients other than wheat flour, such as milk, eggs, sugar, honey, starch, fats, fruit, seeds, etc.
0023	Starch of Wheat	Starch is the carbohydrate component in many plant cells. A white, odourless powder that is insoluble in cold water, it forms a paste in hot water. Wheat starch is used for human consumption and animal feed, and is processed into glucose and dextrine for industrial use. It is usually obtained from low-quality flour.
0024	Wheat Gluten	A by-product of the industrial production of starch, wheat gluten is the preferred cereal gluten for food purposes. Uses include enriching protein in flours for bread, pasta, etc.

0026	Wheat-Fermented Beverages	

Cereals and Products

Rice

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
	RICE	
0027	PADDY *Oryza spp.*, mainly *oryza sativa*	Rice grain after threshing and winnowing.Also known as rice in the husk and rough rice. Used mainly for human food.
0028	Rice, Husked	Rice grain without hulls or husks. Also known as brown or cargo rice.
0029	Rice, Milled (Husked)	White rice milled from imported husked rice. Includes semi-milled, whole-milled and parboiled rice.
0031	Rice, Milled	White rice milled from locally grown paddy. Includes semi-milled, whole-milled and parboiled rice.
0032	Rice, Broken	Residues from the selection of whole-grain, milled rice.
0033	Rice, Gluten	A by-product of the industrial production of starch. Not suitable for food use.

0034	Starch of Rice	See 0023 Rice starch is usually obtained from broken rice. Use primarily in the photographic industry to prepare "matt" paper.
0035	Bran of Rice	
0036	Oil of Rice	
0037	Cake of Rice Bran	
0038	Flour of Rice	Produced by milling broken or milled rice. Finely ground rice flour is widely used in infant foods and in noodles. It is not used in bread because it lacks the necessary gluten-forming protein.
0039	Rice-Fermented Beverages	

Cereals and Products

Barley

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0044	BARLEY *Hordeum spp.:*	Tolerates poorer soils and lower temperatures better than does wheat. Varieties include with husk and without (naked). Used as a livestock feed, for malt and for preparing foods. The roasted grains are a coffee substitute.

	two-row barley *(H. disticum)* six-row barley (H. hexasticum) four-row barley (H. vulgare)	
0045	Pot Barley	Whole-seed barley with the husks, hulls and bran removed.
0046	Barley, Pearled	Small, round pellets obtained by the further milling of pot barley. This definition also includes kibbled, rolled or flaked grains.
0047	Bran of Barley	
0048	Barley Flour and Grits	Fine flour and course meal obtained as milling by-products of pearled barley.
0049	Malt	A grain - usually barley - that has been germinated through a soaking process and then dried. Malt is used in brewing and distilling, and as a nutrient additive. Includes whole, ground, flour, and roasted malt, but excludes extracts and preparations.
0050	Malt Extract	A concentrated solution from water-macerated malt, which is used in infant and dietetic foods and in bread baking.
0051	Beer of Barley	

Cereals and Products

Maize

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0056	MAIZE *Zea mays* Corn, Indian corn, mealies	A grain with a high germ content. At the national level, hybrid and ordinary maize should be reported separately owing to widely different yields and uses. Used largely for animal feed and commercial starch production.
0057	Germ of Maize	The seed embryo that is separated during processing and is valued mainly for its oil.
0058	Flour of Maize	Broadly defined to include meal, groats and pellets.
0059	Bran of Maize	
0060	Oil of Maize	
0061	Cake of Maize	
0063	Maize Gluten	Maize protein is often called gluten, although it lacks the quality characteristics of wheat gluten. It is separated from maize during commercial wet milling and used to enrich animal feeds.
0064	Starch of Maize	See 0023. The primary product of the large-scale industrial wet-milling process. Used mainly for the production of glucose, dextrin and alcohol.

0066	Beer of Maize	
0067	WHITE MAIZE	Although separate data are reported for white maize production owing to its regional importance, its production is also included in 0056.

Cereals and Products

PopCorn

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0068	POPCORN *Zea mays var. everta*	A variety of maize that is eaten after the kernels have been heated and have "popped".

Cereals and Products

Rye

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0071	RYE *Secale cereale*	A grain that is tolerant of poor soils, high latitudes and altitudes. Mainly used in making bread, whisky and beer. When fed to livestock, it is generally mixed with other grains.
0072	Flour of Rye	Broadly defined to include meal, groats and pellets. In northern countries, rye flour is used primarily in bread.

0073	Bran of Rye	

Cereals and Products

Oats

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0075	OATS *Avena spp.*, mainly *Avena sativa*	A plant with open, spreading panicle-bearing large spikelets. Used primarily in breakfast foods. Makes excellent fodder for horses.
0076	Oats, Rolled	Obtained by crushing or rolling the whole or broken grain; includes grains flaked, hulled or otherwise worked for human consumption.
0077	Bran of Oats	

Cereals and Products

Millets

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS

0079	MILLETS Including inter alia: barnyard or Japanese millet *(Echinocloa frumentacea);* ragi, finger or African millet *(Eleusine coracana);* teff *(Eragrostis abyssinica);* common, golden or proso millet *(Panicum miliaceum);* koda or ditch millet *(Paspalum*	Small-grained cereals that include a large number of different botanical species. Originated by the domestication of wild African grasses in the Nile valley and the Sahel zone, millets were subsequently taken to China and India. These cereals tolerate arid conditions and possess a small, highly nutritious grain that stores well. Used locally, both as a food and as a livestock feed. In all areas where they are cultivated, millets are used in traditional beer brewing. Also used as a feed for birds.

	scrobiculatum); pearl or cattail millet *(Pennisetum glaucum);* foxtail millet *(Setaria italica)*	
0080	Flour of Millet	Broadly defined to include meal, groats and pellets.
0081	Bran of Millet	
0082	Beer of Millet	

Cereals and Products

Sorghum

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0083	SORGHUM *Sorghum spp.:* guinea corn *(S. guineense);*	A cereal that has both food and feed uses. Sorghum is a major food grain in most of Africa, where it is also used in traditional beer brewing. It is desirable to report hybrid and other varieties separately.

	common, milo, feterita, kaffir corn *(S. vulgare);* durra, jowar, kaoliang *(S. dura)*	
0084	Flour of Sorghum	Broadly defined to include meal, groats and pellets.
0085	Bran of Sorghum	
0086	Beer of Sorghum	

Cereals and Products

Buckwheat

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0089	BUCKWHEAT *Fagopyrum esculentum* (Polygonaceae)	A minor cereal cultivated primarily in northern regions. Buckwheat is considered a cereal, although it does not belong to the gramineous family.
0090	Flour of Buckwheat	Broadly defined to include meal, groats and pellets. The flour is

		normally used in bread and crackers, and is also mixed with wheat flour. Meal and groats are normally used for soups.
0091	Bran of Buckwheat	

Cereals and Products

Quinoa

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0092	QUINOA *Chenopodium quinoa* (Chenopodiaceae)	A minor cereal, which tolerates high altitudes, quinoa is cultivated primarily in Andean countries. Used for food and to make chicha, a fermented beverage.

Cereals and Products

Fonio

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0094	FONIO *Digitaria*	A minor cereal of importance only in West Africa where it is eaten in place of rice during famines. The seeds are cooked by steaming the whole grain.

	spp.: fonio or findi *(D. exilis);* black fonio or hungry rice *(D. iburua)*	
0095	Flour of Fonio	Broadly defined to include meal, groats and pellets.
0096	Bran of Fonio	

Cereals and Products

Triticale

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0097	TRITICALE	A minor cereal that is a cross between wheat and rye, combining the quality and yield of wheat with the hardiness of rye.
0098	Flour of Triticale	Broadly defined to include meal, groats and pellets.
0099	Bran of Triticale	

Cereals and Products

Canary Seed

FAOSTAT CODE	COMMODITY	DEFINITIONS, COVERAGE, REMARKS
0101	CANARY SEED *Phalaris canariensis*	Minor cereal normally used as bird feed.

Lesson 20

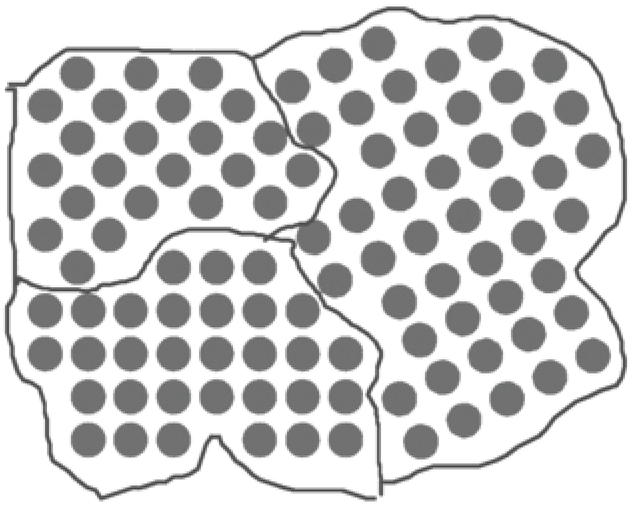
GRAIN STRUCTURE

Metals have a crystalline structure - this is not usually visible but can be seen on galvanized lamp posts for example.
When a metal solidifies from the molten state, millions of tiny *crystals* start to grow.

The longer the metal takes to cool the larger the crystals grow.

These crystals form *the grains* in the solid metal.

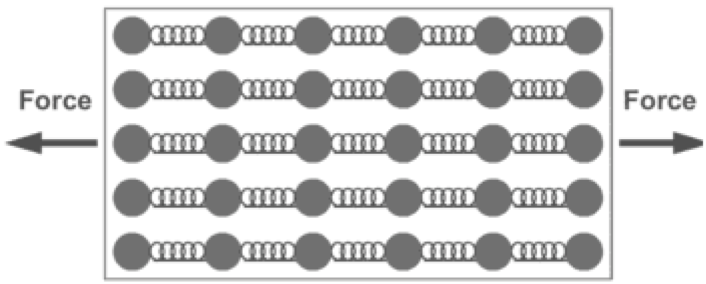
Each grain is a distinct crystal with its own orientation.



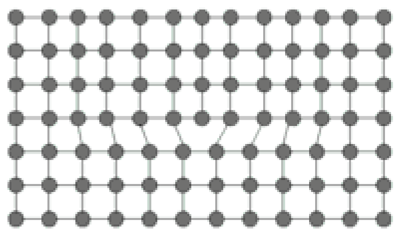
The areas between the grains are known as *grain boundaries.*

Within each grain, the individual atoms form a crystalline lattice. Each atom will have a certain number of close neighbors with which it shares loose bonds. (The number of neighboring atoms depends upon the structure of the lattice.) When stress is applied to the metal, the atoms will start to spread apart. The atomic bonds stretch, and the attractive forces between the atoms will oppose the applied stress, like millions of tiny springs. If the metal has not yielded, the interatomic forces will pull the metal back into its original shape when the stress is removed.

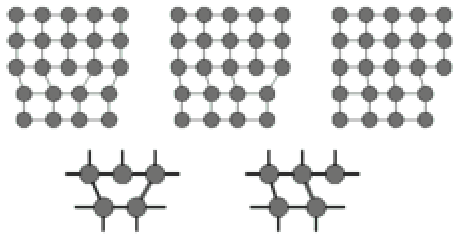
So it is behaving like a piece of rubber -it is elastic!



When the metal is cold worked by forging, stamping or rolling its shape is permanently changed (DEFORMED) this is only possible because of defects (DISLOCATIONS) in the grain structure which move through the crystal structure. These dislocations or slips in the grain structure allow the overall change in shape of the metal. Each grain can have a very large number of dislocations (only visible under a powerful microscope).



Edge Dislocation in Crystal Structure.



Movement of Dislocation Through the Grain.

Of course if the metal is hot worked there is more energy to available for the dislocations to move. This is why the strenghth of most materials falls as the temperature goes up.

Strong materials are those that can slow down or stop the movement of the dislocations.

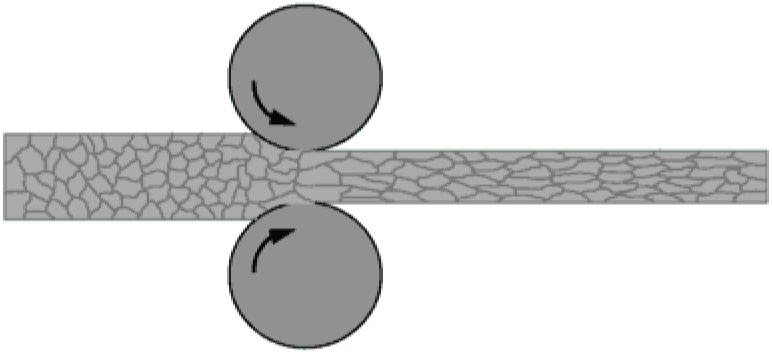
This can be achieved by increasing the number of dislocations by *cold work* or *work hardening (together known as stress hardening). Alloying* where the other metal interacts with the crystal lattice blocking the movement of the dislocation. (Brass is a good example of this where the small percentage of zinc makes the brass stronger than either copper or zinc.)

STRAIN HARDENING

Cold working or work hardening generates many dislocations which pile up and entangle this will prevent the further movement of dislocations. Try this by bending a paper clip back and forth - it becomes hard to bend at the same point and will eventually break if you continue.

[TEMPER is the term used to describe the amount of cold working on a metal. e.g half hard, full hard, spring temper etc.]

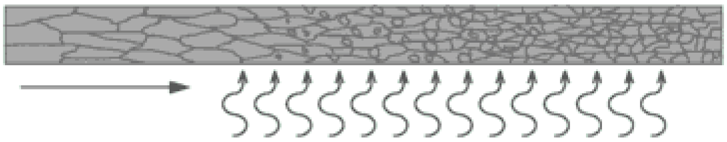
Cold rolling - the strip of metal passes between two rollers which exert heavy pressure. The strip is compressed and becomes much longer and thinner. The grains in the metal also become elongated. This a permanent deformation so dislocations pile up and the strenghth goes up. The larger grain boundary in the elongated strip also helps to stop the formation of further dislocations so that it becomes harder to roll a second time. The metal also becomes more brittle and is more liable to fracture as the number of dislocations goes up.



Cold work being rolled into copper alloy strip.

Annealing

The metal actually becomes difficult to work as cold working continues. The only answer is annealling. This is a high temperature soak (keeping the metal at the same temperaure for some time). The grains recrystallise - old grains are obliterated and new new grains grow. The metal loses all the effects of cold working becoming ductle again but losing its strenghth. Annealling has to be carefully controlled sothat the grains do not become too large.



Growth of new grains within old grains during annealing.

Hot Forging

While cold forging is very useful for increasing the strength of matals - hot forging is widely used in manufacturing. The advantage is that the part can be formed without annealling and the grain structure will follow the form of the object being forged. So for example a spanner would have a central part where the grain structure is elongated but with few dislocations then the grain flows around following the form of the ends. The spanner will of course have to be heat treated to give the right degree of hardness and toughness at the right points.

Text 21

Storage

Storage Temperatures and Procedures

A food service operation needs to have clearly defined storage areas and procedures for several reasons. First, by providing storage facilities it is possible to purchase supplies in quantities large enough quantities to get price breaks. Second, the ability to store supplies on the premises reduces the cost and time needed to order supplies and handle them upon delivery. Third, menu planning is easier when you are aware of the quality, quantity, and types of supplies that are on hand. If there is a run on a particular menu item, it is nice to know there are enough materials on hand to ensure that everyone who orders the item can be served.

In today's market, many food service operations are reducing the amount of stock they keep on hand because storage is expensive. Not only does space need to be found but security needs to be tight. Many operators are willing to pay a bit extra to suppliers in order to avoid the headaches of keeping track of expensive items such as large quantities of high-quality meat, wines, and spirits.

Regardless, there still is a need for storing many types of supplies including dry foods, dairy products, frozen foods, produce, and fresh meats. Storage areas for such items often have design requirements that must be built into the space in order to efficiently handle the specific types of supplies.

Dry Foods

The storeroom for dry foods should be located near the receiving area and close to the main kitchen. Unfortunately, the storeroom for dry foods is often an afterthought in food service facility designs, and the area designated for storage is sometimes in an inconvenient location.

No matter where the location, there are several essential points to be observed in the care and control of the dry storeroom.

- The area should be dry and cool to prevent spoilage and the swelling of canned goods. The ideal temperature range is 10°C to 15°C (50°F to 59°F).
- The storeroom should be easy to keep clean and free from rodents and vermin. This means all wall, ceiling, and floor openings should be sealed and protected to prevent access.
- It should be designed so it is easy to arrange and rearrange supplies to facilitate stock rotation. The best arrangement is to have shelves situated in the middle of the room so they can be stocked from both sides. This allows you to rotate stock by simply pushing out old stock by sliding new stock in from the other side of the shelf. This guarantees that first items received will be the first items used, or the "first in, first out" (FIFO) concept in stock rotation.

- The area should be well lit.
- Shelving must be at least 15 cm (6 in.) above the floor. Do not store items right on the floor.
- Aisles should be wide enough to allow room for carts or dollies, which should be used to prevent possible injuries from lifting.
- Food and supply storage areas should be kept under lock and key to prevent pilferage. Food storage control is an important step in the overall control of food costs. All storerooms should be considered to be like bank safes where the assets of the operation are being stored. This may mean that more valuable commodities such as liquor and wine should be stored and locked inside a larger storage area, such as the dry food storage area.

Refrigerated Products

The refrigerator, whether a walk-in or a standard upright, is an important component in planning the storage of food items. Most fresh foods must be stored in the refrigerator to delay their deterioration and decomposition. The most basic rule must be always followed: store raw products below, *never* above, your cooked or ready-to-eat products.

Critical Control Point

Keep foods 4°C (39°F) or colder, the safe temperature for refrigerated storage.

Here are some considerations to ensure that the refrigerator does not break down and risk spoiling food:

- Monitor the temperature of the refrigerator daily. All refrigerators should be provided with a thermometer so that daily readings can be taken.
- Keep refrigerators in good working order. Maintain a regular servicing contract with a local refrigerator repair company.

- Most breakdowns are beyond the ability of kitchen staff to repair, but if the refrigerator does stop running, first check that the power supply cord hasn't simply been pulled out or the breaker has flipped off.
- Clean refrigerators regularly. Shelves should be shallow and well vented to make such cleaning quick and easy. Develop and follow a schedule to ensure that refrigerators are cleaned on a consistent basis.

There are also several general rules that all personnel using the refrigerator should follow:

- Store raw products below cooked or ready-to-eat products.
- Develop and follow a FIFO system for refrigerated food.
- Designate areas in the refrigerator for certain items, and keep only those items in their designated place.
- Never put hot foods in the refrigerator unless absolutely necessary. (Unfortunately, one person's understanding of "necessary" may not be the same as another person's, so consider developing guidelines.)
- Never leave the refrigerator door open longer than needed.

Although lack of time and personnel shortages often make it difficult to observe these rules, it is imperative that they be followed.

Dairy Products

Dairy products must be stored in the refrigerator at temperatures of 2°C to 4°C (36° to 39°F). Follow these guidelines:

- The fat in dairy products has a tendency to absorb strong odours from the storage surroundings. To reduce the likelihood of this happening, store dairy products in their own area in protective coverings.

- Do not store dairy products in a vegetable cooler; a separate refrigerator is much more acceptable.
- Keep the refrigerator clean at all times.
- Rotate dairy products when fresh product arrives. Dairy products should not be ordered too far in advance of when they will be used. Ideally, such products should be delivered on a daily basis.

Text 22

Milling

Milling is the most common form of machining, a material removal process, which can create a variety of features on a part by cutting away the unwanted material. The milling process requires a milling machine, workpiece, fixture, and cutter. The workpiece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to a platform inside the milling machine. The cutter is a cutting tool with sharp teeth that is also secured in the milling machine and rotates at high speeds. By feeding the workpiece into the rotating cutter, material is cut away from this workpiece in the form of small chips to create the desired shape.

Milling is typically used to produce parts that are not axially symmetric and have many features, such as holes, slots, pockets, and even three dimensional surface contours. Parts that are fabricated completely through milling often include components that are used in limited quantities, perhaps for prototypes, such as custom designed fasteners or brackets. Another application of milling is the fabrication of tooling for other processes. For example, three-dimensional molds are typically milled. Milling is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that milling can offer, it is ideal for adding precision features to a part whose basic shape has already been formed.

Capabilities

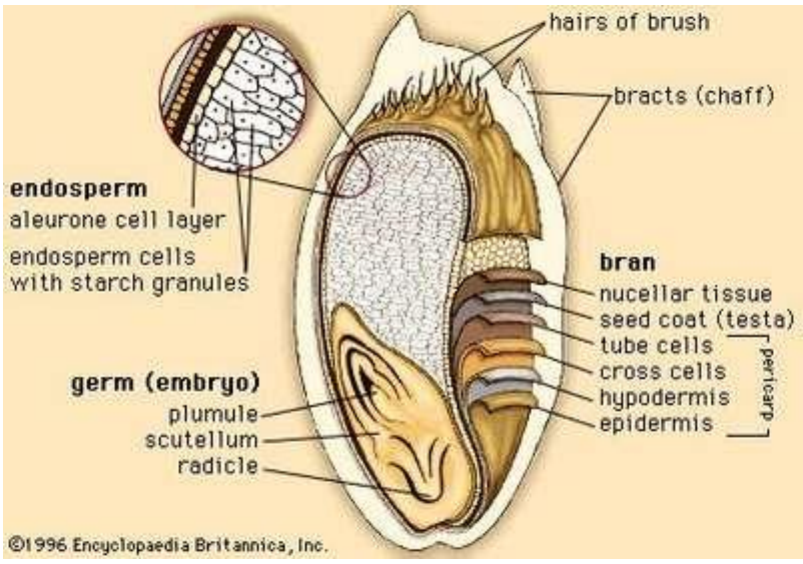
	Typical	Feasible
Shapes:	Solid: Cubic Solid: Complex	Flat Thin-walled: Cylindrical Thin-walled: Cubic Thin-walled: Complex Solid: Cylindrical
Part size:	Length: 0.04 - 72 in Width: 0.04 - 72 in	
Materials:	Metals Alloy Steel Carbon Steel Cast Iron Stainless Steel Aluminum Copper Magnesium Zinc	Ceramics Composites Lead Nickel Tin Titanium Elastomer Thermoplastics Thermosets
Surface finish - Ra:	32 - 125 μin	8 - 500 μin
Tolerance:	± 0.001 in.	± 0.0005 in.
Max wall thickness:	0.04 - 40 in.	0.04 - 72 in.
Quantity:	1 - 1000	1 - 1000000
Lead time:	Days	Hours

Advantages:	All materials compatible Very good tolerances Short lead times
Disadvantages:	Limited shape complexity Part may require several operations and machines High equipment cost Significant tool wear Large amount of scrap
Applications:	Machine components, engine components

Text 23

Rye

Rye, (*Secale cereale*), also called cereal rye or winter rye, cerealgrass (family Poaceae) and its edible grain that is chiefly used to make rye bread and rye whiskey. It is high in carbohydrates and dietary fibre and provides small quantities of protein, potassium, and B vitamins. Rye is also used as livestock feed, as a pasture plant, and as a green manure crop that is plowed under to improve the soil. Its tough fibrous straw can be used for thatching, mattresses, hats, and paper.



cereal processing: Rye

Rye , which has been known for some 2,000 years, ranks second to wheat as a

bread flour. The principal rye producers are Russia, Poland, Belarus,

Germany, and Ukraine. The popularity of true rye bread is decreasing, and a

similar bread, retaining some of the…

Rye is a fast-growing annual with long linear leaves. It can reach heights of 1 to 2 metres (3.3 to 6.6 feet), depending on the variety. Its small florets (reduced flowers) are wind-pollinated and are borne in dense spikes; they develop into one-seeded fruits, or grains, with long awns (bristles). The plant is highly susceptible to the ergotfungus, which if ingested by humans and other animals can result in serious acute or chronic illness known as ergotism.

Rye cultivation probably originated in southwestern Asia about 6500 BCE, migrating westward across the Balkan Peninsula and over Europe. Modern rye is grown extensively in Europe, Asia, and North America. It is mainly cultivated where climate and soil are relatively unfavourable for other cereals and as a winter crop where temperatures are too cool for winter wheat. The plant, which thrives in high altitudes, has the greatest winter hardiness of all small grains, growing as far north as the Arctic Circle.

Rye contains gluten and is the only cereal other than wheat that has the necessary qualities to make a loaf of bread, though it is inferior to wheat for that purpose and lacks elasticity. Because of its dark colour, a loaf made entirely from rye flour is often called black bread. The lighter-coloured rye breads popular in Europe and the United States contain admixtures of wheat or other flours in addition to rye. Pumpernickel, a dark brown bread made wholly from unsifted rye flour, was a staple food in central and eastern Europe for centuries.

dark rye bread

Text 24

Herbal oil

Herbs not only add taste and texture to food, but are also abundant sources of antioxidants, vitamins, minerals and unique medicinal properties. Certain herbs and spices can even help you maintain a healthy body weight, as they promote weight loss.

"Herbs" and "spices" are often used interchangeably; however there are differences between them. Herbs are obtained from the leaves of herbaceous or non-woody plants, and are used in larger amounts than spices. Spices, on the other hand, are obtained from roots, flowers, fruits, seeds or bark, and are usually used in smaller amounts than herbs because of their higher potency and stronger flavor.

Herbs come in various forms, including dried leaves and teas. But this site focuses on herbal oils, which you can make at home or purchase at health food stores. These oils have their own sets of uses and benefits, from food preparation to skin therapy and other practical uses. Herbal oils can be taken or used in different ways, such as for cooking and topical application. They can also be essential or infused.

Essential oils require a large quantity of plant material and need to be diluted before use because they are concentrated. Infused oils, on the other hand, use only a small amount of plant material and are used full-strength. Essential oils can be used in different ways, including aromatherapy, skin massage, adding them to bathwater, using them in a compress or burning them in a diffuser.

Also included are oils that have been popularly touted to be healthy, but actually have potential side effects on your well-being. It is vital for you to know the truth about these oils, so you can weigh the risks and benefits before using them. Just as using too much of any food or health product can carry health risks, remember that herbal oils should be used moderately. They are NOT a substitute for a nutritious, balanced diet.

Pregnant women especially need to consult their physician before consuming or using these oils. Some oils may not be recommended for very young children and people dealing with certain health conditions. Take extra precaution and read through the information thoroughly before using any of the oils in this list.

STORY AT-A-GLANCE

- Tea tree oil has been long valued for its antifungal, antibacterial and antiviral properties

- In the 1920s, it was used in dentistry and surgery to clean wounds and prevent infections. Surgeons believed that it is more effective than carbolic acid, the commonly used antiseptic at that time

Practical, inexpensive, and has many uses for your health and around the home- no wonder tea tree oil is hailed as a "jack of all trades" among nature's herbal oils. Here's what you need to know about tea tree oil.

What Is Tea Tree Oil?

Tea tree oil (TTO), also called melaleuca oil, is made from the leaves of the tea tree plant (Melaleuca alternifolia), a member of the myrtle tree family, which is native to Australia. The name was coined by British explorer Lieutenant James Cook in the 1770s, when he saw native Australians brewing tea using the leaves from the tree. Later on, he brewed his own batch of tea, and gave it to his crew to prevent scurvy.

The tea tree plant is highly prized by primitive Australian communities for its unique healing ability. Numerous aboriginal communities along the east coast of Australia have a long historical use of tea tree as an antiseptic for skin conditions. They simply crushed the tea tree leaves and applied it to cuts, burns and infections.

It was only in the 1920s, after Arthur Penfold, an Australian state government chemist, published a series of papers on tea tree oil's antiseptic properties that this oil's benefits became widely known. Through modern distillation methods, manufacturers are now able to produce tea tree oil with a clear to very pale golden or yellow color, and a fresh, camphor-like scent.

Tea Tree Oil Uses

Tea tree oil has been long valued for its antifungal, antibacterial and antiviral properties. In the 1920s, it was used in dentistry and surgery to help clean wounds and prevent infections.
Surgeons believed that it is more effective than carbolic acid, the commonly used antiseptic at that time.

Tea tree oil's has become more popular within the last few years, and it is now added to soaps, shampoos, lotions and other personal care products. Tea tree oil has many uses around the home, too. An article in Mother Nature Network lists nine tea tree oil home uses, including:

Toothbrush cleaner — A drop of tea tree oil can disinfect your toothbrush, which is a breeding ground for mold and bacteria.

Mold treatment — Mix a drop with a cup of water, spray on moldy areas and then wipe clean. For an all-natural disinfectant, you can also sprinkle a few drops of tea tree oil along with baking soda on your bathroom or kitchen surfaces.

Natural pest control — The strong smell of tea tree oil naturally repels ants and other insects. I recommend making a natural insect repellent by mixing a few drops of tea tree oil with coconut oil.

Laundry freshener — Adding a few drops of this oil during the wash cycle will make your laundry smell crisper and kill organisms lurking in your washer.

Composition of Tea Tree Oil

There are over 100 components in tea tree oil, but it is mostly made up of terpene hydrocarbons: monoterpenes, sesquiterpenes and their alcohols. Light, heat, exposure to air and moisture can affect TTO's stability, so make sure to place it in an airtight container and store it in a dark, cool and dry place.

Benefits of Tea Tree Oil

Tea tree oil has gained a reputation for being an all-around remedy, from removing makeup totreating warts. Numerous studies have been conducted to prove the potential benefits of tea tree oil for health ailments, such as:

Acne — A comparative study published in the Medical Journal of Australia found that TTO and benzoyl peroxide both had a significant effect in ameliorating patients' acne. Although the onset of action in tea tree oil was slower, it caused fewer side effects than benzoyl peroxide.

Fungal infections — A study published in the journal Tropical Medicine and International Health found that treating toenail onychomycosis with 2 percent butenafine and 5 percent TTO in cream cured 80 percent of patients.

Bacterial infections — A 2004 study funded by the National Center for Complementary and Alternative Medicine (NCCAM) found that TTO may be used as an adjunctive treatment for wounds, and may even help treat severe infections like methicillin-resistant Staphylococcus aureus (MRSA).

However, large, well-designed clinical trials are lacking, and the jury is still out on whether tea tree oil really has this potential.

Smaller-scale clinical studies on tea tree oil revealed TTO's potential for helping treat athlete's foot, dandruff, lice, gingivitis and genital infections.

Tea tree oil is said to be helpful in alleviating chest and head congestion, stuffy nose and other symptoms of colds and flu.

In aromatherapy, tea tree oil is said to be helpful in alleviating chest and head congestion, stuffy nose and other symptoms of colds and flu, especially when used in steam inhalation. Steam inhalation clears the congested nasal passages and kills bacteria.

Adding an antiviral essential oil like TTO makes it that much more effective. Just add a few drops to a steaming bowl of hot (purified) water, cover your head with a towel and breathe in the vapors for five to 10 minutes. Adding a few drops of tea tree oil to your bathwater may also help stop a cold from developing.

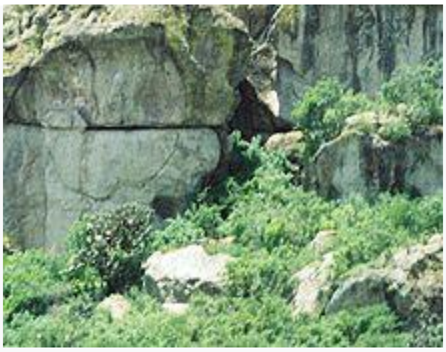
Text 25

Maize

Maize (/meɪz/ *MAYZ*; *Zea mays* subsp. *mays*, from Spanish: *maíz* after Taino: *mahiz*), also known as corn, is a cereal grain first domesticated by indigenous peoples in southern Mexico about 10,000 years ago. The leafy stalk of the plant produces pollen inflorescences and separate ovuliferous inflorescences called ears that yield kernels or seeds, which are fruits.

Maize has become a staple food in many parts of the world, with the total production of maize surpassing that of wheat or rice. However, little of this maize is consumed directly by humans: most is used for corn ethanol, animal feed and other maize products, such as corn starch and corn syrup. The six major types of maize are dent corn, flint corn, pod corn, popcorn, flour corn, and sweet corn.

History



Guilá Naquitz Cave in Oaxaca, Mexico is the site of early domestication of several food crops, including teosinte (an ancestor of maize).

Cultivation of maize in an illustration from the 16th c. Florentine Codex

Most historians believe maize was domesticated in the Tehuacán Valley of Mexico. Recent research in the early 21st century has modified this view somewhat; scholars now indicate the adjacent Balsas River Valley of south-central Mexico as the center of domestication.

An influential 2002 study by Matsuoka *et al*. has demonstrated that, rather than the multiple independent domestications model, all maize arose from a single domestication in southern Mexico about 9,000 years ago. The study also demonstrated that the oldest surviving maize types are those of the Mexican highlands. Later, maize spread from this region over the Americas along two major paths. This is consistent with a model based on the archaeological record suggesting that maize diversified in the highlands of Mexico before spreading to the lowlands.

Archaeologist Dolores Piperno has said:

A large corpus of data indicates that it [maize] was dispersed into lower Central America by 7600 BP [5600 BC] and had moved into the inter-Andean valleys of Colombia between 7000 and 6000 BP [5000–4000 BC].

Dolores Piperno, The Origins of Plant Cultivation and Domestication in the New World Tropics: Patterns, Process, and New Development

Since then, even earlier dates have been published.

According to a genetic study by Embrapa, corn cultivation was introduced in South America from Mexico, in two great waves: the first, more than 6000 years ago, spread through the Andes. Evidence of cultivation in Peru has been found dating to about 6700 years ago. The second wave, about 2000 years ago, through the lowlands of South America.

Before domestication, maize plants grew only small, 25 millimetres (1 in) long corn cobs, and only one per plant. In Spielvogel's view, many centuries of artificial selection (rather than the current view that maize was exploited by interplanting with *teosinte*) by the indigenous people of the Americas resulted in the development of maize plants capable of growing several cobs per plant, which were usually several centimetres/inches long each. The Olmec and Maya cultivated maize in numerous varieties throughout Mesoamerica; they cooked, ground and processed it through nixtamalization. It was believed that beginning about 2500 BC, the crop spread through much of the Americas.[14] Research of the 21st century has established even earlier dates. The region developed a trade network based on surplus and varieties of maize crops.

Maize is the most widely grown grain crop throughout the Americas, with 361 million metric tons grown in the United States in 2014 (Production table). Approximately 40% of the crop—130 million tons—is used for corn ethanol. Genetically modified maize made up 85% of the maize planted in the United States in 2009.

Sugar-rich varieties called sweet corn are usually grown for human consumption as kernels, while field corn varieties are used for animal feed, various corn-based human food uses (including grinding into cornmeal or masa, pressing into corn oil, and fermentation and distillation into alcoholic beverages like bourbon whiskey), and as chemical feedstocks.

The maize plant is often 3 m (10 ft) in height, though some natural strains can grow 13 m (43 ft). The stem is commonly composed of 20 internodes of 18 cm (7.1 in) lengt. A leaf, which grows from each node, is generally 9 cm (4 in) in width and 120 cm (4 ft) in length.

Ears develop above a few of the leaves in the midsection of the plant, between the stem and leaf sheath, elongating by around 3 millimetres (0.12 in) per day, to a length of 18 cm (7 in) with 60 cm (24 in) being the maximum alleged in the subspecies. They are female inflorescences, tightly enveloped by several layers of ear leaves commonly called husks. Certain varieties of maize have been bred to produce many additional developed ears. These are the source of the "baby corn" used as a vegetable in Asian cuisine.

The apex of the stem ends in the tassel, an inflorescence of male flowers. When the tassel is mature and conditions are suitably warm and dry, anthers on the tassel dehisce and release pollen. Maize pollen is anemophilous (dispersed by wind), and because of its large settling velocity, most pollen falls within a few meters of the tassel.

Elongated stigmas, called silks, emerge from the whorl of husk leaves at the end of the ear. They are often pale yellow and 18 cm (7 in) in length, like tufts of hair in appearance. At the end of each is a carpel, which may develop into a "kernel" if fertilized by a pollen grain. The pericarp of the fruit is fused with the seed coat referred to as "caryopsis", typical of the grasses, and the entire kernel is often referred to as the "seed". The cob is close to a multiple fruit in structure, except that the individual fruits (the kernels) never fuse into a single mass. The grains are about the size of peas, and adhere in regular rows around a white, pithy substance, which forms the ear. The maximum size of kernels is reputedly 2.5 cm (1 in). An ear commonly holds 600 kernels. They are of various colors: blackish, bluish-gray, purple, green, red, white and yellow. When ground into flour, maize yields more flour with much less bran than wheat does. It lacks the protein gluten of wheat and, therefore, makes baked goods with poor rising capability. A genetic variant that accumulates more sugar and less starch in the ear is consumed as a vegetable and is called sweet corn. Young ears can be consumed raw, with the cob and silk, but as the plant matures (usually during the summer months), the cob becomes tougher and the silk dries to inedibility. By the end of the growing season, the kernels dry out and become difficult to chew without cooking them tender first in boiling water.