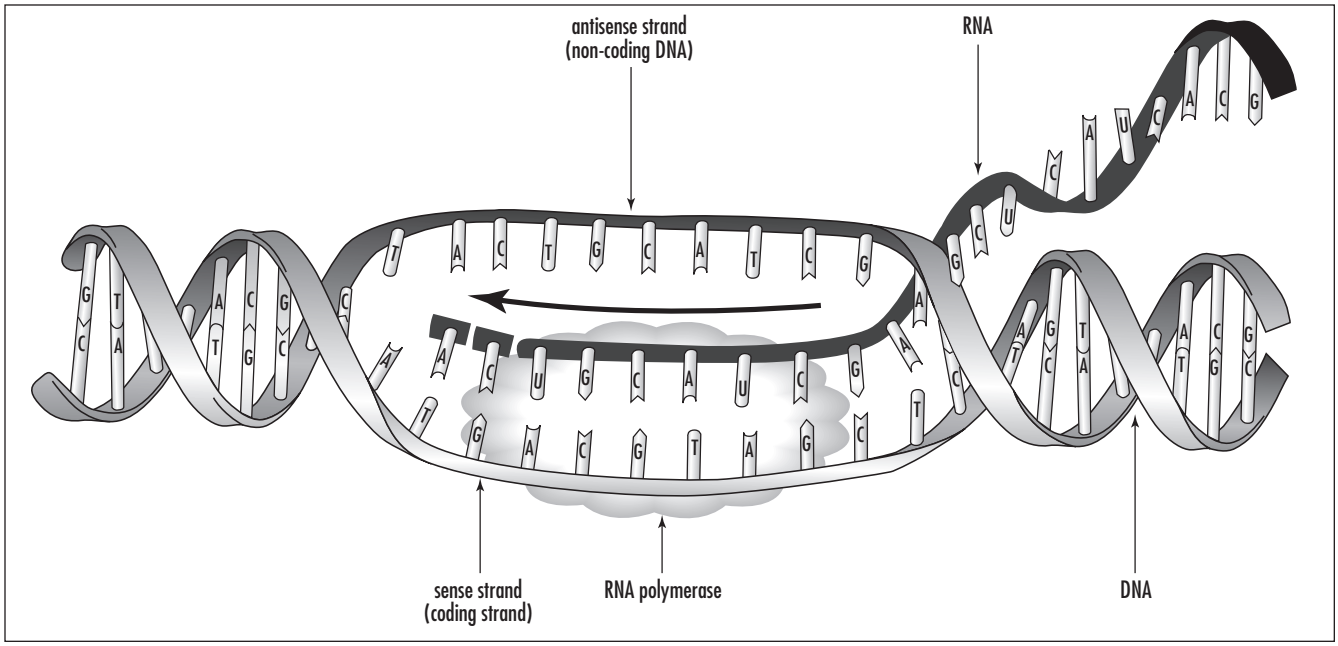


An antisense molecule is the noncoding strand in double-stranded DNA. The antisense strand serves as the template for mRNA synthesis. ***(Courtesy of Darryl Leja, NHGRI, National Institutes of Health)***

apical dominance Concentration of growth at the tip of a plant shoot, where a terminal bud partially inhibits axillary bud growth. It is thought to be caused by the apical bud producing a great deal of IAA (auxin), which is transported from the apical bud to the surrounding area and causes lateral buds to stay dormant.

apical meristem Embryonic plant tissue (meristematic cells) in the tips of roots and in the buds of shoots that supplies cells via mitosis for the plant to grow in length.

apomixis The ability of certain plants to reproduce clones of themselves, i.e., the scaly male fern group, *Dryopteris affinis* (Lowe) Fraser-Jenkins.

apomorphic character A phenotypic character, or homology, in which the similarity of characters found in different species is the result of common descent, i.e., the species evolved after a branch diverged from a phylogenetic tree.

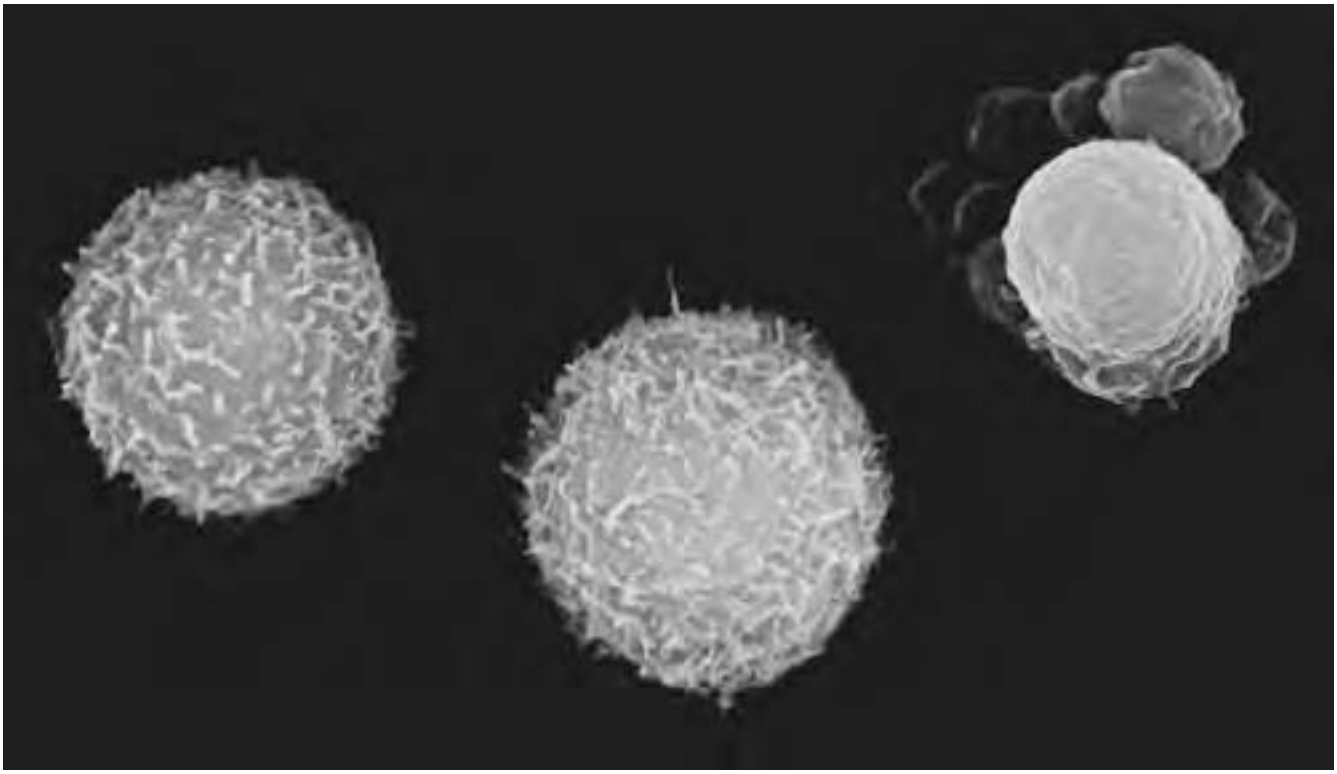
Two characters in two taxa are homologues if they are the same as the character that is found in the ancestry of the two taxa or they are different characters that have an ancestor/descendant relationship described as preexisting or novel. The ancestral character is termed the plesiomorphic character, and the descendant character is termed the apomorphic character. Examples are the flippers of whales and human arms.

See also PHENOTYPE.

apoplast The cell-wall continuum of an organ or a plant; in a plant it includes the xylem. The movement of substances via cell walls is called apoplastic transport.

apoprotein A protein without its characteristic PROSTHETIC GROUP or metal.

apoptosis Cells die by injury or commit "suicide." Apoptosis is a programmed cell death (PCD) brought about by signals that trigger the activation of a flood



Scanning Electron Micrograph (SEM) of human white blood cells (leucocytes) showing one cell undergoing apoptosis. Apoptosis is the process of "genetically programmed cell death." At upper right, an apoptotic white blood cell has shrunk and its cytoplasm has developed blebs (grapelike clusters). Normal white blood cells are seen beside it. These white blood cells are myeloid leucocytes, originating from bone marrow. The human myeloid cell line depends on growth factors to survive, and cells undergo apoptosis when deprived of growth factors. Research on apoptosis may provide genetic treatments for diseases such as cancer. Magnification: ×7,500 at 8×10-in. size. ***(Courtesy © Dr. Gopal Murti/Photo Researchers, Inc.)***

of "suicide" proteins in the cells destined to die. The destined cells then go through a number of molecular and morphological changes until they finally die. PCD is important in proper development in mitosis and cells that may be threatening to the host organism. It can be induced by a variety of stimuli, such as ligation of cell surface receptors, starvation, growth factor/survival factor deprivation, heat shock, hypoxia, DNA damage, viral infection, and cytotoxic/chemotherapeutical agents. *Apoptosis* is a word of Greek origin meaning "falling off or dropping off." There is a Web site devoted to the topic at http://www.celldeath.de/mainfram.htm.

A New York tiger moth (*Grammia virginiensis*) exuding a toxic yellow froth from prothoracic glands. This is an example of lepidoptera showing chemical defense and aposematic coloration. ***(Courtesy of Tim McCabe)***

aposematic coloration The bright coloration of animals with effective physical or chemical defenses that

acts as a warning to experienced predators. The larvae of the monarch butterfly and *Phymateus morbillosus,* a foaming grasshopper from South Africa, are two examples. The warning coloration alerts the predator, who may have eaten a similar-looking animal and was sickened by it, to avoid it. This also helps those species that mimic others in appearance, such as the viceroy butterfly and the monarch butterfly.

See also MIMICRY.

aquaporins (AQPs) The aquaporins are a family of proteins known for facilitating water transport. An aquaporin is a transport protein in the plasma membranes of a plant or animal cell that specifically facilitates the diffusion of water across the membrane (osmosis).

Aquaporin-1, or CHIP-28, discovered in 1992 by Peter Agre, is the major water channel of the red blood cells. In the kidneys, it is involved in the reabsorption of most of the waste filtered through the glomeruli. It is also thought to influence the movement of CO_2 across the cell membrane, since it is present in most cells that have high levels of CO_2. Aquaporin-2, or WCH-CD, is a water channel that makes the principal cells of the medullary collecting duct in the kidneys more permeable to water. Lack of a functional aquaporin-2 gene leads to a rare form of nephrogenic diabetes insipidus. There are many more aquaporins that have been discovered in the more water-permeable parts of the body, such as the moist surface tissues of the alveoli in the lung, the kidney tubules, the choroid plexus of the brain where cerebrospinal fluid is produced, the ciliary epithelium of the eye where aqueous humor is formed, and the salivary and lacrimal tear glands. Aquaporins are believed to be involved in mechanisms defending against brain edema, congestive heart failure, and many other clinical entities.

aquation The incorporation of one or more integral molecules of water into another chemical species with or without displacement of one or more atoms or groups.

See also HYDRATION.

aqueous solution A solution in which water is the solvent or dissolving medium, such as salt water, rain, or soda.

Archaea One of two prokaryotic (no nucleus) domains, the other being the Bacteria. Archaeans include organisms that live in some of the most extreme environments on the planet and resemble bacteria. They are single-cell organisms that, with bacteria, are called prokaryotes. Their DNA is not enclosed in a nucleus. Bacteria and archaea are the only prokaryotes; all other life forms are eukaryotes. Archaeans are among the earliest forms of life that appeared on Earth billions of years ago, and it is believed that the archaea and bacteria developed separately from a common ancestor nearly 4 billion years ago.

Some archaeans are "extremophiles," that is, they live near rift vents in the deep sea at temperatures well over 100°C (212°F). Others live in hot springs (such as the hot springs of Yellowstone National Park, where some of archaea were first discovered) or in extremely alkaline or acid waters. They have been found inside the digestive tracts of cows, termites, and marine life, where they produce methane. They also live in the anoxic muds of marshes and at the bottom of the ocean and in petroleum deposits deep underground. They are also quite abundant in the plankton of the open sea and even have been found in the Antarctic. They survive in these harsh conditions by using a variety of protective molecules and enzymes.

Three groups of archaeans are known and include the Crenarchaeota, those that are extremophiles; the Euryarchaeota, methane producers and salt lovers; and the Korarchaeota, an all-inclusive group that contains a number of types that are little understood today.

Archaeans produce energy by feeding on hydrogen gas, carbon dioxide, and sulfur and can even create energy from the sun by using a pigment around the membrane called a bacteriorhodopsin that reacts with light and produces ATP.

The archaeans were not discovered as a separate group until the late 1970s.

archaezoa This group is believed to be the first to diverge from the prokaryotes. They lack mitochondria (converts foods into usable energy), though some archaezoans have genes for mitochondrial. They also lack an endoplasmic reticulum (important for protein synthesis) and golgi apparatus (important for glycosy-

lation, secretion), have no peroxisomes (use oxygen to carry out catabolic reactions), and have small ribosomes similar to bacteria.

Archaezoa has three known subgroups: diplomonads, microspoidians, and trichomonads. They are usually found with flagellas in moist/damp environments such as streams, lakes, underground water deposits, and in damp soil.

Some members have been found in harsh environments and can exist in bodies of water that can drop below –20° Fahrenheit and around ocean floor vents that exceed 320°F. These organisms can survive in a variety of environments as long as they are in water.

Many archaezoans are parasites and feed off their host. The species *Giardia,* which causes abdominal cramps and severe diarrhea, uses a ventral suction cup to attach to the human intestinal epithelium. Some species have chloroplasts that allow them to take in light energy and use it when needed. Some species contain hydrogenosomes, organelles that are similar to mitochondria but do not respire with oxygen. They convert pyruvate into acetate, CO_2, and H_2, allowing extra ATP synthesis without respiration.

Since they have no mitochondria or plastid, it is believed that they are the intermediate stage between prokaryotes and eukaryotes and are also used as evidence for the evolution of the nucleus before the organelles.

archegonium In plants, the multicellular flask-shaped female gametangium (a moist chamber in which gametes develop in bryophytes, ferns, and gymnosperms).

archenteron The endoderm-lined gut (enteron) hollow cavity formed during the gastrulation process in metazoan embryos. The archenteron is formed by the infolding of part of the outer surface of the BLASTULA and opening to the exterior via the BLASTOPORE. Also called the primitive gut, or gastrocoel in early embryonic development, it is the digestive cavity. The term is Greek for "primitive intestine."

archipelago A group or chain of islands clustered in a body of water, e.g., the African Bazaruto Archipelago, consisting of five islands: Bazaruto, Magaruque, Santa Carolina, Benguera (Benguerra), and Bangue.

Aristotle (384 B.C.E.–322 B.C.E.) Greek *Philosopher* Aristotle, a Greek philosopher and scientist, has had more influence on the field of science than anyone. His influence, which lasted more than 2,000 years, was due to the fact that he was the first to depart from the old Platonic school of thinking by reasoning that accurate observation, description, inductive reasoning, and interpretation was the way to understand the natural world. Since he was the first to use this method, he is often called the "Father of Natural History."

Born in 384 B.C.E. in the Ionian colony of Stagirus (now Macedonia), Aristotle was the son of Nicomachus, a physician and grandfather of Alexander the Great. At 17, he became a student in Plato's academy in Athens and stayed there for more than 20 years as a student and teacher. In 347 B.C.E., he moved to the princedom of Atarneus in Mysia (northwestern Asia Minor), ruled by Hermias, and who presided over a small circle of Plato followers in the town of Assos. Aristotle befriended Hermias, joined the group, and eventually married Hermias's niece and adopted daughter Pythias.

Around 342 B.C.E., he moved to Mieza, near the Macedonian capital Pella, to supervise the education of 13-year-old Alexander the Great. Aristotle returned to Athens in 335 B.C.E. to teach, promote research projects, and organize a library in the Lyceum. His school was known as the Peripatetic School. After Alexander's death in 323 B.C.E., Aristotle was prosecuted and had to leave Athens, leaving his school to Theophrastus. He died shortly after at Chalcis in Euboea in 322 B.C.E.

While his writings were immense, one of his works particularly influenced the field of meteorology for over 2,000 years. *Meteorologica* (meteorology) was written in 350 B.C.E. and comprised four books, although there are doubts about the authenticity of the last one. They deal mainly with atmospheric phenomena, oceans, meteors and comets, and the fields of astronomy, chemistry, and geography.

Aristotle attempted to explain the atmosphere in a philosophical way and discussed all forms of "meteors," a term then used to explain anything sus-

pended in the atmosphere. Aristotle discussed the philosophical nature of clouds and mist, snow, rain and hail, wind, lightning and thunder, rivers, rainbows, and climatic changes. His ideas posited the existence of four elements (earth, wind, fire, and water), each arranged in separate layers but capable of mingling.

Aristotle's observations in the biological sciences had some validity, but many of his observations and conclusions regarding weather and climate were wrong, and it was not until the 17th century—with the invention of meteorological instruments such as the hygrometer, thermometer, and barometer—that his ideas were disproved scientifically. However, he correctly reasoned that the earth was a sphere, recorded information regarding the bathymetry of seas, correctly interpreted dolphins and whales as mammals, separated vertebrates into oviparous and viviparous, and described and named many organisms, including crustaceans and worms, mollusks, echinoderms, and fish from the Aegean Sea.

Arrhenius, Svante August (1859–1927) Swedish *Chemist, Physicist* Svante August Arrhenius was born in Vik (or Wijk), near Uppsala, Sweden, on February 19, 1859. He was the second son of Svante Gustav Arrhenius and Carolina Christina (née Thunberg). Svante's father was a surveyor and an administrator of his family's estate at Vik. In 1860, a year after Arrhenius was born, his family moved to Uppsala, where his father became a supervisor at the university. He was reading by the age of three.

Arrhenius received his early education at the cathedral school in Uppsala, excelling in biology, physics, and mathematics. In 1876, he entered the University of Uppsala and studied physics, chemistry, and mathematics, receiving his B.S. two years later. While he continued graduate classes for three years in physics at Uppsala, his studies were not completed there. Instead, Arrhenius transferred to the Swedish Academy of Sciences in Stockholm in 1881 to work under Erick Edlund to conduct research in the field of electrical theory.

Arrhenius studied electrical conductivity of dilute solutions by passing electric current through a variety of solutions. His research determined that molecules in some of the substances split apart, or dissociated from each other, into two or more ions when they were dissolved in a liquid. He found that while each intact molecule was electrically balanced, the split particles carried a small positive or negative electrical charge when dissolved in water. The charged atoms permitted the passage of electricity, and the electrical current directed the active components toward the electrodes. His thesis on the theory of ionic dissociation was barely accepted by the University of Uppsala in 1884, since the faculty believed that oppositely charged particles could not coexist in solution. He received a grade that prohibited him from being able to teach.

Arrhenius published his theories ("Investigations on the Galvanic Conductivity of Electrolytes") and sent copies of his thesis to a number of leading European scientists. Russian-German chemist Wilhelm Ostwald, one of the leading European scientists of the day and one of the principal founders of physical chemistry, was impressed and visited him in Uppsala, offering him a teaching position, which he declined. However, Ostwald's support was enough for Uppsala to give him a lecturing position, which he kept for two years.

The Stockholm Academy of Sciences awarded Arrhenius a traveling scholarship in 1886. As a result, he worked with Ostwald in Riga with physicist Friedrich Kohlrausch at the University of Wurzburg, with physicist Ludwig Boltzmann at the University of Graz, and with chemist Jacobus Van't Hoff at the University of Amsterdam. In 1889, he formulated his rate equation that is used for many chemical transformations and processes, in which the rate is exponentially related to temperature, known as the "Arrhenius equation."

He returned to Stockholm in 1891 and became a lecturer in physics at Stockholm's Hogskola (high school) and was appointed physics professor in 1895 and rector in 1897. Arrhenius married Sofia Rudbeck in 1894 and had one son. The marriage lasted a short two years. Arrhenius continued his work on electrolytic dissociation and added the study of osmotic pressure.

In 1896, he made the first quantitative link between changes in carbon dioxide concentration and climate. He calculated the absorption coefficients of carbon dioxide and water based on the emission spectrum of the moon, and he also calculated the amount

of total heat absorption and corresponding temperature change in the atmosphere for various concentrations of carbon dioxide. His prediction of a doubling of carbon dioxide from a temperate rise of 5–6°C is close to modern predictions. He predicted that increasing reliance on fossil fuel combustion to drive the world's increasing industrialization would, in the end, lead to increases in the concentration of CO_2 in the atmosphere, thereby giving rise to a warming of the Earth.

In 1900, he published his *Textbook of Theoretical Electrochemistry.* In 1901 he and others confirmed the Scottish physicist James Clerk Maxwell's hypothesis that cosmic radiation exerts pressure on particles. Arrhenius went on to use this phenomenon in an effort to explain the aurora borealis and solar corona. He supported the Norwegian physicist Kristian Birkeland's explanation of the origin of auroras that he proposed in 1896. He also suggested that radiation pressure could carry spores and other living seeds through space and believed that life on earth was brought here under those conditions. He likewise believed that spores might have populated many other planets, resulting in life throughout the universe.

In 1902, he received the Davy Medal of the Royal Society and proposed a theory of immunology. The following year he was awarded the Nobel Prize for chemistry for his work that originally had been perceived as improbable by his Uppsala professors. He also published his *Textbook of Cosmic Physics*.

He became director of the Nobel Institute of Physical Chemistry in Stockholm in 1905 (a post he held until a few months before his death). He married Maria Johansson and had one son and two daughters. The following year he also had time to publish three books, *Theories of Chemistry, Immunochemistry,* and *Worlds in the Making*.

He was elected a foreign member of the Royal Society in 1911, the same year he received the Willard Gibbs Medal of the American Chemical Society. Three years later he was awarded the Faraday Medal of the British Chemical Society. He was also a member of the Swedish Academy of Sciences and the German Chemical Society.

During the latter part of his life his interests included the chemistry of living matter and astrophysics, especially the origins and fate of stars and planets. He continued to write books such as *Smallpox and Its Combating* (1913), *Destiny of the Stars* (1915), *Quantitative Laws in Biological Chemistry* (1915), and *Chemistry and Modern Life* (1919). He also received honorary degrees from the universities of Birmingham, Edinburgh, Heidelberg, and Leipzig and from Oxford and Cambridge Universities. He died in Stockholm on October 2, 1927, after a brief illness, and is buried at Uppsala.

arteriosclerosis Also known as "hardening of the arteries." It is a disease whereby the arteries thicken and the inner surfaces accumulate deposits of hard plaques of cholesterol, calcium, fibrin, and other cellular debris. The arteries become inelastic and narrowed, which increases the stress on the heart as it pumps blood through, and complete obstruction with loss of blood supply can occur. This is a common cause for high blood pressure. There are hereditary links that are associated with increased risk of heart attack and stroke. When arteriosclerosis occurs in large arteries, such as the aorta, it is often referred to as atherosclerosis.

See also ARTERY.

artery A blood vessel that carries oxygenated (except the pulmonary artery) blood away from the heart via the right and left ventricles to organs throughout the body. The main trunk of the arterial system in the body is called the aorta. The aortic divisions are the abdominal aorta, thoracic aorta, aortic artery, and ascending aorta. The pulmonary artery carries unoxygenated blood from the heart to the lungs for oxygenation.

See also VEIN.

arthritis Inflammation of one or more of the joints in the body.

Arthropoda An animal phylum where individuals have a segmented body, exoskeleton, and jointed legs.

artificial selection Artificial selection is the conscious attempt by human beings to alter the environments or traits of other organisms (including their own environment) so as to alter the evolution of these

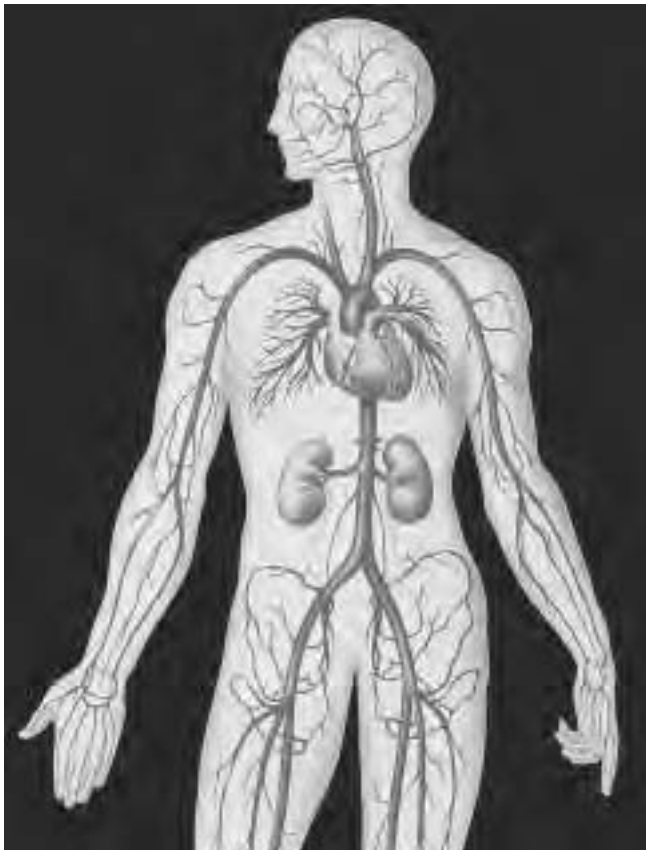


Illustration of the arterial system in the human body, shown in a standing figure. The heart and kidneys are also shown. Note the feathery network of blood vessels in the left and right lungs (next to the heart). Arteries are the blood vessels that carry oxygen-rich blood to the body's tissues. Veins (not shown) carry blood back to the heart. The average adult has about five liters of blood. At rest, this volume of blood passes through the heart each minute. ***(Courtesy © John Bavosi/Photo Researchers, Inc.)***

organism's species. It is used in the selective breeding of domesticated plants and animals to encourage the occurrence of desirable traits or new breeds. Chickens are artificially selected to produce better eggs, and pet fish are selectively bred to produce vibrant colors and other desirable traits.

ascus (plural, asci) In Ascomycota (blue, green, and red molds), a saclike spore capsule located at the tip of the fruiting body, called the ascocarp in dikaryotic (containing two differing haploid nuclei) hyphae, in which ascopores are found and in which karyogamy is performed, i.e., two (dikaryotic) nuclei fuse (karyogamy) to form diploid nuclei. Asci vary in shape from narrow and elongate to nearly round. While the number of ascospores per ascus is usually eight, numerous other counts of ascospores per ascus are also known.

In medicine ASCUS stands for atypical squamous cells of undetermined significance and means that irregular cells have shown up on a Pap smear.

asexual reproduction A type of reproduction, without meiosis or syngamy (the fusion of two gametes in fertilization), involving only one parent that produces genetically identical offspring by budding, by the division of a single cell, or by the entire organism breaking into two or more parts. The offspring has the identical genes and chromosomes as the parent. Most plants are capable of asexual reproduction by means of specialized organs called propagules, such as tubers, stolons, gemma cups, and rhizomes.

Asexual reproduction is also known as vegetative reproduction. Examples of organisms that reproduce by asexual reproduction include aspens, dandelions, strawberries, walking fern (*Asplenium rhizophyllum*), and yeast. While asexual reproduction guarantees reproduction (no dependence on others), it does not allow genetic variation.

See also SEXUAL REPRODUCTION.

A tailless whip scorpion (arthropod) from a cave in the Bahamas is an example of a troglodyte, an animal that lives underground. ***(Courtesy of Tim McCabe)***

assimilation To transform food and other nutrients into a part of the living organism.

assimilative *See* ASSIMILATION.

assimilator *See* ASSIMILATION.

associative learning The acquired ability to associate one stimulus with another, such as one linked to a reward or punishment; also called classical conditioning and trial-and-error learning.

assortative mating A type of nonrandom or preference mating in which mating partners resemble each other in certain phenotypic characteristics. It can be a preference or avoidance of certain individuals as mates based on physical or social traits.

astigmatism Distorted vision, especially at close distances, resulting from an irregularly shaped cornea.

asymmetric carbon A carbon atom covalently bonded to four different atoms or groups of atoms.

asymmetric synthesis A traditional term for stereoselective synthesis. A chemical reaction or reaction sequence in which one or more new elements of CHIRALITY are formed in a SUBSTRATE molecule and which produces the STEREOISOMERic (ENANTIOMERic or DIASTEREOISOMERic) products in unequal amounts.

asymmetry parameter In nuclear quadrupole resonance spectroscopy, the parameter, η, is used for describing nonsymmetric fields. It is defined as $\eta = (qxx - qyy)/qzz$ in which *qxx*, *qyy*, and *qzz* are the components of the field gradient *q* (which is the second derivative of the time-averaged electric potential) along the *x*– , *y*– and *z*–axes. By convention *qzz* refers to the largest field gradient, *qyy* to the next largest, and *qxx* to the smallest when all three values are different.

atomic number The atomic number is equal to the number of positively charged protons in an atom's nucleus and determines which element an atom is. The atomic number is unique for each element and is designated by a subscript to the left of the elemental symbol. The atomic number for hydrogen is 1; it has one proton. Elements are substances made up of atoms with the same atomic number. Most of the elements are metals (75 percent) and the others are nonmetals.

atomic weight or mass The total atomic mass (the weighted average of the naturally occurring isotopes), which is the mass in grams of one MOLE of the atom. The atomic weight is calculated by adding the number of protons and neutrons together. The atomic weight of hydrogen is 1.0079 grams per mole.

ATP (adenosine triphosphate) An adenine (purine base), ribose, and three phosphate units containing nucleoside triphosphate that (a) releases free energy when its phosphate bonds are hydrolyzed and (b) produces adenosine diphosphate (ADP) and inorganic phosphorous. This energy is used to drive ENDERGONIC REACTIONS in cells (chemical reactions that require energy input to begin). ATP is produced in the cristae of mitochondria and chloroplasts in plants and is the driving force in muscle contraction and protein synthesis in animals. It is the major energy source within cells.

ATP synthase (proton translocating ATPase) A protein complex (a chemiosmotic enzyme) that synthesizes adenosine triphosphate (ATP) from adenosine diphosphate (ADP) and enables phosphate coupling with an electrochemical ion gradient across the membrane. It is found in cellular membranes and the inner membrane of mitochondria, the thylakoid membrane of chloroplasts, and the plasma membrane of prokaryotes. The protein consists of two portions: a soluble fraction that contains three catalytic sites and a membrane-bound portion that contains anion channels. It functions in chemiosmosis, the use of ion gradients across membranes, with adjacent electron transport chains, and it uses the

energy stored across the photosynthetic membrane (a hydrogen-ion concentration gradient) to add inorganic phosphate to ADP, thereby creating ATP. This allows hydrogen ions (H^+) to diffuse into the mitochondrion.

atrioventricular valve A valve in the heart between each atrium and ventricle. It prevents a backflow of blood when the ventricles contract.

atrium (plural, atria) An upper chamber that receives blood from the veins returning to the vertebrate heart and then pushes the blood to the ventricles, the lower chambers. There is a left and right atrium. Oxygenated blood returns from the lungs into the left atrium and gets pushed down to the left ventricle. The left ventricle pumps the blood out to the rest of the body, transporting the oxygen to parts of the body that need it. Blood returning from its voyage through the body arrives in the right atrium. It then goes into the right ventricle from which it goes through the lungs again to get more oxygen, and the cycle continuously repeats itself.

auranofin *See* GOLD DRUGS.

autacoid A biological substance secreted by various cells whose physiological activity is restricted to the vicinity of its release; it is often referred to as local HORMONE.

autogenesis model According to autogenesis ("self-generating"), eukaryotic cells evolved by the specialization of internal membranes originally derived from prokaryotic plasma membranes. This is another word for spontaneous generation or abiogenesis.

autoimmune disease An immunological disorder in which the immune system turns against itself. Autoimmunity can be the cause of a broad spectrum of human illnesses. Autoimmune diseases were not accepted into the mainstream of medicine until the 1950s and 1960s. They are diseases in which the progression from benign autoimmunity to pathogenic autoimmunity happens over a period of time and is determined by both genetic influences and environmental triggers. Examples of autoimmune diseases are idiopathic thrombocytopenic purpura, Graves' disease, myasthenia gravis, pemphigus vulgaris (cause of pemphigus), and bullous pemphigoid (a blistering disease).

autonomic nervous system (ANS) A division of the nervous system of vertebrates. The nervous system consists of two major subdivisions: the central nervous system (CNS), made up of the brain and spinal cord, and the peripheral nervous system (PNS), which comprises ganglia and peripheral nerves outside the brain and the spinal cord. The peripheral nervous system is divided into two parts: the somatic, which is concerned with sensory information about the environment outside the body as well as muscle and limb position; and the autonomic nervous system that regulates the internal environment of vertebrates. It consists of the sympathetic (fight/flight), parasympathetic (rest/rebuild), and enteric nervous systems. The ANS is involved in the function of virtually every organ system.

The parasympathetic nervous system takes care of essential background operations such as heart/lungs and digestion, while the sympathetic nervous system provides stress-response and procreation strategies and functions. The enteric nervous system takes care of controlling the function of the gut.

The sympathetic nerves form part of the nerve network connecting the organ systems with the central nervous system. The sympathetic nerves permit an animal to respond to stressful situations and helps control the reaction of the body to stress. Examples of the sympathetic reactions are increase in heart rate, decrease in secretion of salivary and digestive glands, and dilation of pupils. The parasympathetic nerves connect both somatic and visceral organs to the central nervous system, and their primary action is to keep body functions normalized. The ANS works to conserve the body's resources and to restore equilibrium to the resting state.

autophytic The process whereby an organism uses photosynthesis to make complex foods from inorganic substances.

autopolyploid A type of polyploid species resulting from one species doubling its chromosome number to become tetraploid, which may self-fertilize or mate with other tetraploids. This can result in sympatric speciation, where a new species can evolve in the geographical midst of its parent species because of reproductive isolation.

See also POLYPLOIDY.

autoreceptor Present at a nerve ending, a RECEPTOR that regulates, via positive or negative feedback processes, the synthesis and/or release of its own physiological ligand.

See also HETERORECEPTOR.

autosome A chromosome that is not directly involved in determining sex, as opposed to the sex chromosomes or the mitochondrial chromosome. Human cells have 22 pairs of autosomes.

autotroph Any organism capable of making its own food. It synthesizes its own organic food substances from inorganic compounds using sources such as carbon dioxide, ammonia, and nitrates. Most plants and many protists and bacteria are autotrophs. Photoautotrophs can use light energy to make their food (photosynthesis). Chemoautotrophs use chemical energy to make their food by oxidizing compounds such as hydrogen sulfide (H_2S). Heterotrophs are organisms that must obtain their energy from organic compounds.

See also TROPHIC LEVEL.

auxins A group of plant hormones that produce a number of effects, including plant growth, phototropic response through the stimulation of cell elongation (photopropism), stimulation of secondary growth, apical dominance, and the development of leaf traces and fruit. An important plant auxin is indole-3-acetic acid (IAA). (IAA and synthetic auxins such as 2,4-D and 2,4,5-T are used as common weed killers.)

auxotroph A nutritionally mutant organism that is unable to synthesize certain essential molecules (e.g., mineral salts and glucose) and that cannot grow on media lacking these molecules normally synthesized by wild-type strains of the same species without the addition of a specific supplement like an amino acid.

Aves The vertebrate class of birds, characterized by feathers and other flight adaptations, such as an active metabolism, and distinguished by having the body more or less completely covered with feathers and the forelimbs modified as wings. Birds are a monophyletic lineage that evolved once from a common ancestor, and all birds are related through that common origin. There are about 30 orders of birds, about 180 families, and about 2,000 genera with 10,000 species.

axillary bud An embryonic shoot present in the angle formed by a leaf and stem. Also called the lateral bud.

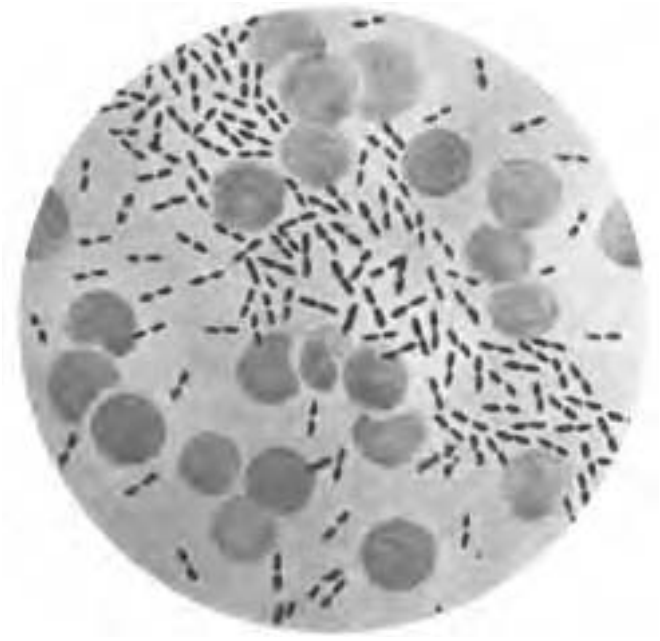
axon A process from a neuron, usually covered with a myelin sheath, that carries nerve impulses away from the cell body and to the synapse in contact with a target cell. The end of the axon contains vesicles (hollow spheres), in which transmitters are stored, and specialized structures forming the synapse.

See also NEURON.

azurin An ELECTRON TRANSFER PROTEIN, containing a TYPE 1 COPPER site, that is isolated from certain bacteria.

B

bacteria One of two prokaryotic (no nucleus) domains, the other being the ARCHAEA. Bacteria are microscopic, simple, single-cell organisms. Some bacteria are harmless and often beneficial, playing a major role in the cycling of nutrients in ecosystems via aerobic and anaerobic decomposition (saprophytic), while others are pathogenic, causing disease and even death. Some species form symbiotic relationships with other organisms, such as legumes, and help them survive in the environment by fixing atmospheric nitrogen. Many different species exist as single cells or colonies, and they fall into four shapes based on the shape of their rigid cell wall: coccal (spherical), bacillary (rod-shaped), spirochetal (spiral/helical or corkscrew), and vibro (comma-shaped). Bacteria are also classified on the basis of oxygen requirement (aerobic vs. anaerobic).



Photomicrograph of *Streptococcus (Diplococcus) pneumoniae* bacteria, using Gram's stain technique. *Streptococcus pneumoniae* is one of the most common organisms causing respiratory infections such as pneumonia and sinusitis, as well as bacteremia, otitis media, meningitis, peritonitis, and arthritis. *(Courtesy of Centers for Disease Control and Prevention, 1979)*

In the laboratory, bacteria are classified as gram-positive (blue) or gram-negative (pink) following a laboratory procedure called a Gram's stain. Gram-negative bacteria, such as those that cause the plague, cholera, typhoid fever, and salmonella, for example, have two outer membranes, which make them more resistant to conventional treatment. They can also easily mutate and transfer these genetic changes to other strains, making them more resistant to antibiotics. Gram-positive bacteria, such as those that cause anthrax and listeriosis, are more rare and are treatable with penicillin but can cause severe damage by either releasing toxic chemicals (e.g., clostridium botulinum) or by penetrating deep into tissue (e.g., streptococci). Bacteria are often called germs.

bacteriochlorin (7,8,17,18-tetrahydroporphyrin) A reduced PORPHYRIN with two pairs of nonfused saturated