# A

**ABO blood groups** Blood group antibodies (A, B, AB, O) that may destroy red blood cells bearing the antigen to which they are directed; also called "agglutinins." These red-cell antigens are the phenotypic expression of inherited genes, and the frequency of the four main groups varies in populations throughout the world. The antigens of the ABO system are an integral part of the red-cell membrane as well as all cells throughout the body and are the most important in transfusion practice.

*See also* LANDSTEINER, KARL.

**abortion** The termination of gestation before the fetus can survive on its own.

**abscisic acid (ABA)** A plant hormone ($C_{15}H_{20}O_4$) and weak acid that generally acts to inhibit growth, induces dormancy, and helps the plant tolerate stressful conditions by closing stomata. Abscisic acid was named based on a belief that the hormone caused the abscission (shedding) of leaves from deciduous trees during the fall.

At times when a plant needs to slow down growth and assume a resting (dormant) stage, abscisic acid is produced in the terminal bud, which slows down growth and directs the leaf primordia to develop scales that protect the dormant bud during winter. Because the hormone also inhibits cell division in the vascular cambium, both primary and secondary growth are put on hold during winter.

This hormone also acts as a stress agent that helps a plant deal with adverse conditions. For example, ABA accumulates on leaves and causes stomata to close, reducing the loss of water when a plant begins to wilt.

In 1963, abscisic acid was first identified and characterized by Frederick Addicott and colleagues. In 1965, the chemical structure of ABA was defined, and in 1967, it was formally called abscisic acid.

**absorption spectrum** Different pigments absorb light of different wavelengths. For example, chlorophyll effectively absorbs blue and red. The absorption spectrum of a pigment is produced by examining, through the pigment and an instrument called a spectroscope, a continuous spectrum of radiation. The energies removed from the continuous spectrum by the absorbing pigment show up as black lines or bands and can be graphed.

**abyssal zone** The portion of the ocean floor below 1,000–2,000 m (3,281–6,561 ft.), where light does not penetrate and where temperatures are cold and pressures are intense. It lies seaward of the continental slope and covers approximately 75 percent of the ocean floor. The temperature does not rise above 4°C. Because oxygen is present, a diverse community of invertebrates and fishes do exist, and some have adapted to harsh environments such as hydrothermal vents

of volcanic creation. Food-producing organisms at this depth are chemoautotrophic prokaryotes and not photosynthetic producers.

*See also* OCEANIC ZONE.

**acclimatization** Acclimatization is the progressive physiological adjustment or adaptation by an organism to a change in an environmental factor, such as temperature, or in conditions that would reduce the amount of oxygen to its cells. This adjustment can take place immediately or over a period of days or weeks. For example, the human body produces more erythrocytes (red blood cells) in response to low partial pressures of oxygen at high altitudes; short-term responses include shivering or sweating in warm-blooded animals.

**accommodation** The automatic reflex adjustment that allows the focal length of the lens of an eye to change to focus on an object. The lens shape, more convex for near objects and less convex for distant objects, is caused by ciliary muscles acting on the elastic property of the lens.

**acetylcholine** (**ACh**) One of the most common neurotransmitters of the vertebrate nervous system, ACh is a chemical ($CH_3COOCH_2CH_2N+(CH_3)_3$) that transmits impulses between the ends of two adjacent nerves or neuromuscular junctions. Released by nerve stimulation (exciting or inhibiting), it is confined largely to the parasympathetic nervous system, where it diffuses across the gap of the synapse and stimulates the adjacent nerve or muscle fiber. It rapidly becomes inactive by the enzyme cholinesterase, allowing further impulses to occur.

**acetyl CoA** A compound formed in the mitochondria when the thiol group (–SH) of coenzyme A combines with an acetyl group ($CH_3CO–$). It is important in the Krebs cycle in cellular respiration and plays a role in the synthesis and oxidation of fatty acids.

Fritz Albert Lipmann (1899–1986), a biochemist, is responsible for discovering coenzyme A and cofactor A, or CoA (A stands for *acetylation*), in 1947. He shared the 1953 Nobel Prize in physiology or medicine with HANS KREBS.

*See also* KREBS CYCLE.

**achiral** *See* CHIRALITY.

**acid** A chemical capable of donating a HYDRON (proton, H+) or capable of forming a covalent bond with an electron pair. An acid increases the hydrogen ion concentration in a solution, and it can react with certain metals, such as zinc, to form hydrogen gas. A strong acid is a relatively good conductor of electricity. Examples of strong acids are hydrochloric (muriatic), nitric, sulfuric, while examples of mild acids are sulfurous and acetic (vinegar). The strength of an acidic solution is usually measured in terms of its pH (a logarithmic function of the H+ ion concentration). Strong acid solutions have low pHs (typically around 0–3), while weak acid solutions have pHs in the range 3–6.

*See also* BASE; PH SCALE.

**acidity constant** The equilibrium constant for splitting off a HYDRON from a BRØNSTED ACID.

**acid-labile sulfide** Refers to sulfide LIGANDs, e.g., the BRIDGING LIGANDs in IRON–SULFUR PROTEINS, which are released as $H_2S$ at acid pH.

*See also* FERREDOXIN.

**acid precipitation** Because pure precipitation (e.g., rain) is slightly acidic (due to the reaction between water droplets and carbon dioxide, creating carbonic acid) with a potential pH of 5.6, acid precipitation refers to precipitation with a pH less than 5.6. Acid precipitation includes rain, fog, snow, and dry deposition. Anthropogenic (man-made) pollutants (carbon dioxide, carbon monoxide, ozone, nitrogen and sulfur oxides, and hydrocarbons) react with water vapor to produce acid precipitation. These pollutants come primarily from burning coal and other fossil fuels. Sulfur dioxide, which reacts readily with water vapor and droplets (i.e., has a short residence time in the atmosphere as a gas), has been linked to the weathering

(eating away) of marble structures and the acidification of freshwater lakes (consequently killing fish). Natural interactions within the biosphere can also lead to acid precipitation.

**acoelomate** A solid-bodied animal lacking a body cavity, the space between the gut (digestive tract) and body wall. Simple animals do not have a body cavity as higher animals do; this body cavity is called a coelom in mammals and contains the gut (a cavity by itself), heart, and lungs, for example. Acoelomates are bilateral animals and are triploblastic (have three layers: ectoderm, endoderm, and mesoderm). They can move forward and have a degree of cephalization (centralization of neural and sensory organs in the head).

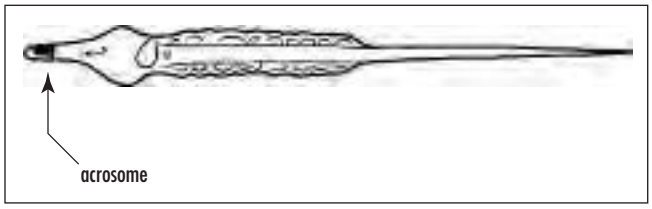
Representative phyla of acoelomates are the Platyhelminthes: flatworms that include the Turbellaria (nonconfined flatworms such as planarians), Monogenea (monogeneans), Trematoda (trematodes, or flukes), and Cestoidea (tapeworms). There are more than 20,000 species of flatworms living in wet environments such as marine or freshwater bodies and damp terrestrial areas.

*See also* COELOM.

**aconitase** A name for citrate (isocitrate) hydro-LYASE (aconitate hydratase), which catalyzes the interconversion of citrate, *cis*-aconitate ((Z)-prop-1-ene-1,2,3-tricarboxylate), and isocitrate. The active ENZYME contains a catalytic [4FE-4S] CLUSTER.

**acrosome** The acrosome is a special area or compartment that is located at the tip of the head of a sperm cell. It contains special digestive enzymes that on contact with the egg help the sperm head penetrate the egg for fertilization. Directly behind the acrosome is the haploid nucleus (single set of unpaired chromosomes) that contains the genetic material.

*See also* FERTILIZATION.

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**Mariposa lily from California. An example of an actinomorphic, radially symmetrical flower.** ***(Courtesy of Tim McCabe)***

**actin** A globular protein found in muscle tissue as thin filaments and in microfilaments that form portions of cell cytoskeletons. Actin links into chains, and paired chains twist helically around each other, forming microfilaments in muscle and other contractile elements in cells. Actin and myosin filaments interact to initiate muscle contraction.

Tropomyosin and troponin are two protein molecules associated with actin filaments in muscle. Tropomyosin runs along the length of the actin filament and covers the area of the actin molecule that interacts with myosin when at rest. On the other hand, when a muscle is contracted, tropomyosin is replaced with troponin as it binds to calcium ions. Troponin is

***Solanum* species as an example of an actinomorphic flower from Sierra Madre Oriental in Mexico. *(Courtesy of Tim McCabe)***

located at regular intervals along the actin filament and allows actin to interact with myosin.

*See also* CYTOSKELETON.

**actinomorphic** Symmetrical over more than one vertical plane; e.g., flowers that can be separated into symmetrical halves along any plane.

**action potential** A localized rapid change in voltage that occurs across the membrane of a muscle or nerve cell when a nerve impulse is initiated. It is caused by a physicochemical change in the membrane during the interaction of the flow and exchange of sodium and potassium ions.

*See also* DEPOLARIZATION.

**active center** The location in an ENZYME where the specific reaction takes place.

**active site** The active site of an enzyme is the area—a depressed region comprising a few of the protein's amino acids—on a portion of an enzyme that binds to its substrate. The enzyme's specificity is based on the shape of the active area, which can alter itself to snugly fit the substrate to which it is binding by using weak chemical bonds.

*See* ACTIVE CENTER.

**active transport** The movement of a substance across a biological membrane, such as living cells, against a concentration (diffusion) gradient with the help of metabolic energy, usually provided by ATP (adenosine triphosphate). Active transport serves to maintain the normal balance of ions in cells, in particular ions of sodium and potassium, which play a vital role in nerve and muscle cells. Because a molecule is "pumped" across the membrane against its gradient with the help of metabolic energy, it is referred to as "active" transport.

The sodium–potassium "pump" that exchanges sodium (Na+) for potassium (K+) across the plasma membrane of animal cells is an example of the active transport mechanism.

It is the carriage of a solute across a biological membrane from low to high concentration that requires the expenditure of metabolic energy.

**adaptive radiation** The process where a population of plants or animals evolves into a number of different ones over time, usually as a response to multiplying and living under different environmental conditions. Subpopulations from the common ancestor develop as a response to adapting to the new environmental conditions, and new species evolve from this original parent stock.

Impressive rapid adaptive radiations have occurred over time after mass extinctions caused by cataclysmic episodes on the Earth. Plate tectonics, volcanism, and possible Earth-comet-asteroid collisions all have wiped the landscape clean, allowing survivors and new species to rapidly fill the voids of these new adaptive zones.

**address-message concept** Refers to compounds in which part of the molecule is required for binding (address) and part for the biological action (message).

**adenosine 5'-triphosphate (ATP)** Key NUCLEOTIDE in energy-dependent cellular reactions, in combination with Mg(II). The reaction: ATP + water → ADP + phosphate is used to supply the necessary energy.

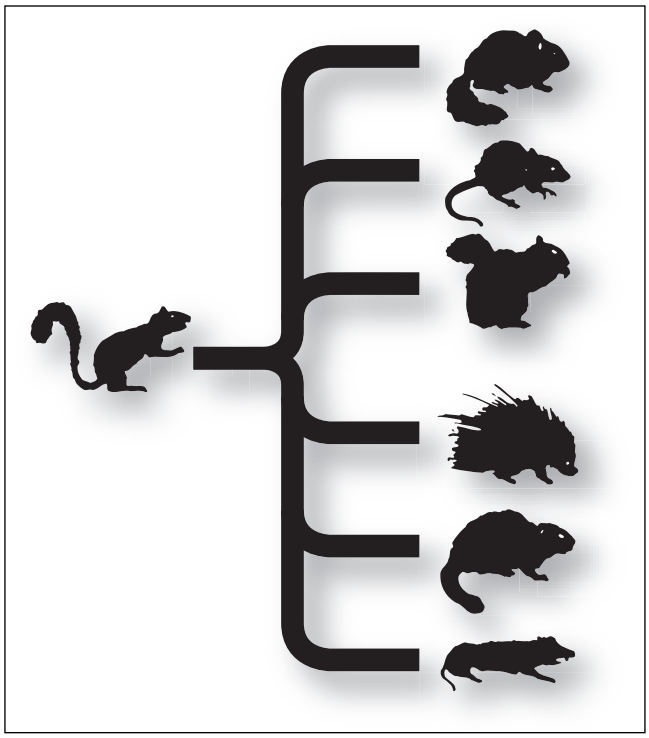
*See also* ATP.

**adenylyl cyclase** An enzyme, embedded in the plasma membrane, that converts ATP to cyclic adenosine monophosphate (cyclic AMP, or cAMP) in response to a chemical signal. It is activated when a signal molecule binds to a membrane receptor. Cyclic AMP acts as a second messenger, relaying the signal from the membrane to the metabolic machinery of the cytoplasm.

**adrenal glands** A pair of small triangular endocrine glands (one above each kidney in animals) that are ductless and secrete hormones into the blood. The glands are composed of two portions. The adrenal cortex, which forms an outer shell on each and is controlled by the pituitary gland, responds to endocrine signals in reacting to stress and homeostatic conditions by (a) secreting steroid hormones (corticosteroid, cortisol, and aldosterone) that deal with carbohydrate metabolism and with salt and water balance (electrolyte metabolism), such as the reabsorption of water by the kidneys, and (b) releasing androgens (male sex hormone) and estrogens (female sex hormone).

The adrenal cortex surrounds the central medulla, is controlled by the nervous system, and responds to nervous inputs resulting from stress and produces adrenaline and noradrenaline, hormones that increase blood sugar level and reduce body fat. The adrenal glands are also known as the suprarenal glands.

*See also* GLAND.



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**adrenodoxin** A [2FE-2S] FERREDOXIN involved in electron transfer from $NADPH^+$ (the reduced form of NADP [nicotinamide adenine dinucleotide phosphate, a coenzyme]), via a REDUCTASE, to CYTOCHROME P-450 in the adrenal gland.

**Adrian, Edgar Douglas** (1889–1977) British *Physiologist* Edgar Douglas Adrian was born on November 30, 1889, in London to Alfred Douglas Adrian, a legal adviser to the British Local Government Board. He attended the Westminster School, London, and in 1908 enrolled at Trinity College, Cambridge. At Cambridge University, he studied physiology, receiving a bachelor's degree in 1911.

In 1913 he entered Trinity College, studied medicine, did his clinical work at St. Bartholomew's Hospital, London, and received his M.D. in 1915.

In 1929 he was elected Foulerton professor of the Royal Society and in 1937 became professor of physiology at the University of Cambridge until 1951, when he was elected master of Trinity College, Cambridge. He was chancellor of the university from 1968 until two years before his death.

He spent most of his research studying the physiology of the human nervous system, particularly the brain, and how neurons send messages. In 1932 he shared the Nobel Prize in physiology or medicine for his work on the function of the neuron. He is considered one of the founders of modern neurophysiology.

He wrote three books, *The Basis of Sensation* (1927), *The Mechanism of Nervous Action* (1932), and *The Physical Basis of Perception* (1947), and was knighted baron of Cambridge in 1955. He died on August 4, 1977, and is buried at Trinity College.

**aerobic** Any organism, environmental condition, or cellular process that requires atmospheric oxygen. Aerobic microorganisms, called aerobes, require the presence of oxygen for growth. An aerobe is capable of using oxygen as a terminal electron acceptor and can tolerate oxygen levels higher than that present in the air (21 percent oxygen). They have a respiratory type of metabolism, and some aerobes are also capable of growing anaerobically with electron accepters other than oxygen.

*See also* ANAEROBIC.

**affinity** The tendency of a molecule to associate with another. The affinity of a DRUG is its ability to bind to its biological target (RECEPTOR, ENZYME, transport system, etc.). For pharmacological receptors, it can be thought of as the frequency with which the drug, when brought into the proximity of a receptor by diffusion, will reside at a position of minimum free energy within the force field of that receptor.

For an AGONIST (or for an ANTAGONIST), the numerical representation of affinity is the reciprocal of the equilibrium dissociation constant of the ligand–receptor complex, denoted $K_A$, calculated as the rate constant for offset ($k_{-1}$) divided by the rate constant for onset ($k_1$).

**age structure** The relative number of individuals of each age in a population, or the composition of a country by age groups. Since generations coexist over a time period, an age structure develops and is important in foreseeing the growth rate of an entire population. Except for the "baby boom" generation of the late 1940s–50s, the United States has a pretty even age distribution.

**Agnatha** A superclass family of jawless vertebrate fish that probably originated during the late Precambrian or early Cambrian. This superclass is the source of the oldest vertebrate fossils, dating some 465 million years ago during the Paleozoic era. Early agnathans, such as the now extinct ostracoderms, were encased in bony plates. While most were small, no larger than 20 in., they lacked paired fins and had circular mouths or slits with no jaws, although there were exceptions that had paired fins. Agnathans were most likely bottom-dwelling mud suckers or suspension feeders, taking in food through the mouth and then trapped in the gill, which also functioned as the area for gas exchange.

Only about 60 species comprising two classes of agnathans exist today, while the rest declined and disappeared during the Devonian period. Two classes, the Myxini (hagfishes) and Cephalaspidormorphi (lampreys), are all that remain.

Both hagfishes and lampreys lack paired appendages and lack body armor. Hagfishes are scavengers, living only in salt water and feeding on dead fish or marine worms, and lack a larval stage. Lampreys use their round mouth and a rasping tongue to latch on the side of a fish, penetrate the skin, and ingest its blood. As larvae, they live in freshwater streams, are suspension feeders, and migrate to the sea and lakes when they become adults. Some species only feed while in the larval stage, reproduce, and die. The agnathans are considered the most primitive living vertebrates known today.

**agonist** An endogenous substance or a DRUG that can interact with a RECEPTOR and initiate a physiological or a pharmacological response characteristic of that RECEPTOR (contraction, relaxation, secretion, ENZYME activation, etc.).

**agonistic behavior** This behavior usually involves two animals in a competitive contest, which can be in the form of combat, threat, or ritual, for food, a sexual partner, or other need. The end result is one becoming a victor while the other surrenders or becomes submissive, both exhibiting different traits. When one surrenders, it stops the combat because the continued battle could end up injuring both. Likewise, any future combat between the two individuals will likely end with the same result as the first and will not last as long.

Many animal social groups are maintained by agonistic behavior where one individual becomes dominant, others become subdominant, and so on down the line, each controlling the others in a dominance hierarchy or "pecking order." This dominant behavior can be used to control access to food or mates. Chickens, gorillas, and wolves are good examples of social groups maintained by dominance.

Agonistic behavior is used to defend territories, areas that a dominant individual will defend for feeding, mating, rearing, or any combination of these activities.

**AIDS (acquired immunodeficiency syndrome)** AIDS is the name given to the late stages of HIV infection, first discovered in 1981 in Los Angeles, California. By 1983 the retrovirus responsible for it, the human immunodeficiency virus (HIV), was first described, and since then millions around the world have died from contracting the disease. It is thought to have originated in central Africa from monkeys or to have developed from contaminated vaccines used in the world's first mass immunization for polio.

AIDS is acquired mostly by sexual contact either through homo- or heterosexual practice by having unprotected sex via vaginal or anal intercourse. The routes of infection include infected blood, semen, and vaginal fluid. The virus can also be transmitted by blood by-products, through maternofetal infection (where the virus is transmitted by an infected mother to the unborn child in the uterus), or by maternal blood during parturition, or by breast milk consumption upon birth. Intravenous drug abuse also is a cause.

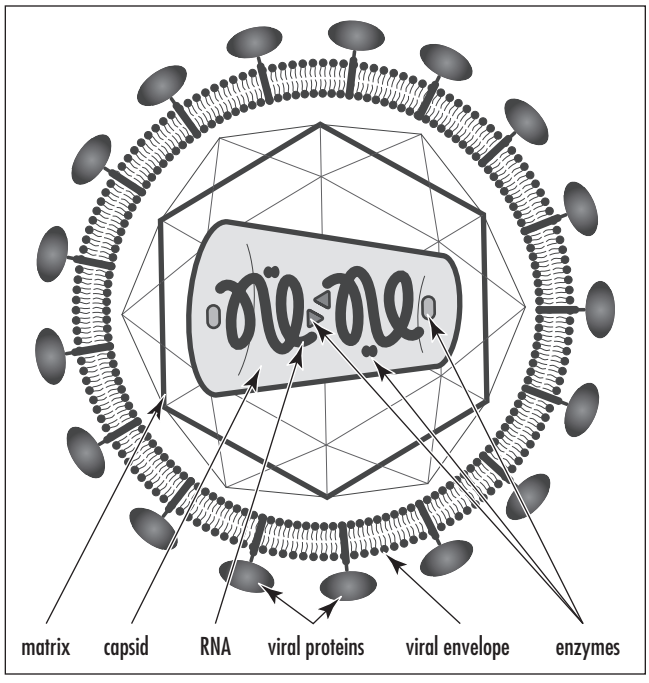
The virus destroys a subgroup of lymphocytes, essential for combating infections, known as the helper T cells, or CD4 lymphocytes, and suppresses the body's immune system, leaving it prone to infection.

Infection by the virus produces antibodies, but not all those exposed develop chronic infection. For those that do, AIDS or AIDS-related complex (ARC) bring on a variety of ailments involving the lymph nodes, intermittent fever, loss of weight, diarrheas, fatigue, pneumonia, and tumors. A person infected, known as HIV-positive, can remain disease-free for up to 10 years, as the virus can remain dormant before full-blown AIDS develops.

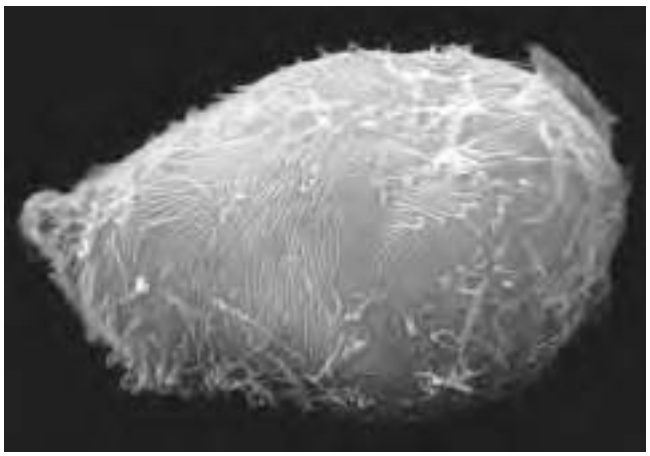
While HIV has been isolated from bodily fluids such as semen to breast milk, the virus does not survive outside the body, and it is considered highly unlikely that ordinary social contact can spread the disease. However, the medical profession has developed high standards to deal with handling blood, blood products, and body fluids from HIV-infected people.

In the early discovery stage of the disease, AIDS was almost certainly fatal, but the development of antiviral drugs, such as zidovudine (AZT), didanosine (ddl), zalcitabine (ddc), lamivudine (3TC), stavudine (DAT), and protease inhibitors used in combination with the others, has showed promise in slowing or eradicating the disease. Initial problems with finding a cure have to do with the fact that glycoproteins encasing the virus display a great deal of variability in their amino acid sequences, making it difficult to prepare a specific AIDS vaccine.

During the 1980s and 1990s, an AIDS epidemic brought considerable media coverage to the disease, especially as well-known celebrities such as actors Rock Hudson and Anthony Perkins, Liberace, and others died from it. Hudson was the first to admit having the disease in 1985. During the 1980s and 1990s, the homosexual community became active in lobbying for funds to study the disease, as it early on was considered simply a "gay" disease. ACT UP, acronym for the AIDS Coalition to Unleash Power, began as a grassroots AIDS organization associated with nonviolent civil disobedience in 1987. ACT UP became the standard-bearer for protest against governmental and




**AIDS was first reported in 1981 in the United States and has since become a major epidemic, killing nearly 12 million people and infecting more than 30 million others worldwide. The disease is caused by HIV, a virus that destroys the body's ability to fight infections and certain cancers.** ***(Courtesy of Darryl Leja, NHGRI, National Institutes of Health)***



**HIV-infected white blood cell. Scanning electron micrograph (SEM) of the abnormal surface of a white blood cell infected with HIV virus that causes AIDS. Glycosaminoglycan (GAG) gene expression for cell surface proteins is abnormal. The HIV virus's genetic material controls the cell, forcing it to express abnormal structural proteins. Normally these surface GAG proteins are tiny spheres, but here the cell's outer surface is formed from large irregular rods. HIV causes AIDS (acquired immunodeficiency syndrome). AIDS destroys white blood cells, leading to a weakened immune system. Magnification: × 6600 at 4.5 × 5.5 inch size.** ***(Courtesy © NIBSC/Photo Researchers, Inc.)***

societal indifference to the AIDS epidemic. Public attitude changed when heterosexuals became infected, and greater education on the causes of the disease became more widespread, initiated by celebrities such as Elizabeth Taylor and the American Foundation for AIDS Research, where fundraising activities made national news coverage.

There have been significant advances in the treatment for HIV/AIDS by attacking the virus itself, strengthening the immune system, and controlling AIDS-related cancers and opportunistic infections. At present, there is still no cure or vaccine.

**albumin** A type of protein, especially a protein of blood PLASMA, that transports various substances, including metal ions, drugs, and XENOBIOTICs.

**aldehydes** Aldehydes are organic chemicals that contain the –CHO (aldehyde) group, a carbonyl group (C=O) that has the carbon and hydrogen atom bound. They are the result of the oxidation of alcohols and, when further oxidized, form carboxylic acids. Methanal (formaldehyde) and ethanal (acetaldehyde) are common examples.

**aldosterone** An adrenal steroid hormone, derived from cholesterol, that is secreted by the adrenal cortex and acts on the distal tubules of the kidney to control the elimination of salts and water by the kidneys. The presence of the pituitary hormone ACTH, changing levels of sodium and potassium, and variations in blood volume stimulate the production of aldosterone by the cortex.

Aldosterone is a component of the rennin-angiotensin-aldosterone system (RAAS) that is a complex feedback system that functions in homeostasis.

*See also* GLAND.

**algae (singular, alga)** A large and diverse group of photosynthetic organisms formerly called simple plants but now members of their own phyla, the Protoctista, that also includes the slime molds and protozoa. Algae, some 17,000 species or more, live in aquatic and moist inland regions. They do not have roots, stems, or leaves and have no vascular water-conducting systems. They reproduce by spores, and in some species the spores are mobile with the use of flagella. They range from simple single cells (e.g., *Euglena*) to "plants" many feet long (e.g., kelps such as *Macrocytis*) and make up marine seaweed and much of the plankton that provide food for other species.

Unusual growth outbursts result in "algal blooms" or "red tides" and occur when there is an increase in nutrient levels in a body of water.

Cyanophyta, or blue-green algae, are now classified as cyanobacteria. The phylum Cyanophyta also includes chloroxybacteria. Cyanophytes contain phycocyanin, a photosynthetic pigment giving them a blue color. The red pigment phycoerythrin is also almost always present. They are diverse and can live as single cells or as colonies or large filaments. Some are nitrogen fixers in soil and others, like lichens, display symbiosis with a fungus, usually with a member of Ascomycota. The fungus provides the host plant for the algae cells that are distributed throughout and provide food to the fungus while the fungus protects the algae

cells. While many lichen have a different fungi component, they often have the same algae species. Some common species of lichens are British soldiers (*Cladonia cristatella*), pixie cups (*Cladonia grayi*), cedar lichen (*Vulpicidia viridis*), wrinkled shield lichen (*Flavoparmelia caperata*), and reindeer lichen (*Cladina subtenuis*).

The chloroxybacteria, or green-grass bacteria, contain both chlorophylls a and b but do not contain the red or blue pigments of the blue-green algae. They are nonmotile, aerobic organisms.

Other phyla of algae include the Bacillariophyceae, comprising the diatoms; Charophyceae, fresh- or brackish- water algae that resemble bryophytes; Chlorophyceae, or green algae believed to be the progenitor of plants; Chrysophyceae, or yellow-green algae; Dinophyceae, unicellular algae with two flagella; Phaeophyceae, or brown algae; and Rhodophyceae, or red algae.

The Bacillariophyceae or diatoms are unicellular algae that are found in single, colonial, or filamentous states. Under the microscope they often are beautifully symmetrical, as their cell walls, or frustules, are composed of silica and are bivalved, one of which overlaps the other, and the frustule is often punctated and ornamented. The two orders, Centrales and Pennales, occupy two different environments. The centric diatoms (Centrales) are circular in shape with radial symmetry and live mostly in marine environments. The pennate diatoms (Pennales) are elliptical in shape, have bilateral symmetry, and are found in freshwater environments.

Deposits of fossil diatoms known as diatomaceous earth have been mined and used for years in paints, abrasives, and other products such as chalk. The famous White Cliffs of Dover in England (rising to 300 feet) are composed of massive amounts of diatoms—coccoliths—that were laid down some 790 million years ago when Great Britain was submerged by a shallow sea.

The Charophyceae, also known as stoneworts, and which resemble bryophytes, live in fresh and brackish water especially rich in calcium, where they become stiff and lime encrusted. The stoneworts consist of a complex branched thallus with an erect stemlike structure and many whorls of short branches.

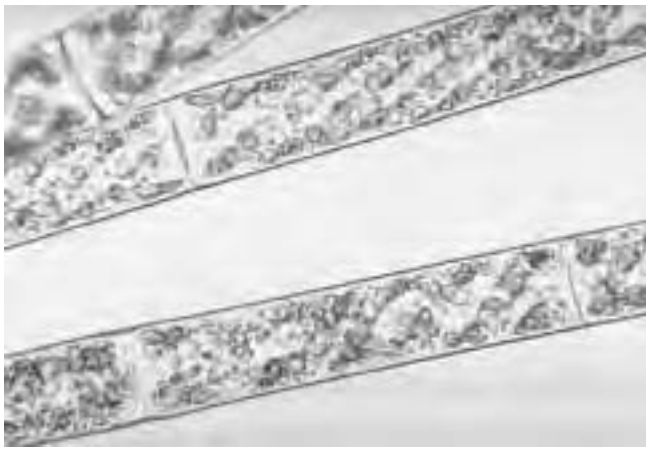
The Chlorophyceae (or green algae) are the closest to plants in pigment composition and structure and are related based on a common ancestor. More than 7,000 species live in freshwater and marine environments as unicellular parts of plankton, in damp soil and even snow as colonies or filaments, symbiotically with other eukaryotes, or mutually with fungi as lichens.

The Chrysophyceae or golden algae, named because of their yellow and brown carotene and xanthophyll pigments, are typically cells with two flagella at one end of the cell, and many live among freshwater and marine plankton. While most are unicellular, a few are colonial.

The Dinophyceae or dinoflagellates are algae that are unicellular with two flagella of unequal length contained in channels on the cell surface. They can change shape with different water temperatures and are very tolerant of chemical and physical conditions.

The Phaeophyceae or brown algae are the largest and most complex of the algae. All members are multicellular, and the majority live in marine environments, especially common in cool water along temperate coastlines. Many of the marine seaweeds are brown algae.

The Rhodophyceae or red algae are more recent and have lost their flagellate stages in their life cycle. Some species are actually black and not red, as those that live deeper in waters, because of different levels of the pigment phycoerythrin. While most are found in warm coastal waters of the tropical oceans, some also live in freshwater and on land in the soil. Most rhodophytes are multicellular, sharing seaweed status with brown algae.



***Spirogyra*** **is a filamentous algae that can be found in almost every pond or ditch.** ***(Courtesy of Hideki Horikami)***

Because the various forms of algae are now assigned to different phyla, the words *alga* and *algae* are used informally and have no taxonomic status.

**allantois** During the embryonic stage of mammals, birds, and reptiles, the allantois, a small sac, is one of four extra-embryonic membranes (along with amnion, yolk sac, chorion) and serves several functions, such as a repository for the embryo's nitrogenous waste (chiefly uric acid) in reptiles and birds (in the egg). The allantois provides oxygen to mammals, birds, and reptiles, as well as food in mammals (via the placenta).

The membrane of the allantois works with the chorion in respiratory functions, allowing the exchange of gases between the embryo and surrounding air. In humans, it is involved in the development of the urinary bladder.

*See also* EMBRYO.

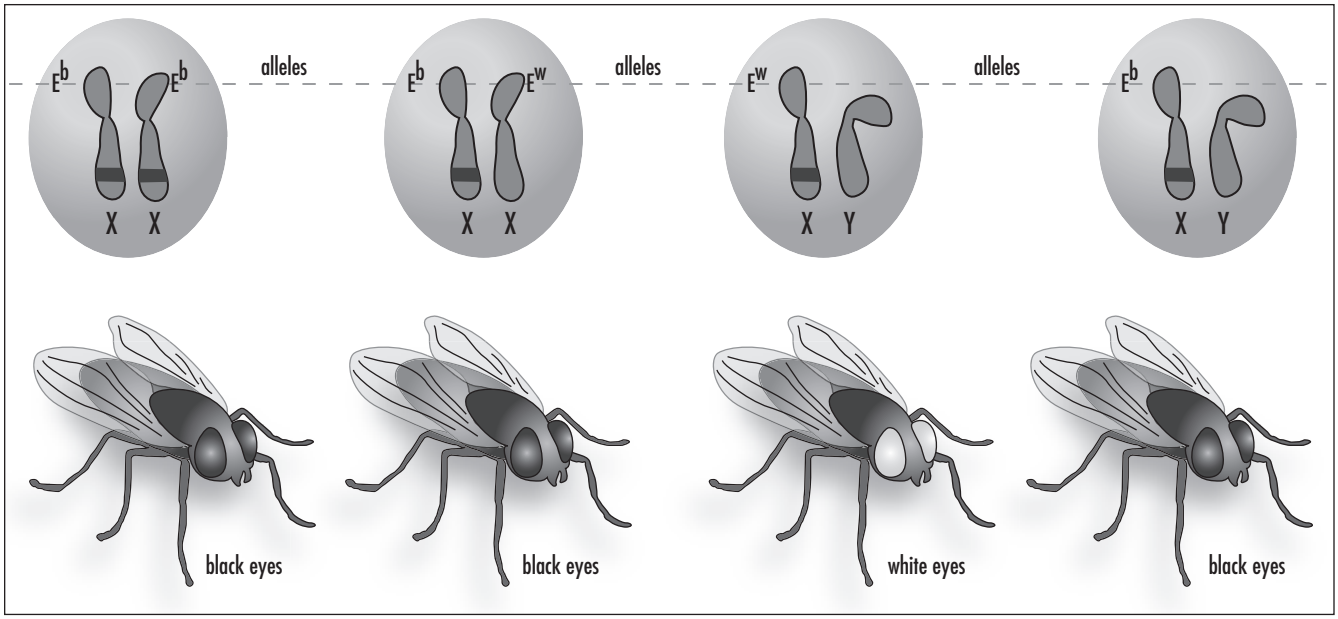
**allele** An allele is one of two or more alternative forms of a gene that can exist at a single locus. Each allele therefore has a unique nucleotide sequence and may lead to different phenotypes for a given trait. If the alleles for a gene are identical, the organism is called homozygous. If the alleles are different, the organism is heterozygous.

If two alleles are different, one becomes dominant and is fully expressed in appearance in the organism, while the other is recessive and has no noticeable effect on the appearance of the organism.

This is shown in the color of your eyes, determined by the genes inherited from your parents. The gene for brown eyes is dominant and overrides genes for other eye colors. The gene for blue eyes is recessive and will appear when there are no genes for other eye colors. A person with brown eyes may have a recessive, or "hidden," gene for blue eyes. Therefore, two brown-eyed parents may each give a recessive gene for blue eyes to their child, who would then have blue eyes. Gray, green, and other eye colors result from a complex mixing of different eye color genes.

*See also* GENE.

**Allen's Rule** In warm-blooded animals, the warmer the climate, the longer the appendages (ears, legs, wings) as compared with closely related taxa from colder areas.




**An allele is one of the variant forms of a gene at a particular locus, or location, on a chromosome. Different alleles produce variation in inherited characteristics such as hair color or blood type. In an individual, one form of the allele (the dominant one) may be expressed more than another form (the recessive one).** ***(Courtesy of Darryl Leja, NHGRI, National Institutes of Health)***

**allochronic speciation** Speciation that takes place related to time rather than space; populations that are reproductively isolated due to mating at different times.

*See also* SPECIATION.

**allometric growth** The variation in the relative rates of growth of various parts of the body, which helps shape the organism. In other words, it is the pattern of growth whereby different parts of the body grow at different rates with respect to each other. Allometry is the study of relative growth and of changes in proportion with increase in size. For example, human arms and legs grow at a faster rate than the body and head, making adult proportions strikingly different from those of infants. Another striking example is the male fiddler crab *Uca pugnax*. In small males, the two claws are of equal weight, each weighing about 8 percent of the total crab weight. However, as the crab enlarges, its large crushing claw grows more rapidly, eventually constituting about 38 percent of the crab's weight.

In 1932, Sir Julian Huxley described a simple mathematical method for the detection and measurement of the allometric growth. In order to compare the relative growth of two components (one of which may be the whole body), they are plotted logarithmically on *x*- and *y*-axes:

$$\log y = \log b + k \log x$$

The slope of the resulting regression is called the allometric growth ratio, often designated as *k*.

$k = 1$, both components are growing at the same rate.

$k < 1$, the component represented on the *y*-axis is growing more slowly than the component on the *x*-axis.

$k > 1$, the *y*-axis component is growing faster than the *x*-axis component.

Another formula for measuring allometric growth is $Y=bx^a$, where *Y* is equal to the mass of the organ, *x* = mass of the organism, *a* = growth coefficient of the organ, and *b* = a constant.

Yet another formula for measuring allometric growth is $Y = bx^{a/c}$, where *a* and *c* are the growth rates for two body parts.

Allometric growth studies have also been applied to animal husbandry, archaeology, and urban systems studies.

**allometry** The study of relative growth and of changes in proportion with increase in size.

**allopatric speciation** One of two methods of speciation (the other is sympatric), allopatric speciation happens when the ancestral population becomes segregated by a geographical barrier. The Karner blue butterfly (*Lycaeides melissa samualis*) became allopatric from its parent the Melissa blue butterfly (*Lycaeides melissa melissa*) when the climate changed and restricted various populations along its range to northeastern pine barrens environments several thousand years ago. As populations become isolated, the isolated gene pools accumulate different genetic traits by microevolution. Small populations are more likely to evolve into separate species than larger isolated populations. Several populations of the Karner blue butterfly are now separated from each other by human-made development and may be evolving into separate subspecies or species, even though geographically they are isolated by only a few miles in some cases.

Conditions that favor allopatric speciation are when one population becomes isolated at the fringe of the parent population's range. This splinter population, called a peripheral isolate, is likely to become allopatric because the gene pool of the isolate may already be different, since living on the border of the range encourages the expression of the extremes of any genotypic CLINEs that existed in the original population. Furthermore, if the population is small enough, a FOUNDER EFFECT will occur, giving rise to a gene pool that is not that of the parent population.

Genetic drift will also occur until the peripheral isolate becomes a larger population and will continue to change the gene pool at random until the population grows. New mutations or combinations of existing alleles that are neutral in adaptive value now may become fixed in the population by chance, causing genotypic or phenotypic divergence from the parent population. For example, the Karner blue butterfly has a row of orange spots on the top of the hindwing, whereas, the ancestral parent, the Melissa blue butterfly, has orange spots on the top of both front and hindwing, a phenotypic variation.

Another factor in causing allopatric speciation is that evolution via natural selection may take a different road in the peripheral population. The isolate will