



# Glossary

## A

**ABERRANT:** Deviation from some specified standard. In optics, the failure of a lens or mirror to focus an image perfectly at its intended focal point. In astronomy, the apparent displacement of an observed object due to the relative motion of the object and the telescope.

**ABIOTIC:** The portion of an ecosystem that is not living, such as water or soil.

**ABSOLUTE MAGNITUDE:** The apparent brightness of a star, measured in units of magnitudes, at a fixed distance of 10 parsecs.

**ABSORPTION SPECTRUM:** The spectrum formed when light passes through a cool gas.

**ACADEMY:** The world of university researchers, teachers, and students is often referred to as the academy. Specific academies, such as the U.S. National Academy of Sciences, are groups of experts asked to serve as a scientific advisory body, usually to a government.

**ACCRATIELEON:** A change in the velocity (either magnitude or direction) of an object.

**ACCRETION DISK:** When gas and dust are attracted to a heavy, spinning object such as a neutron star or black hole, they form a disk that rotates at right angles to the spin axis of the heavy object. Material from the innermost edge of the accretion disk continually falls into the heavy object.

**ACETYLCHOLINE:** One of many neurotransmitters employed by the human body and used throughout the nervous system. A neurotransmitter is a chemi-

cal released by nerve cells into a synapse—the narrow, fluid-filled space separating it from another nerve cell—in order to stimulate chemical activity in that other cell.

**ACHROMATIC LENS:** Achromatic lenses are built by forming lenses out of sandwiched parts that are made of different types of glass. The optical properties of each part of the lens compensate for or balance the properties of the others, reducing aberrations caused by other types of lenses. For example, simple glass lenses have the unwanted property of acting as prisms, that is, dividing white light up into rainbow-like spectra: This effect is termed chromatic aberration. Uncorrected lenses also suffer from spherical aberration, which is the focusing of different colors at different distances from the lens rather than at a single image plane.

**ACQUIRED CHARACTERISTICS:** Characteristics that are acquired by a plant or animal by interacting with its environment. These may include scars, lost limbs, calluses, strengthened or weakened muscles, and so forth. Although some acquired characteristics (e.g., low body weight due to malnutrition) can be inherited briefly and in part, it is now known that inheritance of acquired characteristics is not a significant factor in biological evolution.

**ACUPUNCTURE:** The Chinese practice of treating disease or pain by inserting very thin needles into specific sites in the body.

**ADAPTIVE RADIATION:** In evolutionary biology, adaptive radiation occurs when a species colonizes a new environment and rapidly evolves a wide range of new forms to adapt to niches or opportunities in that environment. Here “radiation” refers to the radiating

or fanning-out of the species into ecological opportunities, not to nuclear radiation. A classic example of adaptive radiation is the history of cichlid fishes in the Great Rift Lakes of Africa. In Lake Victoria, for example, over 500 species of cichlid fish have evolved from a single ancestral species in the last 12,000 years or less.

**ADDISON'S DISEASE:** A disorder resulting from insufficient secretion of hormones from the adrenal cortex, named after the doctor who first characterized it, Englishman Thomas Addison (1793–1860). Its symptoms include weakness and bronze discoloration of the skin.

**ADJUVANT THERAPY:** Cancer treatments (radiation, chemotherapy) that are given after surgery in order to prevent recurrence of a tumor.

**ADRENAL GLANDS:** A pair of endocrine glands that sits atop the kidneys and releases hormones directly into the bloodstream. The adrenals are flattened, somewhat triangular bodies that, like other endocrine glands, receive a rich blood supply. The phrenic (from the diaphragm) and renal (from the kidney) arteries send many small branches to the adrenals, while a single large adrenal vein drains blood from the gland.

**ADULT STEM CELL:** A renewable and unspecialized cell found among specialized cells in a tissue or organ.

**ALBEDO EFFECT:** Albedo is the ability of a planet, moon, or other body in space to reflect light. Brighter objects have higher albedo, darker objects lower albedo. In climate science, the albedo effect is the influence of Earth's albedo on climate. Bright features such as ice caps tend to reflect solar energy into space, cooling the climate. Melting ice lowers Earth's albedo, making it a more efficient absorber of solar energy and tending to warm its climate.

**ALCHEMY:** The study of the reactions of chemicals in pre-modern times. It was often, but not always, directed by the goal of making gold. In a general sense, alchemy is perceived as the transmutation (transformation) of a common substance to something rare and valuable. Medieval alchemists are often portrayed as little more than quacks attempting to make gold from lead. This depiction is not entirely correct. To be sure, there were such characters, but for real alchemists, called adepts, the field was an almost divine mixture of science, mystery, and philosophy.

**ALCOHOL:** Any of the large number of molecules containing a hydroxyl ( $-OH$ ) group bonded to a car-

bon atom to which only other carbon atoms or hydrogen atoms are bonded.

**ALGORITHM:** A mathematical relation between an observed quantity and a variable used in a step-by-step mathematical process to calculate a quantity.

**ALLELE:** Any of two or more alternative forms of a gene that occupy the same location on a chromosome.

**ALLOGRAFT:** Transplanted tissues or organs from donors of the same species.

**ALLOTRANSPLANTATION:** The transplantation of an organ to an individual from an animal of the same species, e.g., human to human. This is the most common form of transplantation. Xenotransplantation, on the other hand, is the transplantation of an organ from an animal of another species, e.g., a pig's heart valve into a human.

**ALPHA PARTICLE:** A positively charged nuclear particle that consists of two protons and two electrons; it is ejected at a high speed from disintegrating radioactive materials.

**AMINO ACID:** One of about two dozen relatively simple chemical compounds from which proteins are made, amino acids are the building blocks of proteins and serve many other functions in living organisms. They are nitrogen-containing organic compounds that consist of at least one acidic carboxyl group ( $COOH$ ) and one amino group ( $NH_2$ ). In alpha amino acids that are contained in the proteins found in cells, these two groups are both attached to a carbon atom, which also carries a hydrogen atom, plus a side chain known as the R group. The R group varies from one amino acid to another and gives each amino acid its distinctive properties. The prime function of DNA (deoxyribonucleic acid) is to carry the information needed to direct the proper sequential insertion of amino acids into protein chains during protein synthesis (translation). Although relatively simple compounds, amino acids can vary widely; to date, more than 80 different amino acids have been found in living organisms. Of these 80 amino acids, 22 are considered the precursors of animal proteins.

**AMORPHOUS:** A substance that lacks any well-defined structure. In earth science, substances made of randomly-organized atoms, such as glass. Crystals, whose atoms are organized in a definite pattern, are not amorphous; therefore, amorphous substances are sometimes said to be acrySTALLINE (i.e., not-crystalline).

**AMPLIFICATION:** Increasing the strength of some signal such as the amount of electrical current passing through a transistor.

**AMPUTATION:** The surgical or accidental removal of a limb (arm or leg) or a distinct part of a limb (finger, toe, hand, foot, etc).

**ANABOLISM:** The process by which energy is used to build up complex molecules.

**ANADROMOUS:** Fish that migrate up streams and rivers to mate and produce offspring are said to be anadromous (from the Greek for “up-running”); all other fish are catadromous.

**ANAEROBIC:** Living or growing in an atmosphere lacking oxygen.

**ANALOG:** A process that is fluctuating or continually changing. In electronics, an analog signal is a base alternating current frequency that is modified, usually by amplification or varying of the frequency, in order to add information to the signal. Conventional forms of television and telephone transmissions use analog technology.

**ANALOGOUS STRUCTURE:** In evolutionary biology, an analogous structure is a part of a creature’s anatomy that resembles a part of some other creature’s anatomy, even though the two creatures are not related by evolutionary descent. The two structures evolved independently to perform the same function; for example, the eye of the squid and the human eye are analogous structures, as are birds’ wings and bats’ wings. Structures that resemble each other because of descent from a shared ancestor are homologous, not analogous.

**ANALYSIS:** In chemistry, the process of separating out the constituents of a complex chemical substance.

**ANAPHYLAXIS:** Any severe allergic reaction to a substance to which the body has been previously exposed. In the most severe form, the patient experiences anaphylactic shock, which may cause death through stopped breathing. Insect stings and penicillin are two common triggers for anaphylactic shock.

**ANASTOMOSE:** To make a connection between tubes in the body (blood vessels, digestive organs, or the like) that joins the mid-part of one tube to another, as opposed to connecting them end-to-end. Anastomosis may occur surgically or in the natural growth of a network of vessels. For example, the capillary beds that deliver blood to most of the body’s tissues form an extensively anastomosed network.

**ANEURYSM:** A bulging or ballooning of part of a blood vessel. Aneurysms can burst, causing internal

bleeding and severe damage, depending on the location or size of the break: a cerebral aneurysm can destroy part of the brain or cause death, while an aortic aneurysm is usually immediately fatal.

**ANGULAR SIZE:** The size of an object in the sky, measured in degrees.

**ANIMALCULE:** The term “animalcules,” from Latin, means “tiny animals.” The inventor of the microscope, Dutch scientist Anton van Leeuwenhoek (1632–1723), was the first person to observe microscopic animals and used this term to describe them. The word had previously been applied occasionally to any small animals, such as mice or insects.

**ANTHROPOCENTRISM:** The tendency to view human beings and their needs, values, and desires as all-important or central to the cosmos (from the Greek for “human-centered”). For example, the belief that Earth rotates on its axis so that humans can have a daily rest period would be anthropocentric.

**ANTHROPOGENIC:** Made by people or resulting from human activities. Usually used in the context of emissions that are produced as a result of human activities.

**ANTIBIOTIC:** Natural or synthetic compounds that kill or reduce populations of bacteria. There are a myriad of different antibiotics that act on different structural or biochemical components of bacteria. Antibiotics have no direct effect on viruses. Also, a specific drug, such as penicillin, that is used to fight infections caused by bacteria.

**ANTIBODIES:** Large, Y-shaped proteins found in blood that lock on to specific substances foreign to the body (antigens). Typical antigens are molecules found on the surfaces of viruses and bacteria. Some antibodies, when bound to antigens, act as flags targeting the antigen for attack by white blood cells; others combine with other blood molecules to attack the antigen directly. If a person’s blood already contains antibodies for a particular antigen, the person’s immune system attacks that antigen as soon as it appears. This is the basis of acquired immunity to specific viruses and bacteria, whether natural or instilled by immunization.

**ANTIBODY:** An antibody, or Y-shaped immunoglobulin, is a protein molecule found in the blood that is created by the immune system in response to the presence of an antigen (a foreign substance or particle). It marks foreign microorganisms in the body for destruction by other immune cells. There are a myriad of different antigens that are presented

to the immune system. Hence, there are a myriad of antibodies that can be formed.

**ANTIGEN:** Any substance that the body considers foreign, such as a bacterial cell, that stimulates the body's immune system to produce antibodies. Antibodies, or Y-shaped immunoglobulins, are proteins that inactivate the antigen and help to remove it from the body. While antigens can be the source of infections from pathogenic (disease-causing) bacteria and viruses, organic molecules detrimental to the body from internal or environmental sources also act as antigens. Antigens are usually proteins or polysaccharides.

**ANTIOXIDANTS:** Antioxidants are substances, often found in foods and capable of being transferred to body cells, that interfere with oxidation reactions. These are reactions involving free radicals (free-floating charged molecules). Free radicals can damage cell chemistry by triggering unwanted chemical reactions; antioxidants reduce this damage.

**ANTIPARTICLE:** In particle physics, most fundamental particles having non-zero rest mass (e.g., neutron, proton, electron) have an antiparticle that is an almost perfect mirror-image of the particle. When a particle and its antiparticle meet, they annihilate each other, releasing all their energy in the form of photons. At the big bang, about 13.7 billion years ago, slightly more particles were produced than antiparticles. After all particle-antiparticle pairs annihilated each other, the remaining fraction of particles became all the ordinary matter seen in the universe today.

**ANTISEPTIC:** A substance that prevents or stops the growth and multiplication of pathogenic (disease-causing) microorganisms in or on living tissue. An antiseptic may kill a microorganism, but it does not necessarily have to. The treated microbes may only be weakened. The weaker, slower-growing microbes may then be more susceptible to the defense mechanisms of the host.

**ANTISERUM (PLURAL: ANTISERUMS OR ANTISERA):** A clear liquid blood fraction that contains certain antibodies against a specific agent, usually a bacterium or bacterial toxin, that is used to treat persons infected with that agent. Both antisera and antitoxins are means of proactively combating infections. The introduction of compounds to which the immune system responds is an attempt to build up protection against microorganisms or their toxins before the microbes actually invade the body. An antiserum is injected into the body to confer immunity against a pathogen (disease-causing organism) that is targeted by the antibody contained in the antiserum.

**ANTITOXIN:** An antidote to a toxin that neutralizes its poisonous effects. Both antisera and antitoxins are means of proactively combating infections. The introduction of compounds to which the immune system responds is an attempt to build up protection against microorganisms or their toxins before the microbes actually invade the body.

**AORTA:** The main artery of the body that arises from the left ventricle of the heart and runs down the body in front of the spine, supplying blood through branch arteries throughout the body.

**APERIODICITY:** A pattern or process that is not periodic; that is, it does not repeat itself after a fixed time interval or distance. Aperiodic geometric patterns or tilings were proposed in the 1960s and have since been found to be of importance in crystallography and the physics of solids.

**APPARENT (OR RELATIVE) MAGNITUDE:** The apparent brightness of a star as seen from Earth.

**APPLIED GEOGRAPHY:** Geographic knowledge applied to human activities such as settlement planning, agriculture, environmental protection, resource extraction, disaster relief, or military operations.

**APPLIED MATHEMATICS:** All mathematical knowledge used in physical science, economics, social science, and technology. Applied mathematics is often contrasted to pure mathematics, which is pursued without regard to any specific real-world use.

**APPLIED SCIENTIFIC FIELD:** An area of scientific knowledge that is used for some practical purpose—amusement, war, medicine, transport, communication, or other. Physics, chemistry, mathematics, biology, and other fields all have applied areas. Labeling some knowledge “applied” does not imply that knowledge that is not applied directly is useless: first, it satisfies the human desire to know, and second, the applied knowledge in each field would not exist or make sense without all the knowledge of the field, including that which is not directly applied.

**APPRENTICE:** A person serving at low wages in order to learn a skill, trade, or craft from an established practitioner. Apprenticeship was widespread in the European economy during the late Middle Ages.

**ARCHAEOASTRONOMER:** A scientist who studies the astronomical practices of ancient peoples, especially as reflected in the monuments and religious structures built by those peoples. For example, an archaeoastronomer might analyze the Great Pyramids or the megaliths of Stonehenge to discern their

astronomical properties and the importance of those properties for their builders.

**ARCHAEOASTRONOMY:** The study of the astronomical practices of ancient peoples, especially as reflected in the monuments and religious structures built by those peoples.

**ARCHETYPE:** In the theories of Swiss psychologist Carl Jung (1875–1961), an image or event that is innately possessed by the minds of all human beings and that therefore recurs in stories and dreams as a basic, meaningful pattern across history and cultures. Examples of Jungian archetypes are birth and death, mother and father, the trickster and the wise woman, the bride and the hero.

**AROMATIC:** In organic chemistry, a compound whose molecular structure includes some variation of the benzene ring.

**ARPANET:** Early Department of Defense program, initiated by the Defense Advanced Research Projects Agency (DARPA), that led to the development of the Internet.

**ARTERY:** Any of the large elastic-walled blood vessels that carry blood away from the heart to other parts of the body.

**ARTHAŚĀTRA:** A prose work describing the principles of statecraft or political economy—how to run a country—that was written in India some time in the first few centuries AD. It is often compared to *The Prince* by Italian diplomat Niccolò Machiavelli (1469–1527), which also recommends ruthless measures for stabilizing centralized political power.

**ASTROLABE:** An instrument used throughout the Middle East and Europe from classical times through the Renaissance as an aid in observing star positions and calculating longitude and local time. It was used in astronomy, astrology, and navigation, and was a precursor of the slide rule. Astrolabes varied in design; typically, one consisted of a metal disk marked with lines conveying astronomical information and a center-mounted rotating pointer.

**ASTROLOGY:** The practice of studying the apparent motions of the planets, moon, sun, and stars in order to draw conclusions about human character (supposedly affected by sky patterns at the time of one's birth) or about the future of a person's affairs. Astrology has been practiced since at least about 3000 BC; European, Indian, and Chinese astrological systems have all been developed. Although astrology is still widely popular, it is not a form of science.

**ASTRONOMICAL UNIT (AU):** A unit of measurement equal to the average distance from Earth to the sun: 93 million miles (150 million km). Distances within the solar system are frequently expressed in AUs.

**ASTRONOMY:** The study of the physical and chemical properties of objects and matter outside Earth's atmosphere.

**ATOM:** The smallest particle in which an element can exist.

**ATOMIC CLOCK:** A device for keeping time based on natural oscillations within atoms.

**ATOMIC NUMBER:** The number of protons in the nucleus of an atom; the number that appears over the element symbol in the periodic table.

**ATOMIC WEIGHT:** A quantity indicating atomic mass that tells how much matter there is in something or how dense it is, rather than its weight. Atomic weight is expressed in units known as atomic mass units (amu).

**ATTENUATED:** A bacterium or virus that has been weakened, often used as the basis of a vaccine against the specific disease caused by the bacterium or virus.

**AUGURS:** Priests in ancient Rome who believed that they could discern the will of the gods by interpreting the flight patterns of birds.

**AURICLE:** Also known as pinna or external ear; the flap-like organ on either side of the head. Also, an atrium of a heart.

**AUSPICES:** In pre-Christian Roman religion, auspices were patterns of bird flight observed by priests called augurs and interpreted as revealing the will of the gods.

**AUTAPOMORPHY:** In evolutionary biology, an autapomorphy is a feature of a clade (a species or group of species evolved from a common ancestor) that is unique and original to that clade, that is, which was not inherited from earlier species. For example, hair is an autapomorphy of the clade of mammals; articulate speech is an autapomorphy of human beings.

**AUTOGRAFT:** A type of skin graft that uses tissue from another part of the patient's own body, and therefore has cells with the same genes, reducing the chances of complications associated with tissue rejection.

**AUTOIMMUNE DISEASE:** A disease in which the body's defense system attacks its own tissues and