

The Facts On File

# **DICTIONARY** **of** **BIOLOGY**

Revised and Expanded Edition

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Revised and Expanded Edition

Edited by  
**Elizabeth Tootill**



**Facts On File**

*New York • Oxford • Sydney*

**The Facts On File Dictionary of Biology**  
**Revised and Expanded Edition**

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## A

**abaxial** In lateral organs, such as a leaf, the lower surface, i.e. the side facing away from the main axis. Abaxial is synonymous with dorsal when the latter term is being applied to lateral organs. *Compare* adaxial.

**abdomen 1.** The section of the body cavity of vertebrates that contains the stomach, intestines, and other viscera.

**2.** The posterior section of the body in arthropods. Primitively it consists of a series of similar segments.

**abducens nerve** (cranial nerve VI) One of the pair of nerves that arises from the anterior end of the medulla oblongata in the vertebrate brain to supply the posterior rectus muscle of each eyeball. It contains chiefly motor nerve fibres. *See* cranial nerves.

**abiogenesis** The development of living from nonliving matter, as in the origin of life.

**abiotic environment** The nonliving factors of the environment that influence ecological systems. Abiotic factors include climate, chemical pollution, geographical features, etc.

**abomasum** The fourth and last region of the specialized stomach of ruminants (e.g. the cow). It is lined with normal mucosa containing gastric pits, producing hydrochloric acid, pepsin, and rennin, and is the true digestive stomach.

**abscisic acid** (ABA) A plant growth substance, first isolated from sycamore, that functions chiefly as a growth inhibitor. It was previously known as *abscisin II* or *dormin*.

**abscission** The organized loss of part of a plant, usually a leaf, fruit, or unfertilized flower. An *abscission zone* occurs at

the base of the organ. Here a separation layer (*abscission layer*) is formed by breakdown or separation of cells and final severance occurs when the vascular bundles are broken mechanically, e.g. by wind.

**absorption** The uptake of liquid by cells. Most digested food is absorbed in the small intestine, the inner surface of which is lined with finger-like projections (villi): the liquid products of digestion are absorbed through the villi into the blood and lymphatic systems. In plants, water and mineral salts are absorbed mainly by the root hairs, just behind the root tips.

**absorption spectrum** A plot of the absorbance by a substance of radiation at different wavelengths, usually of ultraviolet, visible, or infrared radiation. It can give information about the identity or quantity of a substance. Chlorophylls, for example, have absorption peaks in the red and blue (and therefore reflect green light).

**abyssal** Inhabiting the portion of the ocean deeper than 2000 m and shallower than 6000 m. The abyssal realm is the largest environment on earth. Abyssal fauna tend to be black or grey, unstreamlined, and delicately structured.

**accessory cell** (subsidiary cell) One of a number of specialized epidermal cells of a plant that are found adjacent to the guard cells, and may help in opening and closing the stomata.

**accessory nerve** (cranial nerve XI) One of the pair of nerves that arises from the posterior region of the medulla oblongata in the brain of higher vertebrates. It carries motor nerve fibres and merges with the adjacent vagus nerve close to its root. In fishes and amphibians it is considered an integral part of the vagus. *See* cranial nerves.

## accommodation

**accommodation 1.** The reflex process in the eye by which an image is focused on the retina. In man, the eye at rest is focused on infinity, with the lens and cornea flattened. To focus on a near object the ciliary muscles contract, and the lens, being elastic, becomes more convex and thus of shorter focal length; the cornea also becomes more convex and assists in the focusing.

Although the structure of the eye is similar in all vertebrates, the method of accommodation varies from group to group. Fishes and amphibians have muscles that move the lens (of fixed focal length) backwards for distant vision and forwards for near vision.

Reptiles and birds accommodate by action of the ciliary muscles, which on contraction actually pushes the lens into a convex shape.

**2.** See adaptation.

**acellular** Denoting relatively large tissues or organisms that are not composed of discrete cells and are, in effect, unicellular. Examples are aseptate fungal hyphae and muscle fibres. The term is used in preference to unicellular to distinguish such structures (which are often multinucleate) from conventional cells and show their equivalence to multicellular structures.

**acentric** Denoting a chromosome or fragment of a chromosome that lacks a centromere.

**acetabulum** A cup-shaped socket on each side of the pelvic girdle in tetrapods that holds the rounded head of the thigh bone (femur) to form the hip joint. This 'ball-and-socket' arrangement allows for great stability and a wide range of movement.

**acetic acid** (ethanoic acid) A carboxylic acid,  $\text{CH}_3\text{COOH}$ , obtained by the oxidation of ethyl alcohol. Acetic acid is a component of vinegar (which is obtained by bacterial oxidation of wine waste).

**acetylcholine** (ACh) A neurotransmitter found at the majority of synapses, which occur where one nerve cell meets another. Nerves that produce acetylcholine are called *cholinergic nerves*; they form the parasympathetic nervous system. See neurotransmitter.

**ACh** See acetylcholine.

**achene** A dry indehiscent fruit formed from a monocarpellary ovary containing a single seed. Different types of achenes include the caryopsis, cypsela, nut, and samara. See also etaerio.

**acid-base balance** Maintenance of the optimum pH of body fluids by regulating the acid:base ratio. This usually involves a buffer system (see buffer). For example mammalian blood must be maintained at a pH of 7.4, which requires a ratio of carbonic acid to bicarbonate of 1:20; any serious deviation would result in the conditions of acidosis or alkalosis. The optimum pH for higher plants is around 6.7, and they tend to be somewhat more tolerant to pH changes.

**acidic stain** See staining.

**acid rain** The deposition of acids by natural precipitation (e.g. rain, snow, fog), leading to acid pollution. The very dilute acids are formed by reaction of gaseous waste products (e.g. sulphur dioxide, nitrogen oxide, or carbon monoxide), with moisture present in the air. This has led to environmental damage in many areas, for example over 10 000 lakes and streams in Scandinavia are unable to support life, which has been attributed to pollution carried by southwesterly winds from Britain. Unpolluted rain is slightly acidic, having a pH of 5.0–5.6; damage will occur to sensitive ecosystems when the pH falls below 4.6.

**acoustic nerve** See auditory nerve.

**acoustico-lateralis system** A system in vertebrates (especially fish and aquatic amphibians) consisting of the

## action potential

neuromast cells in various tracts on or near the surface of the body (i.e. the *lateral-line system*) and the inner ear (*membranous labyrinth*). Neuromasts and receptor cells of the inner ear are similar, consisting of groups of cells with sensory processes innervated by nerves from the medulla oblongata of the brain. They are responsible for the detection of sounds in water.

**acquired characteristics** Changes in the structure or function of an organ or system during the life of an organism, brought about by the use or disuse of that organ or system, or by environmental influences. Sportsmen may develop strong muscles, plants growing near coasts show adaptations to the drying effects of sea air. Acquired characteristics are not inherited. See also Lamarckism.

**Acrania** (Protochordata) A subdivision of the Chordata that includes two subphyla, the Urochordata and the Cephalochordata (i.e. all the invertebrate chordates). Brain, skull, heart, and kidneys are absent and the notochord is never replaced by cartilage or bone. Sometimes the term is restricted to the Cephalochordata only.

**acropetal** Developing from the base upwards so that the youngest structures are at the apex. An acropetal sequence of development is seen in flower formation in which the calyx forms first and the carpels form last. The term may also be applied to the movement of substances towards the apex, for example the transport of auxin in roots. Compare basipetal. See also centrifugal, centripetal.

**acrosome** A membrane-bound structure in the anterior head region of a spermatozoon, usually forming a cap over the nucleus. It contains enzymes that are released on contact with the egg at fertilization and break down the egg coats, enabling the spermatozoon nucleus to enter the egg.

**ACTH** See corticotrophin.

**actin** One of the two contractile proteins present in muscle. Actin molecules are capable of polymerization to form the thin filaments that are part of the muscle myofibrils. Thus muscle myofibrils consist of alternating and overlapping sets of thick myosin and thin actin filaments. In muscle contraction, overlapping actin and myosin molecules interact to form actomyosin complexes.

**actinomorphy** See radial symmetry.

**actinomycetes** (filamentous bacteria) A group of bacteria characterized by a mycelial fungus-like growth habit. Next to the true bacteria, they are the most numerous type of organisms in the topsoil and are important in soil fertility. Most of the antibiotics (e.g. streptomycin, actinomycin, and tetracycline) are obtained from actinomycetes.

**actinostele** A type of protostele in which the xylem is star shaped and the phloem lies between the points of the star. See stele.

**action potential** The transitory change in electrical potential that occurs across the membrane of a nerve or muscle fibre during the passage of a nervous impulse. The degree of change is independent of the strength of the impulse; it either occurs or does not (see all-or-none). In the absence of an impulse a *resting potential* of about  $-70$  mV exists across the membrane (inside negative) as a result of the unequal distribution of ions between the intracellular and extracellular media (see sodium pump). However, during the passage of an impulse the resistance of the membrane falls and allows an inward current of sodium ions, which makes the inside less negative and eventually alters the membrane potential to about  $+30$  mV (inside positive). An outward flow of potassium ions follows shortly afterwards and restores the resting potential. Local currents flow ahead of the action potential that in turn give rise to further action potentials. In this way a wave of

## action spectrum

activity is propagated along the membrane to produce the impulse.

**action spectrum** A graph showing the effect of different wavelengths of radiation, usually light, on a given process. It is often similar to the absorption spectrum of the substance that absorbs the radiation and can therefore be helpful in identifying that substance. For example, the action spectrum of photosynthesis is similar to the absorption spectrum of chlorophyll. See absorption spectrum.

**active site** The region of an enzyme molecule that combines with and acts on the substrate. It consists of amino acids arranged in a configuration specific to a particular substrate or type of substrate. Binding of an inhibiting compound elsewhere on the enzyme molecule may change this configuration and hence the efficiency of the enzyme activity.

**active transport** The transport of molecules or ions across a cell membrane against a concentration gradient, with the expenditure of energy: it is probably an attribute of all cells. Anything that interferes with the provision of energy will interfere with active transport. The exact mechanism is not certain but there is a carrier involved, thought to be a protein or lipoprotein.

**actomyosin** A protein complex found in muscle, formed between molecules of actin and myosin present in adjacent thick and thin muscle filaments. These actomyosin complexes are involved in the process of muscle contraction; their formation is important in the concerted mechanism that pulls the thin filaments past the thick ones.

**Adamkiewicz's test** See Hopkins-Cole reaction.

**adaptation 1.** The extent to which an organism, or a physiological or structural characteristic of an organism, is suited to a particular environment. Organisms that have become highly adapted to one envi-

ronment are then often not so adaptable as less specialized organisms and are at a disadvantage in a changing environment (adaptation versus adaptability).

**2.** (accommodation) The decrease with time of the frequency of response of sensory receptors subjected to a constant intensity of stimulus. A more intense stimulus is then required to elicit a response.

Receptors vary greatly in the rate and degree of adaptation they show depending on their function. Many monitor relatively static stimuli, such as internal temperature, and exhibit no adaptation, while others monitoring rapidly changing stimuli, such as touch sensation in the skin, rapidly adapt to a constant intensity stimulus.

**adaptive enzyme** (inducible enzyme) An enzyme that is produced by an organism only in the presence of its substrate. Adaptive enzymes are known only in microorganisms. Compare constitutive enzyme.

**adaptive radiation** The gradual formation through evolution of a number of different varieties or species from a common ancestor, each adapted to a different ecological niche. A classic example of adaptive radiation is illustrated by Darwin's finches. See also Darwin's finches.

**adaxial** In lateral organs, such as a leaf, the upper surface, i.e. the side facing towards the main axis. Adaxial is synonymous with ventral when the latter term is being applied to lateral organs. Compare abaxial.

**adenine** A nitrogenous base found in DNA and RNA. It is also a constituent of certain coenzymes, e.g. NAD and FAD, and when combined with the sugar ribose it forms the nucleoside adenosine found in AMP, ADP, and ATP. Adenine has a purine ring structure. See illustration at DNA.

**adenosine** (adenine nucleoside) A nucleoside formed from adenine linked to D-ribose with a  $\beta$ -glycosidic bond. Adeno-

## aerobic respiration

sine triphosphate (ATP) is a nucleotide derived from adenosine.

**adenosine diphosphate** See ADP

**adenosine monophosphate** See AMP

**adenosine triphosphate** See ATP

**adenovirus** One of a group of DNA-containing viruses, about 80 nm in diameter, causing respiratory diseases in man. These viruses can also cause tumours in animals. See oncogenic.

**ADH** (antidiuretic hormone) See vasopressin.

**adipose tissue** (fatty tissue) A type of connective tissue consisting of closely packed cells (adipocytes) containing fat. Adipose tissue is found in varying amounts in the dermis of the skin and around the kidneys, heart, and blood vessels. It provides an energy store, heat insulation, and mechanical protection. The fat is deposited as tiny droplets scattered in the cytoplasm, but as these enlarge they fuse to form one large drop with a thin layer of cytoplasm and a nucleus squashed to one side. The distended cells are pressed against each other, so that they appear angular.

Most adipose tissue is in the form of *white fat*, but hibernating and newborn animals have deposits of darker coloured *brown fat*, rich in unsaturated fatty acids, which is well supplied with blood vessels and acts as a readily mobilizable source of heat energy. Some theories on the cause of obesity in man postulate a lack of brown fat in those affected.

See also connective tissue. See illustration at skin.

**ADP** (adenosine diphosphate) A nucleotide consisting of adenine and ribose with two phosphate groups attached. See ATP

**adrenal glands** A pair of glands that are situated above each kidney and produce the hormone adrenaline. Secretion

is controlled by the nervous system. The adrenal glands have a central medulla and an outer cortex, each behaving independently. The former produces noradrenaline and adrenaline. The adrenal cortex is rich in vitamin C and cholesterol. Three types of hormones are produced: aldosterone, cortisol, and sex hormones.

**adrenaline** (epinephrine) A hormone produced by the adrenal glands. The middle part of these glands, the adrenal medulla, secretes the hormone, which is chemically almost identical to the transmitter substance noradrenaline produced at the ends of sympathetic nerves. Adrenaline secretion into the bloodstream in stress causes acceleration of the heart, constriction of arterioles, and dilation of the pupils. In addition, adrenaline produces a marked increase in metabolic rate thus preparing the body for emergency.

**adrenergic** Designating the type of nerve fibre that releases adrenaline or noradrenaline from its ending when stimulated by a nerve impulse. Vertebrate sympathetic motor nerve fibres are adrenergic. Compare cholinergic.

**adrenocorticotrophic hormone** See corticotrophin.

**adventitious** Describing plant organs that arise in unexpected places, for example the development of adventitious roots from stems, and adventitious buds from leaves.

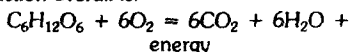
**aerenchyma** Modified parenchyma with large air spaces to facilitate diffusion of gases and, in aquatic plants, to provide buoyancy.

**aerobe** An organism that can live and grow only in the presence of free oxygen, i.e. it respire aerobically (see aerobic respiration). Compare anaerobe.

**aerobic respiration** Respiration in which free oxygen is used to oxidize organic substrates to carbon dioxide and

## aerotaxis

water, with a high yield of energy. The reaction overall is:



It occurs in a number of stages, the first of which (glycolysis) also occurs in anaerobic respiration in the cell cytoplasm. With glucose as the substrate, a sequence of reactions results in the formation of pyruvate. The remaining stages, which do not occur in anaerobic respiration, take place in the mitochondria. Pyruvate is converted to acetyl coenzyme A (see oxidative decarboxylation), which enters a cyclic series of reactions, the Krebs cycle, with the production of carbon dioxide and hydrogen atoms. These and other hydrogen atoms produced at earlier stages are now passed to the electron-transport chain (involving cytochromes and flavoproteins). Here they combine with atoms of free oxygen to form water. Energy released at each stage of the chain is used to form ATP during a coupling process (see oxidative phosphorylation). There is a net production of 36 ATPs per molecule of glucose during aerobic respiration, a yield of about 18 times that of anaerobic respiration, and therefore the preferred mechanism of the majority of organisms.

**aerotaxis** (aerotactic movement) A taxis in response to an oxygen concentration gradient. For instance, motile aerobic bacteria are positively aerotactic, whereas motile obligate anaerobic bacteria are negatively aerotactic. See taxis.

**aestivation 1.** The way in which sepals and petals are folded in the flower bud before expansion. Compare ptysis, vernalization.

**2.** A period of inactivity seen in some animals during the summer or dry hot season. For example, lungfish respond to the drying up of water by burying themselves in the mud bottom. They re-emerge at the start of the rainy season. See also hibernation.

**afferent** Conveying (impulses, blood, etc.) from the outer regions of an organ or body towards the centre. For example, af-

ferent nerves convey nerve impulses from sense organs to the central nervous system. Compare efferent.

**afلاتoxin** See *Aspergillus*.

**afterbirth** The placenta, umbilical cord, and membranes discharged from the body shortly after the birth of the young.

**after-ripening** The collective name for processes that are necessary before germination can take place in certain seeds, even though external conditions may be suitable. A period of dormancy is thus imposed on the seed, preventing premature germination before an unfavourable season such as winter. After-ripening is common in the family Rosaceae.

**aftershaft** See contour feathers.

**agamospermy** See apomixis.

**agar** A gelling agent prepared from seaweed, used to set liquid nutrients. Agar gels are extensively used for growing microorganisms.

**agglutination** The clumping together of red blood cells or bacteria as a result of the action of antibodies. Agglutination may occur in transfusion if blood of the wrong group is given. The surfaces of the donor's red blood cells contain antigen molecules that are attacked by antibody molecules in the serum of the recipient, which causes the red cells to clump together. These clumps may block capillaries, causing fatal damage to the heart or brain. Agglutination of bacteria by antibodies causes them to disintegrate. See also antibody, blood groups.

**aggression** The type of animal behaviour involving threats and actual attacks on other animals. Aggression is normally a response to opposition (e.g. defence of territory) and results in the displacement of the opponent, which is usually of the same species. It operates in the interests of survival of the individual or species.

**Agnatha** The class containing the earliest and most primitive vertebrates, characterized by the absence of jaws. The only living order is the Cyclostomata, which includes lampreys (e.g. *Petromyzon*) and hagfish (e.g. *Myxine*) – aquatic fishlike animals lacking the paired fins typical of true fishes. There are also several extinct Palaeozoic orders known collectively as the Ostracodermi, which had a heavy armour of bony plates and scales. Compare Gnathostomata. See Cyclostomata.

**agonism** See agonistic behaviour.

**agonistic behaviour** (agonism) A type of animal behaviour exhibiting features of both aggression and avoidance. For example, the establishment of a territory involves both attack and escape behaviour; if two neighbours meet at the boundary of their territories, conflicting tendencies to attack and flee are aroused, resulting in conflicting responses. Some forms of agonistic behaviour have become modified into threat displays, which tend to intimidate rivals and reduce actual fighting.

**agranulocyte** A white blood cell (leucocyte) that does not contain granules in its cytoplasm. There are two types: lymphocytes and monocytes (comprising 25% and 4%, respectively, of all leucocytes). Both have large nuclei and a small amount of clear cytoplasm. See lymphocyte, monocyte.

**Agrobacterium** A genus of bacteria, the species *A. tumefaciens* being the causative agent of crown gall, a type of tumour in plants. A segment of DNA (T-DNA) from a plasmid in the bacterium is transferred into the host DNA and induces tumour formation. Since the plasmid is capable of independent replication in host cells of many dicotyledonous plants, it has been used as a cloning vector in genetic engineering. Once the desired segment of DNA has been spliced into the T-DNA, the plasmid can be introduced into certain plant cultures and entire plants with the desired characteristic can be produced.

Unfortunately, the bacterium does not infect monocotyledonous plants, which include important cereal crops. See also gene cloning, tissue culture.

**AIDS** (acquired immunodeficiency syndrome) A viral disease characterized by destruction of the lymphocytes responsible for cell-mediated immunity (see T-cell), the patient consequently succumbing to opportunistic fatal infections, cancers, etc. The causative agent – HIV (human immunodeficiency virus) – is transmitted in blood, semen, or vaginal fluid; it is a retrovirus and can remain inactive in its host for several years without causing any symptoms. Such carriers, although free of symptoms, can nevertheless transmit the virus.

**air bladder** See swim bladder.

**alanine** See amino acids.

**albinism** The absence of pigmentation in the eyes, skin, feathers, hair, etc., of some animals. It is a hereditary condition in vertebrates, resulting from abnormalities in production or function of the pigment cells. Albinism in humans is due to a recessive gene and results in the absence of a dark brown pigment (melanin). The complete albino has milk-white skin and hair and the irises of the eyes appear pink.

**albumen** See albumin.

**albumin** One of a group of simple proteins, which are usually deficient in glycine. They are water-soluble and when heated coagulate. Albumins are the products of plants and animals; e.g. legumelin in peas and the serum albumin of blood. The protein in egg white (*albumen*) is a mixture of albumins. These also contain carbohydrate groups and consequently are classified as conjugated proteins.

**albuminous cell** A vertically elongated parenchyma cell, found in groups in the rays of the secondary phloem in gymnosperms.

## **albumum**

**albumum** An obsolete term for sapwood.

**aldohexose** An aldose sugar with six carbon atoms. See sugar.

**aldopentose** An aldose sugar with five carbon atoms. See sugar.

**aldose** A sugar containing an aldehyde (CHO) or potential aldehyde group. See sugar.

**aldosterone** A hormone secreted by the cortex of the adrenal glands. It is a steroid, and is important in the control of sodium and potassium ion concentrations in mammals. The hormone has an important effect on the handling of sodium and potassium by the kidney tubules, favouring the reabsorption of sodium ions and the excretion of potassium ions. It also has the effect of increasing the uptake of sodium ions by the gut. The overall result is that sodium ion concentration in the blood rises, whereas potassium falls.

**aleurone grain** (aleurone body) A modified vacuole found in the embryo and endosperm of seeds and containing mostly reserve proteins, but also phytic acid and various enzymes associated with mobilization (digestion) of these reserves. The protein and phytic acid are present in crystalline form in the dormant seed.

**aleurone layer** The outermost protein-rich layer of the endosperm of grass fruits (e.g. cereal grains). At germination, the embryo produces gibberellin, which stimulates the aleurone layer to synthesize enzymes, especially  $\alpha$ -amylase. The latter causes hydrolysis of the starch in the endosperm. The enzymes are synthesized from the amino acids supplied by breakdown of aleurone grains.

**aleuroplast** A type of proteoplast in which protein is stored in the form of aleurone grains. They are common in seeds; for example, in the endosperm of castor oil.

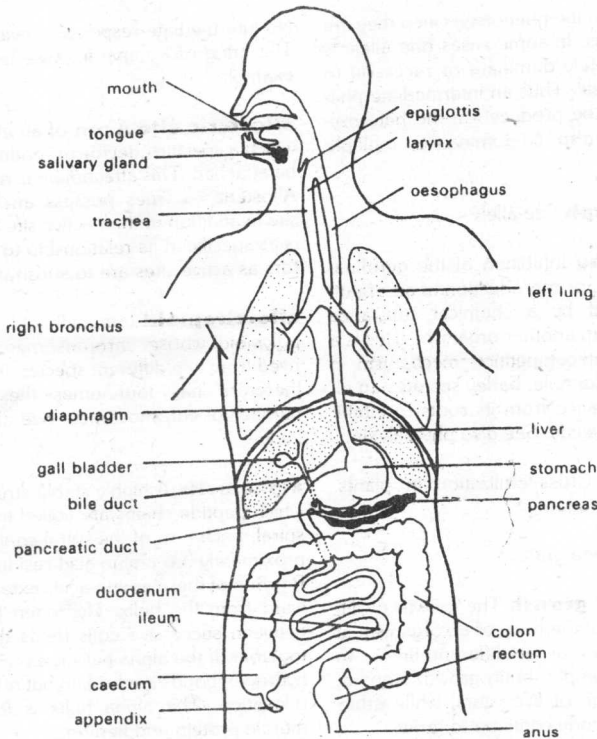
**algae** A large mixed group of simple plants, largely found in marine or freshwater habitats, although some algae are terrestrial. The term algae has no taxonomic significance but is generally used to encompass those plants showing little cell differentiation and no real differentiation of leaves, stems, and roots. Algae can be unicellular (e.g. *Chlamydomonas*), colonial (e.g. *Volvox*), filamentous (e.g. *Spirogyra*), or thalloid (e.g. *Fucus*). All algae contain chlorophyll, but this may be masked by various accessory pigments, these being one of the major characteristics used to divide the algae into some six divisions, this number varying with different classifications. Other characters used to classify the algae are the nature of storage products, the type of cell wall, the form and number of flagella, ultrastructural cell details, and reproductive processes. See also Chlorophyta, Phaeophyta, Rhodophyta.

**alimentary canal** A tube (8–9 m long in man) through which food is passed for digestion and absorption into the bloodstream of an animal. In most Metazoa, it leads from the mouth to the anus, and different parts are modified for digestion and absorption of soluble food. Numerous glands pass secretions, containing enzymes, into the alimentary canal and these digest the food as it is moved along by peristalsis.

The wall of the alimentary canal of vertebrates consists of a number of coats. Starting from the inside they are:

- (1) The mucous membrane – epithelium and underlying connective tissue.
- (2) Muscularis mucosa – a thin band of muscle.
- (3) Submucous coat of areolar connective tissue with blood vessels and lymphatics.
- (4) The muscle coat – circular and longitudinal, and in the stomach, oblique.
- (5) The peritoneum – a thin layer of connective tissue with an outer squamous epithelium.

**alkaloid** One of a group of organic compounds found in plants, that are poisonous insoluble crystalline compounds. They



The alimentary canal

contain nitrogen and usually occur as salts of acids such as citric, malic, and succinic acids. Their function in plants remains obscure, but it is suggested that they may be nitrogenous end-products of metabolism, or they may have a protective function against herbivores. Important examples are quinine, nicotine, atropine, opium, morphine, codeine, and strychnine. They occur mainly in the poppy family, the buttercup family, and the nightshade family of plants.

**allantois** One of the three embryonic membranes of reptiles, birds, and mammals. It first appears as a ventral outgrowth of the embryo's gut or a 'bubble' ventrally (in primates). It nearly always expands into the coelom under the hindgut, then across the extra-embryonic coelom

to fuse with the chorion, forming the chorio-allantoic membrane (birds) or placenta (mammals). In reptiles and birds, excreted uric acid is stored in the allantoic cavity. *See* cleidoid egg. *See also* amnion, chorion, placenta.

**allele** (allelomorph) One of the possible forms of a given gene. The alleles of a particular gene occupy the same positions (*loci*) on homologous chromosomes. A gene is said to be *homozygous* if the two loci have identical alleles and *heterozygous* when the alleles are different. When two different alleles are present, one (the *dominant* allele) usually masks the effect of the other (the *recessive* allele). The allele determining the normal form of the gene is usually dominant while mutant alleles are usually recessive. Thus most mutations

## **allelomorph**

only show in the phenotype when they are homozygous. In some cases one allele is not completely dominant or recessive to another allele. Thus an intermediate phenotype will be produced in the heterozygote. *See also* co-dominance, multiple allelism.

**allelomorph** *See* allele.

**allelopathy** Inhibition of the germination, growth, or reproduction of an organism effected by a chemical substance released from another organism. This is a common anti-competition mechanism in plants; for example, barley secretes an alkaloid substance from its roots to inhibit competing weeds. *See also* phytoalexin.

**allogamy** Cross-fertilization in plants. *Compare* autogamy.

**allograft** *See* graft.

**allometric growth** The growth of different parts of the body of an organism at different rates or at different times. In man, for example, brain growth stops at about the age of five years, while other parts of the body continue to grow.

**allopatric species** *See* species.

**allopolyploidy** A type of polyploidy involving the combination of chromosomes from two or more different species. *Allopolyploids* usually arise from the doubling of chromosomes of a hybrid between species, the doubling often making the hybrid fertile. The properties of the hybrid, e.g. greater vigour and adaptability, are retained in the allopolyploid in subsequent generations and such organisms are often highly successful. *Compare* autopolyploidy.

**all-or-none** Designating the type of response shown by certain irritable tissues that occurs either with full strength or not at all. A stimulus will produce no response until it reaches a certain threshold level, when it produces a fixed maximum response, independent of stimulus intensity.

No intermediate response is ever elicited. The firing of a nerve impulse is a typical example.

**allosteric site** A part of an enzyme to which a specific effector or modulator can be attached. This attachment is reversible. Allosteric enzymes possess an allosteric site in addition to their active site. This site is as specific in its relationship to modulators as active sites are to substrates.

**allotetraploid** (amphidiploid) An allopolyploid whose chromosomes are derived from two different species and which therefore has four times the haploid number of chromosomes. *See* allopolyploidy.

**alpha helix** A highly stable structure in which peptide chains are coiled to form a spiral. Each turn of the spiral contains approximately 3.6 amino-acid residues. The R group of these amino-acids extends outward from the helix. Hydrogen bonding between successive coils holds the helix together. If the alpha helix is stretched the hydrogen bonds are broken but reform on relaxation. The alpha helix is found in muscle protein and keratin.

**alpha-naphthol test** (Molisch's test) A standard test for carbohydrates in solution. Molisch's reagent, alpha-naphthol in alcohol, is mixed with the test solution. Concentrated sulphuric acid is added and a violet ring at the junction of the two liquids indicates the presence of carbohydrates.

**ALS** *See* antilymphocyte serum.

**alternation of generations** The occurrence of two, or occasionally more, generations during the life cycle of an organism. It is found in some animals, e.g. certain parasites and hydrozoan coelenterates, and in plants, being particularly clear in some ferns where the generations are independent. Most commonly there is an alternation between sexual and asexual generations, which are usually very different from each other morphologically. In

nearly all plants there is also an alternation between haploid and diploid stages. Generally the haploid plant produces gametes mitotically and is thus termed the gametophyte while the diploid plant produces spores meiotically and is called the sporophyte, though many algae do not follow this rule. The gametes fuse to form a zygote, which develops into the sporophyte, and the spores germinate and produce the gametophyte, so forming a cycle. In bryophytes the haploid gametophyte is the dominant phase of the life cycle and the sporophyte is represented only by the capsule, seta, and foot. In tracheophytes the diploid sporophyte is the dominant phase and in the ferns, for example, the gametophyte is a small prothallus. The concept of an alternation of generations can be extended to the flowering plants, in which the embryo sac and pollen represent the much reduced female and male gametophyte generations respectively.

**altricial** See *nidicolous*.

**altruism** Behaviour by an animal that favours the survival of other animals of the same species at its own expense. The most common example is that of parents putting themselves at risk, and sometimes losing their lives, to protect and save their offspring. This has been shown to be genetically favourable to the altruist, increasing the chance that its genes will be passed on, particularly if the parent animal has exhausted, or nearly exhausted, its reproductive capacity. Similarly group altruism, in which genetically more distant group members are protected, will favour gene survival in the long term. See also *kin selection*.

**alveolus 1.** A minute air sac in the lungs of mammals. Alveoli occur in clusters at the ends of each bronchiole. They have thin moist walls and each is surrounded by a network of capillaries, enabling free exchange of gases between the blood in the capillaries and the inspired air in the alveolus. In birds their function is performed by air capillaries leading from the

*parabronchi* (branches of the bronchus). See *lung*.

**2.** The socket in the jaw bone of a mammal that encloses the root of a tooth. The tooth is fixed into the socket by the vascular *alveolar (periodontal) membrane*, which is derived from the periosteal membranes of the jaw bone and the cement covering the root of the tooth. The interlacing fibres of the alveolar membrane pass into both the jaw bone and the cement, allowing a very slight movement between tooth and jaw during chewing.

**amino acids** Derivatives of carboxylic acids in which a hydrogen atom in an aliphatic acid has been replaced by an amino group. Thus, from acetic acid, the amino acid, glycine, is formed. All are white, crystalline, soluble in water, and with the sole exception of the simplest member, glycine, all are optically active. In the body the various proteins are assembled from the necessary amino acids and it is important therefore that all the amino acids should be present in sufficient quantities. In man, all but ten of the twenty amino acids can be synthesized by the body itself. Since these are not required in the diet they are known as *non-essential amino acids*. The remaining ten cannot be synthesized by the body and have to be supplied in the diet. They are known as *essential amino acids*.

Various other amino acids fulfil important roles in metabolic processes other than as constituents of proteins. For example, ornithine ( $\text{H}_2\text{N}(\text{CH}_2)_3\text{CH}(\text{NH}_2)\text{COOH}$ ) and citrulline ( $\text{H}_2\text{N}.\text{CO}.\text{NH}(\text{CH}_2)_3\text{CH}(\text{NH}_2)\text{COOH}$ ) are intermediates in the production of urea.

**amino sugar** A sugar in which a hydroxyl group (OH) has been replaced by an amino group ( $\text{NH}_2$ ). Glucosamine (from glucose) occurs in many polysaccharides of vertebrates and is a major component of chitin. Galactosamine or chondrosamine (from galactose) is a major component of cartilage and glycolipids. Amino sugars are important components of bacterial cell walls.

## amitosis

### *The amino acids most commonly found in proteins*

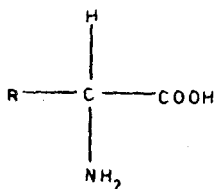
alanine  
arginine  
asparagine  
aspartic acid  
cysteine  
glutamic acid  
glutamine

glycine  
histidine\*  
isoleucine\*  
leucine\*  
lysine\*  
methionine\*  
phenylalanine\*

proline†  
serine  
threonine\*  
tryptophan\*  
tyrosine\*  
valine\*

\* essential amino acids in animal diets

† an imino acid derived from pyrrolidine



Amino acid: The amino acids in proteins are alpha amino acids. The -COOH group and -NH<sub>2</sub> group are on the same carbon atoms

**amitosis** Nuclear division characterized by the absence of a nuclear spindle and leading to the production of daughter nuclei with unequal sets of chromosomes. The ordered process of division, duplication of chromosomes, dissolution of nuclear membrane, and production of a spindle as in mitosis is apparently absent. Cells produced amitotically inherit variable numbers of chromosomes. The chances of a daughter cell lacking essential genes are less than may be expected since many cells that characteristically divide amitotically are polyploid, e.g. the endosperm nucleus in angiosperms and the macronucleus of ciliates. Compare endomitosis, mitosis.

**amniocentesis** A process whereby a sample of amniotic fluid is obtained from a pregnant woman in order to identify an abnormal foetus. It may be carried out between the 12th and 16th weeks of pregnancy, and involves inserting a needle through the abdominal wall and uterus and withdrawing a sample of amniotic fluid. Stray foetal cells in the fluid may be examined for chromosome abnormalities (see Down's syndrome), while abnormal concentrations of various substances may

indicate other problems, e.g. a significantly raised concentration of alpha-fetoprotein may be due to spina bifida or anencephaly.

**amnion** One of the three embryonic membranes of reptiles, birds, and mammals. It is the inner layer of membrane enclosing the embryo, first as a hood and later as a complete bubble. The amniotic cavity contains *amniotic fluid*, which may be sampled in pregnant women to diagnose some kinds of genetic abnormality in the foetus (see amniocentesis). See also chorion.

**amniotes** Reptiles, birds, and mammals, i.e. those vertebrates whose embryos always possess an amnion.

**Amoeba** The best-known member of the Protozoa. A microscopic organism found universally in fresh water, it has a continually changing shape due to the formation of pseudopodia for locomotion and food capture. Food and water vacuoles carry out digestion and osmoregulation. Reproduction is by binary fission and spore formation takes place in adverse conditions. See also Protozoa, Rhizopoda.

**amoebocyte** A cell that can wander freely in animal tissues. Amoebocytes are found, for example, in the walls of sponges and in the blood and body fluids of mammals. They have the general appearance of *Amoeba*, particularly in exhibiting amoeboid movement.

**AMP** (adenosine monophosphate) A nucleotide consisting of adenine, ribose, and phosphate. See ATP, cyclic AMP.

**Amphibia** The class of vertebrates that contains the most primitive terrestrial tetrapods – the frogs, toads, newts, and salamanders. Amphibians have four pentadactyl limbs, a moist skin without scales, a pelvic girdle articulating with the sacrum, and a middle-ear apparatus for detecting airborne sounds, but no external ear. They are poikilothermic and the adults have lungs and live on land but their skin, also used in respiration, is thin and moist and body fluids are easily lost, therefore they are confined to damp places. In reproduction, fertilization is external and so they must return to the water to breed. The eggs are covered with jelly and the aquatic larvae have gills for respiration and undergo metamorphosis to the adult. Partial or complete neoteny occurs in some amphibians; for example *Ambystoma* (Mexican axolotl) is permanently aquatic, with larval gills retained in the adult and atrophied lungs. See also Anura.

**amphicribal** See amphiphloic.

**amphidiploid** See allotetraploid.

**amphimixis** True sexual reproduction by fusion of gametes. Compare apomixis.

**Amphioxus** (*Branchiostoma*) A genus of small marine burrowing cephalochordates, the lancelets. *Amphioxus* has a fish-shaped body with a dorsal and caudal fin and segmentally arranged muscle blocks (myotomes). The pharynx and gill slits are modified for food collection as well as respiration. Excretion is by

nephridia, which is unique among chordates. See Cephalochordata.

**amphiphloic** (amphicribal, periphloic) Describing a centric vascular bundle in which the tissues are arranged concentrically and an outer ring of phloem completely surrounds a central core of xylem, as seen in the stele of *Selaginella*. Compare amphixylic.

**amphistylic jaw suspension** An arrangement found in a few sharks and many fossil fish (e.g. the *Cladoselellii*) whereby the jaws are suspended by ligaments from the skull and by the hyomandibular bone. Compare autostylic jaw suspension, hyostylic jaw suspension.

**amphivasal** See amphixylic.

**amphixylic** (amphivasal, perixylic) Describing a centric vascular bundle in which the tissues are arranged concentrically and an outer ring of xylem completely surrounds a central core of phloem cells. This arrangement can be seen, for instance, in lily of the valley. Compare amphiphloic.

**amylase** (diastase) A member of a group of closely related enzymes, found widely in plants, animals, and microorganisms, that hydrolyses starch or glycogen to the sugars maltose, glucose, or dextrin. Both  $\alpha$ - and  $\beta$ -amylases occur in plants, the latter particularly in malt (being used in the brewing industry), but only  $\alpha$ -amylase is found in animals, in the pancreatic juices and in saliva (see ptyalin), having an important role in digestion.

**amyopectin** The water-insoluble fraction of starch. See starch.

**amyloplast** A plastid storing starch grains. They are common in storage organs, e.g. the potato tuber. They have a physiological role in the root cap and elsewhere where the starch grains act as statoliths. See also geotropism.