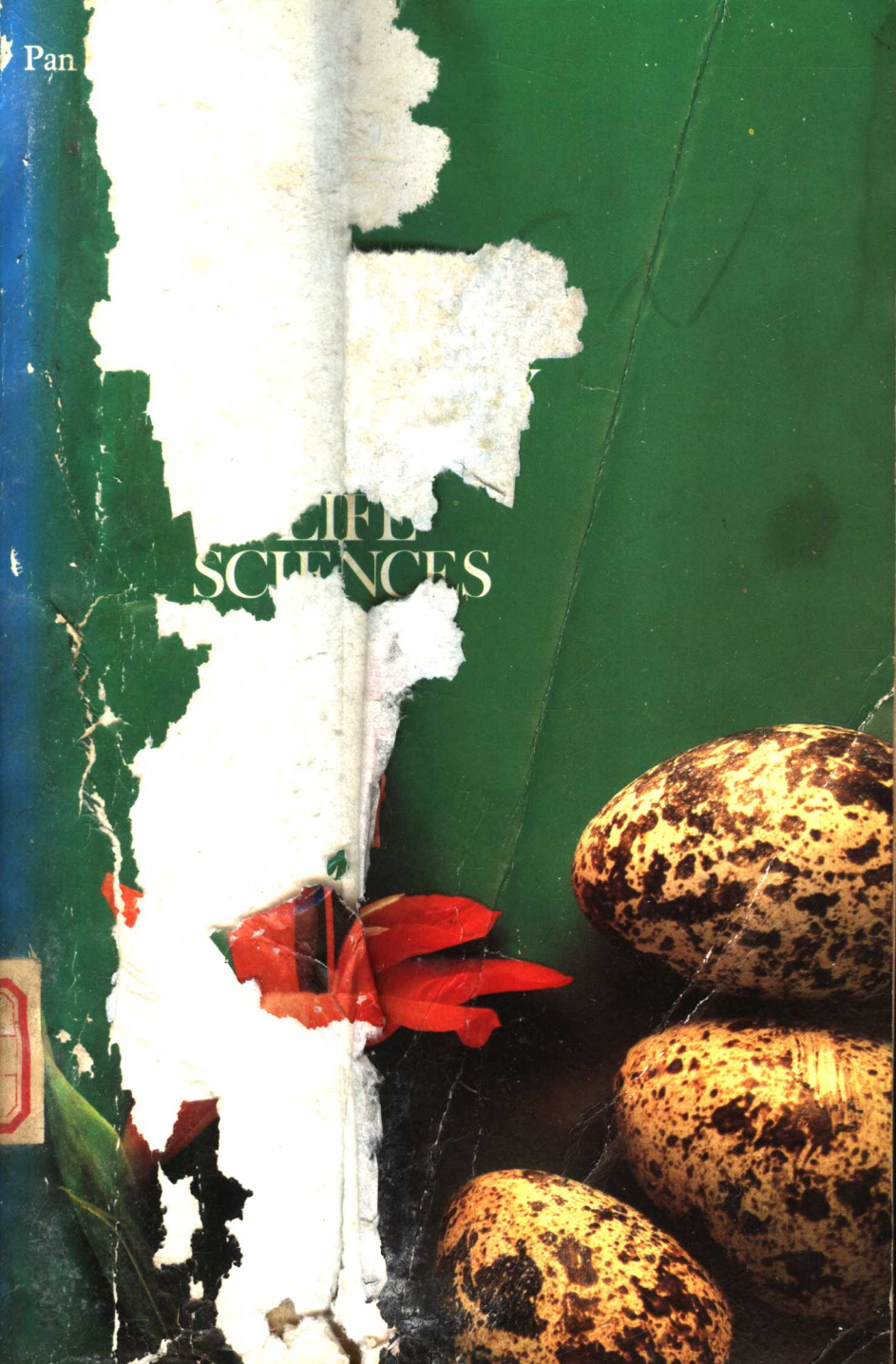


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edited by E. A. Martin MA

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Key to Symbols

Asterisks before words in the text denote cross-references to entries that will provide additional information. Entries are defined under the most commonly used term, with synonyms shown in brackets.

A

aardvark. See Tubulidentata.

abaxial. Designating the surface of a leaf or other lateral organ that is developmentally furthest from the apex of the axis that bears it (the *lower* (or *dorsal*) surface of such organs). The true nature of an abaxial surface may later become masked, as by twisting of the petiole. *Compare* adaxial.

abdomen. 1. The part of the body cavity of vertebrates in which the stomach, intestine, liver, kidneys, etc., are suspended (*compare* thorax). In mammals the abdomen is clearly separated from the thorax by the diaphragm.

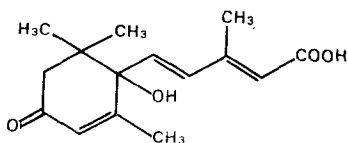
2. The posterior region of the body of arthropods, often consisting of a series of similar segments.

abducens nerve. See cranial nerves.

abiogenesis. See spontaneous generation.

abomasum. The fourth chamber of the stomach of ruminants. See Ruminantia.

abscisic acid (ABA). A plant growth substance (see formula) previously known as *dormin* or *abscisin II*. (Abscisin I is a similarly acting, but chemically unrelated and less effective, substance.)



ABA has been implicated in abscission (e.g. leaf fall and fruit drop), leaf senescence, seed dormancy (e.g. in cotton and apple), bud dormancy (e.g. in birch), apical dominance (where it may inhibit lateral bud growth), and inhibition of flowering of long-day plants under short-day conditions. In all its roles it appears to be inhibitory, and it may be that the relative balance

(environmentally controlled) between ABA and the growth promoters (auxins, gibberellins, and cytokinins) determines response.

abscission. The organized separation of a plant organ from the plant, as in leaf fall, fruit drop, and loss of unfertilized flowers. It is caused by the breakdown or separation of a layer of cells, the *abscission layer*, which forms part of an *abscission zone* at the base of the organ. A second, *protective layer* is left. Abscission is controlled by growth substances, probably by a balance between *auxins and *abscisic acid, the former usually inhibiting and the latter promoting the phenomenon. Gibberellins may also be involved.

absorption spectrum. The spectrum obtained when radiation (light, ultraviolet radiation, etc.) from a source giving a continuous spectrum is passed through a substance. If the substance is in the gaseous state dark lines or bands appear in the spectrum in the same positions as the coloured lines that appear in the characteristic *emission spectrum* of that substance. If the substance is a solid or liquid the spectrum of the light transmitted through the substance consists of broad dark regions, which cannot be resolved into sharp lines. However a graph of the relative amounts absorbed by different wavelengths can be used to identify the presence of some biologically important substances. The chlorophylls have absorption peaks in the red and blue parts of the visible spectrum and therefore appear green (reflecting green light). Nucleic acids do not markedly absorb visible light and therefore appear colourless in solution; they do, however, have characteristic peaks at 260 nm in the ultraviolet absorption spectrum. Instruments designed to measure light absorption at different wavelengths, for purposes of identification or quantification, are called *spectrophotometers* or *colorimeters*.

abyssal. Designating or inhabiting the deep waters of an ocean (approximately below 1000 metres), where conditions are cold, dark, and still.

Acanthocephala. A phylum of elongated cylindrical pseudocoelomate parasitic worms. The adults inhabit the intestines of vertebrates, with arthropods as the intermediate hosts. They are characterized by a retractile spiny proboscis, which they use to cling to the host's gut wall. There is no mouth or digestive tract. *See also* Aschelminthes.

Acanthodii. The class of vertebrates containing the earliest jawed fishes, which appeared in the Silurian, were common in the Devonian, and became extinct in the Permian. They were characterized by a number of paired fins, each composed of a web of skin supported along the front edge by a spine, and a heterocercal tail. The acanthodians show affinities to both the Osteichthyes and the Chondrichthyes and are sometimes placed in one or other of these classes.

Acari (Acarina). A large order of the Arachnida, containing the ticks and mites. They typically have small round bodies with the cephalothorax and abdomen fused and the segmentation obliterated. The chelicerae and pedipalps may be pincers, fangs, or suckers and there are often accessory mouthparts. Acarids are terrestrial or aquatic. The order includes scavengers, e.g. *Megninia* (feather mite); ectoparasites, e.g. *Ixodes* (sheep tick); and blood suckers, e.g. *Eutrombidium* (velvet mite); the latter are important in spreading disease.

accessory cell. *See* subsidiary cell.

accessory nerve. *See* cranial nerves.

accommodation. 1. The reflex adjustments in the eye by which an image is brought to focus on the retina. The process may involve constriction of the pupil to increase the depth of focus (stopping down), as well as either moving the lens backwards or forwards

(cephalopods, fish, and amphibians), changing the shape of the cornea (birds), or changing the curvature of the lens by the action of the ciliary body (amniotes).

2. (of sense organs). *See* adaptation.

acellular. Designating an organism, tissue, part, etc., consisting of a mass of protoplasm that has no size limit and is not divided into cells. For example, the multinucleate hyphae of fungi and the muscle fibres of animals are acellular.

acervulus. A sorus of parasitic fungi of the order Melanconiales (Fungi Imperfecti). It is formed beneath the host epidermis and consists of a mass of short conidiophores giving rise to conidia that eventually erupt through the surface of the host.

acetabulum. The socket in a tetrapod pelvic girdle that holds the ball-shaped head of the femur to form the hip joint.

acetylcholine (ACh). A neurotransmitter of the vertebrate and invertebrate peripheral nervous system that is the acetyl ester of *choline. Acetylcholine was the first chemical demonstrated to be a neurotransmitter: in 1920 Otto Loewi found that stimulation of the vagus nerve of a frog heart held in saline solution inhibited the beat of a second heart placed in the solution. The substance released by the first heart and responsible for the inhibition was later identified as acetylcholine.

ACh acts as a neurotransmitter at the synapses of parasympathetic nerves, sympathetic and parasympathetic ganglia, all preganglionic nerve endings of the ANS, and at the neuromuscular junction of all somatic motor nerves. There is also a small resting release of ACh from somatic motor nerve endings, detected as miniature end-plate potentials. ACh may also function as a neurotransmitter in certain parts of the central nervous system.

Nerve fibres or nerve endings that release ACh as a neurotransmitter are termed *cholinergic*.

acetylmuramic acid. An amino sugar, derived from D-glucosamine and lactic acid. It is a component of bacterial cell wall polysaccharides (see *mucopeptide*).

achene. A dry indehiscent monocarpellary uniovular *fruit.

acid-base balance. The maintenance of the acid:base ratio in the blood (see *homeostasis*). Blood contains carbonic acid and bicarbonate in the ratio of 1:20, which maintains the pH at 7.4. If this ratio is altered, as in respiratory acidosis (when carbonic acid accumulates in the blood), bicarbonate reabsorption by the kidney tubules is increased as a compensatory action to bring the ratio back to the required value.

acidic stains. See *staining*.

acoelomate. Designating any metazoan animal that lacks a coelom. The term is often restricted to the Platyhelminthes and Nemertina but may be extended to include the Nematoda, Rotifera, and a few other phyla.

Aconta. Eukaryotic algae that never produce flagella, comprising only the *Rhodophyta. *Compare* Contophora.

acorn worms. See *Hemichordata*.

acoustico-lateralis system. A system of receptors for the detection of movement and vibration in water, found in invertebrate chordates, fish, and aquatic amphibians. It consists of a series of sensory papillae (*neuromasts*) scattered or arranged in rows above the cranial nerves on the head or along the body (*lateral line system*). The neuromasts either lie on the body surface or are sunk into grooves or canals connected to the surface by pores. The structure and function of the neuromasts resembles that of the *macula of the tetrapod ear and the system is probably homologous with the inner ear.

acquired characteristics. See *Lamarckism*.

Acrania. See *Cephalochordata*.

Acrasiales. A group of fairly common soil fungi, the cellular slime fungi, whose plant body is a pseudoplasmodium (see *plasmodium*). The Acrasiales are of uncertain affinities but are usually classified as *Myxomycophyta.

acrocarp. A moss with an upright growth habit and terminal sex organs. *Compare* pleurocarp.

acrogyny. The condition of leafy liverworts in which the apical meristematic cell is used up in the production of archegonia.

acropetal (in botany). Undergoing development from base to apex, i.e. with the oldest structure at the base, as of leaves and inflorescences. *Compare* basipetal, centripetal, centrifugal.

acrosome. See *spermatozoon*.

acrostichoid. See *sorus*.

ACTH (adrenocorticotrophic hormone, corticotrophin). A straight-chain polypeptide hormone of 39 amino acid residues synthesized and secreted during most states of stress by the pars distalis of the mammalian pituitary gland. Its main action is on the growth and maintenance of the adrenal cortex and the stimulation of synthesis and release of corticosteroid hormones. ACTH also stimulates melanin production in pigment cells and lipolysis in fatty tissue, reflecting its similarity in structure to melanocyte-stimulating hormone and lipotrophin. Isolation of the hormone in the late 1950s revealed that the N-terminal 1-24 amino acids were common to all species studied and showed full biological activity. ACTH secretion is regulated by a specific hypothalamic hormone, *corticotrophin-releasing factor (CRF)*, and possibly also by vasopressin; ACTH release is further modulated by a negative feedback action of corticosteroids and ACTH itself by acting at both pituitary and hypothalamic levels.

actin. A protein characteristic of contractile systems, e.g. muscle and flagella. See striated muscle, smooth muscle.

actinomorphic (in botany). Showing *radial symmetry. The term is applied particularly to flowers whose parts are arranged in radial symmetry around the receptacle. Compare zygomorphic.

actinomycetes. A group of nonmotile Gram-positive eubacteria with a mycelial vegetative growth habit. The genus *Mycobacterium* has a transient mycelial growth phase, breaking into irregular rods, while the genera *Nocardia* and *Actinomyces* produce a more extensive mycelium, which fragments only when growth ceases. *Streptomyces* and *Microspora* have a permanent mycelial growth and resemble fungi in producing reproductive conidia at the tips of the hyphae. Most actinomycetes are saprophytic, but some species of *Actinomyces*, *Streptomyces*, and *Nocardia* are parasites and can cause disease in animals (*actinomycosis*). Species of *Streptomyces* produce almost all the important antibiotics, excepting those of the fungus *Penicillium*.

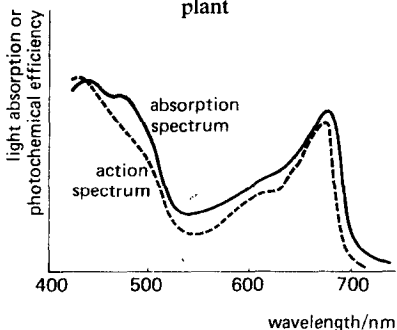
Actinopterygii. A subclass of the Osteichthyes containing the majority of living bony fishes, the ray-finned fishes, in which the fins are composed of a web of skin stiffened by approximately parallel rows of horny rays and lack a central axis. In early forms the body was covered with heavy *ganoid scales and the tail was heterocercal, but in most modern types the scales are reduced or absent. The paired nostrils on the front of the head lack an internal opening and the jaw suspension is *hyostylic. In modern forms there is usually a *swim bladder functioning as a hydrostatic organ but primitive types possessed lungs. There are three subdivisions, the *Chondrostei, *Holostei, and *Teleostei. Compare Choanichthyes.

actinostele. See stele.

Actinozoa. See Anthozoa.

action potential. The transitory reversal of the potential across a nerve or muscle membrane from -70 mV to $+30$ mV (approximately). The action potential is the most easily observed manifestation of the passage of a nervous *impulse. See also resting potential.

Light absorption spectrum and action spectrum of photosynthesis for a green plant



action spectrum. A plot of the relative efficiencies of different wavelengths of radiation (usually light) in causing a reaction. The action spectrum for photosynthesis is shown in the diagram and corresponds closely with the absorption spectrum of the chlorophylls, indicating that the latter pigments are the primary light-trapping molecules in photosynthesis.

active site. The region of an *enzyme with which the substrate reacts.

active transport. The transport of molecules across a biological *membrane against a concentration gradient (i.e. from a region of low concentration to one of high concentration). Active transport is mediated by a carrier (C), thought to be a protein or lipoprotein, which becomes saturated at high concentration levels. It also requires a source of energy, e.g. ATP (see Fig. 1), and is usually unidirectional (unlike passive diffusion, which is reversible). Active transport is responsible for the

Membrane transport systems

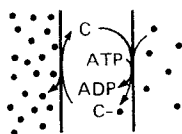


Fig. 1: Active transport

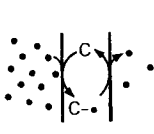


Fig. 2: Facilitated diffusion



Fig. 3: Exchange diffusion

entry of amino acids into cells and for the exclusion of sodium from neurones to produce a resting potential across the cell membrane (see sodium pump).

Passive transport (i.e. without expenditure of energy) may occur reversibly by carrier-mediated systems. Two such systems are *facilitated diffusion*, which occurs along a concentration gradient (see Fig. 2), for example in the transport of glucose into red blood cells; and *exchange diffusion*, in which molecules are exchanged between one side of the membrane and the other (see Fig. 3), for example in the exchange of phosphate across the mitochondrial membrane.

actomyosin. A protein consisting of combined actin and myosin, formed transitorily during contraction of *striated muscle.

acyl glycerols. See glycerides.

adaptation. 1. Any change in an organ or characteristic of an animal or plant that makes it better suited to survive a particular environment. Adaptations eventually result in the evolution of new species.

2. The diminution with time of the frequency of the impulses evoked in a receptor by a constant stimulus. Adaptation may be a property of the accessory structures of a *sense organ* or of the receptor membrane. The rate and extent of adaptation of a receptor is

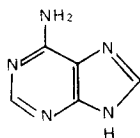
related to its function: nonadapting receptors monitor the static aspects of a stimulus; rapidly adapting phasic receptors, responding to a change in the level of stimulation, are able to monitor dynamic aspects, i.e. the rate of change of a stimulus. Also called: *accommodation*.

adaptive enzyme (inducible enzyme).

An enzyme that is synthesized only in the presence of an inducing agent, such as its substrate: a property of the enzyme-synthesizing system and not of the enzyme itself. For example, if the bacterium *Escherichia coli* is grown on a medium containing lactose, it will produce large amounts of β -galactosidase in order to utilize this substrate. Compare constitutive enzyme.

adaptive radiation. The evolutionary divergence of many forms of animals or plants from a single ancestral stock to fill many ecological niches. These forms can become new species or even, in time, new genera and families. For example, insects underwent adaptive radiation into types suited for flying, burrowing, aquatic life, parasitism, etc.; mammals, both placental and marsupial, evolved into carnivores, herbivores, burrowers, and aquatic, arboreal, and flying types. Flowering plants adapted to suit desert conditions, freshwater, marshland, and salt-marsh habitats, and into climbing, insectivorous, and parasitic modes of life.

adaxial. Designating the surface of a leaf or other lateral organ that is developmentally closest to the apex of the axis that bears it (the *upper* (or *ventral*) surface of such organs). The true nature of an adaxial surface may later become masked, as by twisting of the petiole. Compare abaxial.



Adenine

adenine. A purine base (see formula) that is an essential constituent of the nucleic acids (see DNA, RNA) and also of such coenzymes as NAD and FAD. See also nucleotide, nucleoside.

adenohypophysis. See pituitary gland.

adenosine. A *nucleoside consisting of D-ribose and adenine linked with a β -glycoside bond.

adenosine diphosphate. See ADP.

adenosine monophosphate. See AMP.

adenosine triphosphate. See ATP.

adenylic acid. See AMP.

ADH (antidiuretic hormone). See vasopressin.

adipose tissue (fatty tissue). Tissue consisting of an aggregation of fat cells, in mammals occurring predominantly in subcutaneous tissue, the mesenteries, around the kidneys, and in the mediastinum. A typical fat cell contains a thin band of cytoplasm that has been displaced to the cell periphery by a single large fat droplet. While being present in all connective tissue, fat cells are not called adipose tissue unless aggregated in large masses. Adipose tissue represents a considerable energy source in both normal and starvation conditions; in some species it also provides insulation against heat loss and acts as shock-absorbing tissue, e.g. on the soles of the feet.

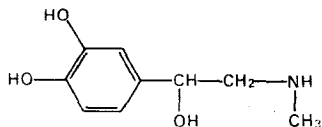
adjuvant. A substance that is not itself antigenic but, when mixed with an antigen, enhances antibody production. Adjuvant not only helps to produce antibody against small amounts of antigen but also prolongs the period of antibody production. Adjuvants for therapeutic use must be easily metabolizable and ultimately eliminated. Although the exact mode of action of adjuvants is uncertain, they are known to promote the persistence of antigen and to cause an inflammatory response that leads to a local influx of antibody-

forming cells. See also Freund's adjuvant.

ADP (adenosine diphosphate). A nucleotide consisting of adenine, D-ribose, and two phosphate groups that is an important coenzyme in many biological reactions. It undergoes phosphorylation to ATP, which is required for many anabolic processes. In the mitochondria ADP is converted to ATP by *oxidative phosphorylation. The level of ADP with respect to that of ATP controls the balance of anabolic and catabolic processes occurring in the cell; the rate of oxidative phosphorylation is stimulated by high levels of ADP and depressed by high levels of ATP.

adrenal glands. A pair of compound endocrine glands in mammals, situated along the anterior surface of each kidney. The adrenals of man were first described in 1563, by the anatomist Eustachius, but it was not until 1805 that Cuvier distinguished two distinct regions of the gland, and 1849 that Addison realized their functional significance. The outer cortex region and the inner medulla region are derived from different embryonic tissues. The *adrenal cortex* originates from lateral mesoderm, in close association with the developing gonads, and consists of three distinct regions surrounded by a thick capsule. It synthesizes and secretes various steroid hormones (see corticosteroid). The outer *zona glomerulosa* produces mineralocorticoids and glucocorticoids, while the inner *zona reticularis-fasciculata* synthesizes mainly glucocorticoids, especially cortisol. In humans this zone also secretes small amounts of androgens and possibly oestrogens. The *adrenal medulla* differentiates from the neural crest into modified ganglion cells in close contact with the sympathetic nervous system; it consists chiefly of *chromaffin tissue and secretes the catecholamines adrenaline and nor-adrenaline under sympathetic stimulation. Adrenal tissues are present in all other vertebrates but considerable variation occurs in the arrangement and

Adrenaline



distribution of the steroid-producing and chromaffin tissues.

adrenaline (epinephrine). The main hormone secreted by the chromaffin tissue of the adrenal medulla in mammals and by the corresponding tissue in other vertebrates and in some invertebrates. It was first isolated in 1901, by Takamine, and synthesized in 1904, by Stolz (see formula). Adrenaline secretion is stimulated by the sympathetic nervous system under various conditions of stress, including pain, fear, muscular activity, and a fall in blood-sugar levels, and has been popularly named the "fight, fright, flight, and frivolity hormone." Its most important effects are on the dilation and constriction of blood vessels and on carbohydrate metabolism, which result in stimulated blood flow and higher blood-glucose levels. Adrenaline is also secreted at the endings of sympathetic nerves and may act as a neurotransmitter. *See also* catecholamines.

adrenergic. Designating a nerve fibre or nerve ending that releases adrenaline or noradrenaline as a neurotransmitter from the presynaptic membrane. Vertebrate postganglionic sympathetic neurones are adrenergic. *Compare* cholinergic.

adrenocorticotrophic hormone. *See* ACTH.

adventitious. Designating a structure produced in an uncharacteristic position. For example, roots produced at the nodes of grass stems and buds produced on leaf surfaces are adventitious.

aecidium (aecium). A sorus characteristic of fungi of the order Uredinales,

including the *rusts. It contains sporogenous hyphae that produce asexual *aecidiospores* by abstriction at their tips. The hyphae are part of the dikaryotic mycelium (*see* heterokaryosis) produced by the *spermatogonium and the aecidiospores are the first binucleate spores of the life cycle, the next being teleutospores (*see* teleutospore).

aerenchyma. A form of parenchymatous tissue with numerous air spaces between the individual cells. It is found mainly in aquatic plants, to which it gives buoyancy.

aerobe. An organism that uses aerobic respiration, i.e. one that requires the presence of free oxygen for life and growth.

aerobic respiration. A type of cellular *respiration in which organic foodstuffs, usually carbohydrates, are completely oxidized to carbon dioxide and water using free oxygen from the atmosphere. The overall equation is usually written: $C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O$. By this process the maximum chemical energy is extracted from the organic substrate.

The initial stage, in which glucose is degraded to pyruvate (*see* glycolysis), occurs in both aerobic and anaerobic respiration; it takes place in the cell cytoplasm. In aerobic respiration pyruvate is converted to acetyl coenzyme A and subsequent processes occur in the mitochondria of the cell. Acetyl CoA then enters the *Krebs cycle, where it is converted to carbon dioxide and hydrogen atoms (or their electron equivalents). The latter are passed to the *electron transport chain, where they reduce a series of catalytic pigments (*see* cytochrome, flavoprotein) and are passed to molecular oxygen to form water. This process is coupled to phosphorylation (*see* oxidative phosphorylation), in which the energy released at each stage of the electron transport chain is used to generate ATP. *Compare* anaerobic respiration.

aerotaxis. See taxis.

aestivation. 1. (in botany). The way in which young flower parts are folded in the bud before opening. See also ptyxis. 2. (in zoology). Dormancy or sluggishness during a dry hot period. Some lungfish, e.g. *Protopterus*, aestivate by burying themselves in swamp mud before it dries out in the hot season and re-emerge when the rains start. Compare hibernation.

aethalium. A large spore-producing structure of the Myxomycetes. It may be stalked or sessile and consists of a wall, the *peridium*, within which the spores are produced and a *capillitium* may form. The capillitium is a meshwork of nonliving hygroscopic threads that aid spore liberation. After the peridium disintegrates it often expands considerably. Aethalia are probably phylogenetically derived by the fusion of numerous small sporangia to form a few (one to six) large bodies (the aethalia) per plasmodium.

afferent. 1. Designating a nerve or neurone that transmits ingoing information from the peripheral receptors to the CNS; i.e. any sensory neurone.

2. Designating a blood vessel that breaks up to form a capillary bed, especially any of the arteries of the aortic arches of fish that lead from the dorsal aorta to the gills. Compare efferent.

afatoxin. A poisonous metabolite of the fungus *Aspergillus*. It came into prominence in the 1950s when the death of a large number of turkeys was traced to groundnut meal contaminated by *Aspergillus flavus*. Contamination of stored nuts and cereals in warm and humid climates by *Aspergillus* is suspected of being the cause of some liver diseases (especially cancers) in these parts of the world.

afterbirth. See placenta.

after-ripening. The period of dormancy of many apparently mature seeds, particularly of the Rosaceae, that cannot be

broken by conditions normally favourable for germination. During this period physiological changes, such as degradation of inhibitors, must occur before the seed can become sensitive to external conditions. It ensures that premature germination (for instance, just before winter) does not occur.

agamospermy. Any type of apomixis excluding vegetative propagation.

agar. A complex mucilaginous polysaccharide extracted from seaweeds and used as a gelling agent for solidifying liquid nutrient media. Many types of microorganisms can be grown on the gel surface as only very few bacteria produce enzymes capable of liquifying the gel. Agar gels melt at 100°C but solidify at about 44°C.

agglutination. A process in which cells or bacteria cross-link with or attach to each other when the antigens on the surface of their cells interact with antibodies (*agglutinins*), which form bridges linking the antigen determinant sites of the different cells. Agglutination reactions are used to identify blood groups, bacteria, etc.

aggression (in animal behaviour). Any of various actions involving threatening postures and activities and attacks on other animals. The term is usually restricted to all types of behaviour shown by an animal that serve to displace other animals, usually those of the same species and especially in defence of a *territory.

Agnatha. The class containing the earliest and most primitive vertebrates, characterized by the absence of jaws. Agnathans are aquatic fishlike animals that lack the paired fins typical of true fishes, although some fossil types had a single anterior pair of finlike appendages. There are several fossil orders (known collectively as the Ostracodermi), including the *Osteostraci and *Heterostraci, as well as the modern *Cyclostomata (lampreys and hagfish).

agonistic behaviour. Any or all of various types of animal behaviour associated with aggression, including threatening postures, appeasement, and flight. Some types of agonistic behaviour have evolved into displays, which keep the actual fighting to a minimum.

agranulocyte. One of a group of white blood cells having no distinct cytoplasmic granules, e.g. lymphocytes and monocytes. *Compare* granulocyte.

air bladder. See swim bladder.

air sacs. 1. Blind-ending extensions of the bronchi in birds, projecting from the lungs and extending into most regions of the body. The compression and expansion of the air sacs, which is effected by contraction and relaxation of surrounding muscles and by movements of the limbs during flight, ensures a constant flow of air over the respiratory surface. In most flying birds diverticula of the air sacs penetrate the marrow cavity of many bones (the *pneumatic bones*), reducing the body weight.

2. Small bladder-like dilations of the tracheae in many swiftly flying insects. Respiratory movements of the insects bring about the collapse and expansion of these sacs, which increases ventilation of the tracheal system.

alanine (ala). An amino acid, $\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH}$, one of the 20 common *amino acids found in proteins.

albinism. 1. The absence of pigmentation in the skin, hair, and eyes, found in some animals and thought to be due to a recessive gene.

2. The absence of chlorophyll in the leaves or stems of plants in the layers in which it usually occurs.

albumen. See albumin.

albumin. One of a group of simple proteins that are soluble in water and coagulated by heat. The best-known albumins are those occurring in the blood (*serum albumins*). The water-

soluble protein of egg white was formerly known as *albumen*. In fact it consists of a number of proteins, notably *ovalbumin*, which contains a carbohydrate prosthetic group and is thus a conjugated, rather than a simple, protein.

albuminous cell. See companion cell.

albumum (sapwood). See wood.

aldose. A *monosaccharide, such as glucose or ribose, that possesses an aldehyde group ($-\text{CHO}$).

aldosterone. A potent *mineralocorticoid hormone secreted by the adrenal glands of mammals from the cells of the outer cortex (glomerulosa zone) and by the adrenal tissue of many other vertebrates. It was finally isolated and crystallized from cortico-adrenal extracts in 1953, by Simpson and Tait. Aldosterone secretion can be stimulated by ACTH, but angiotensin is a more important regulator, operating independently of trophic factors from the pituitary gland. Deprivation of sodium and reduced blood volumes also stimulate secretion.

aleurone grain. A storage body of plant tissues, particularly those of seeds. It is surrounded by a single membrane and stores mainly proteins and the enzymes necessary for their mobilization (hence it is sometimes called a *protein body*). It is variously regarded as a special type of vacuole or a type of *aleuroplast. See aleurone layer.

aleurone layer. The outermost layer, several cells in thickness, of the endosperm of cereal seeds. The cells contain aleurone grains for food storage and they synthesize the enzyme α -amylase, which catalyses the digestion of starch in the endosperm. The signal for α -amylase synthesis is a gibberellin secreted by the scutellum of the embryo at the onset of germination.

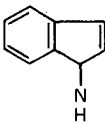


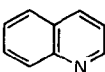
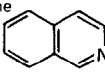

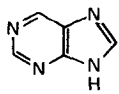
aleuroplast. A plastid that stores protein, often in the form of grains. See aleurone grain.

Algae. A large group of thallophytes whose plant bodies vary from microscopic unicells through coenocytes and filamentous forms to the giant kelps. They possess chlorophyll and most are photosynthetic. Sex organs are either unicellular or multicellular; the cells of multicellular sex organs are all gametic (except in the Charophyceae and Rhodophyta). The classification of the algae is constantly changing but there are seven major groups most frequently recognized: *Chlorophyta, *Chrysophyta, *Cyanophyta, *Euglenophyta, *Phaeophyta, *Pyrophyta, and *Rhodophyta. Classification is based on (1) form of the nuclear material, (2) form of the photosynthetic membranes, (3) types of pigment present, (4) storage products formed, (5) nature of the cell wall, (6) methods of reproduction, and (7) structure and number of flagella. The flagellated unicellular algae are regarded by zoologists as animals and placed in the subclass Phytomastigina (see Mastigophora).

alimentary canal. The canal in animals through which foodstuffs pass, to be broken down by mechanical and chemical means until they are in a form suitable for absorption and assimilation by the body tissues. The anterior and posterior sections are lined with ectoderm; the midsection, in which digestion and absorption occurs, is lined with endoderm (see also intestine). In the Coelenterata and Platyhelminthes the canal has a single opening. In other Metazoa a distal opening, the *anus, is present and food is propelled from the mouth to the anus by the action of cilia and/or muscles. Reverse movements of food may occur (as in ruminant mammals) or food may be temporarily located in diverticula (as in molluscs). The alimentary canal shows a diversity of morphological and biochemical specializations to suit particular diets, e.g. carnivorous, fluid, filter feeders, etc. It becomes adapted for the sequential processing of food, with regions for reception, storage, mechanical break-

down, chemical digestion, absorption, and faeces formation. The terminology of these regions is functional and does not necessarily reflect embryological similarity (see foregut, midgut, hindgut). Parts of the canal, e.g. the pharynx and cloaca, may be secondarily utilized for nondigestive functions. A canal is absent in parasites and other animals whose food is ingested in an absorbable form.

Representative alkaloids

HETEROCYCLIC GROUP	ALKALOID
indole 	lysergic acid reserpine strychnine
pyridine 	nicotinic acid nicotine
reduced pyridine 	coniine cocaine
quinoline 	quinine
isoquinoline 	morphine papaverine
pyrimidine 	barbituric acid
purine 	caffeine

alkaloids. A heterogeneous group of basic nitrogen-containing substances that are produced by plants and have potent pharmacological activities. Alkaloids are often of complex struc-

ture, typically with heterocyclic rings containing nitrogen; they can be classified according to the type of heterocyclic group present (see table).

Most alkaloids are produced by dicotyledonous plants (ergotamine, obtained from the fungus *Claviceps purpurea*, is a notable exception) and particular alkaloids are usually restricted to certain families or genera. All members of the family Papaveraceae produce alkaloids; in other families, e.g. Ranunculaceae, Apocynaceae, Solanaceae, alkaloids are produced only by certain genera.

Alkaloids show varied pharmacological activities. They can act as analgesics (e.g. morphine), tranquillizers (e.g. reserpine), respiratory stimulants (e.g. nicotine), vasoconstrictors (e.g. scopalamine), local anaesthetics (e.g. cocaine), muscle relaxants (e.g. strychnine), and psychedelic agents (e.g. psilocybin, LSD). Many alkaloids or their synthetic derivatives are used medicinally, e.g. cinchona (to treat malaria), morphine, and reserpine. Some are poisons, notably coniine (from hemlock) and strychnine.

The function of alkaloids in plants is still a matter of conjecture. For example it has been suggested that they are by-products of metabolism; alternatively they may provide protection against insects that feed on the plants.

alkanes. See chemical fossils.

allantois. See extraembryonic membranes.

allele (allelomorph). One of a pair of genes that occupy the same relative position (*locus*) on homologous chromosomes and separate during meiosis. Alleles are responsible for the production of contrasting characteristics, such as normal or vestigial wings in *Drosophila* and round or wrinkled seed coats in peas. When alleles are present in pairs, one is often *dominant to the other, which is known as the *recessive. The wild-type allele is usually dominant; recessives arise by mutation and are

usually deleterious. In Mendelian genetics, there are several ways of representing alleles. They are often represented by the initial letter of the characteristic produced by the dominant allele, so that round seeds (dominant) would be denoted *R* and wrinkled seeds (recessive) as *r*. Alternatively the dominant, or wild type, is represented as + and the recessive by the initial letter (or two letters) of its characteristic. Thus in *Drosophila*, normal wings is represented as + and vestigial as *vg*. The term *allelomorph* is also used for the characteristic produced by an allele. See also pseudoallele, multiple allele.

allelomorph. See allele.

alloantigen. See isoantigen.

allogamy. Cross-fertilization in plants.

allograft. See homograft.

allopatric speciation. See speciation.

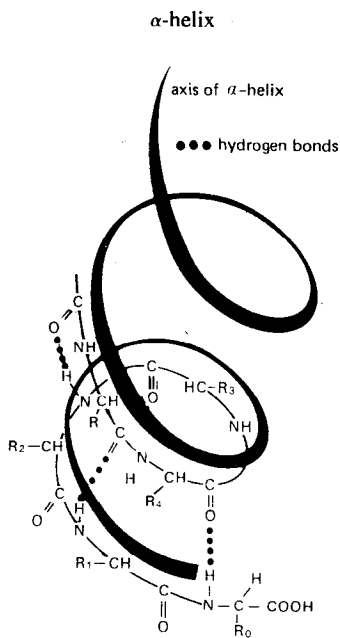
allopolyploidy. See polyploidy.

all-or-none. Designating a response that takes one of two discrete levels, either no response or maximal response, whatever the stimulus intensity. A stimulus characteristically elicits no response unless it is above a threshold value, when it initiates an explosive chain reaction. The initiation of a nervous impulse is a typical all-or-none event.

allosteric site. A region of an *enzyme, other than the active site, to which molecules other than the substrate can be bound. Binding to an allosteric site may activate or inhibit the enzyme.

allotetraploid (amphidiploid). A tetraploid produced by allopolyploidy. See polyploidy.

alpha-helix. A regular right-handed helical structure that is the stable configuration of many polypeptide chains and contributes to the secondary and tertiary structure of the protein. The peptide bond and α -amino acid carbon form the backbone of the helix, which is stabilized by hydrogen bonds between



amino acids in successive turns of the helix (see illustration). The hydrogen bonds are formed between the peptide nitrogen of one amino acid and the carbonyl oxygen of the amino acid four residues along, giving a periodicity of 3.6 amino acid residues per turn of the helix. Compare beta-pleated sheet.

ALS. See antilymphocyte serum.

alternation of generations. The condition of having more than one type of individual to complete the *life cycle, occurring very commonly in both animals (especially parasites) and plants. The generations usually differ from each other in appearance and reproduction. The most usual type of alternation is between sexual and asexual generations. For example, in many hydrozoan coelenterates a sexual medusoid phase alternates with an asexual polypoid phase. In bryophytes the dominant generation (i.e. the most conspicuous

plant in the life cycle) is the sexual (gametophyte) phase. The zygote develops into the asexual (sporophyte) phase, the capsule, which produces spores that give rise to the sexual plants. In pteridophytes the dominant plant is the sporophyte, whose spores, on germination, produce small prothalli (the gametophyte phase), which bear the sex organs. In seed plants, too, the sporophyte is dominant but the gametophyte phase is reduced to microscopic proportions (see seed).

In most plants alternation of generations is associated with an alternation in diploid and haploid conditions and the intervention of meiosis and karyogamy. The asexual phase is diploid and produces the spores by meiosis; the resulting gametophyte is haploid and karyogamy (of the gametes) restores the diploid condition of the sporophyte. In the life cycles of some organisms more than two generations alternate regularly with each other. For example, in many red algae the life cycle runs gametophyte — carposporophyte — tetrasporophyte — gametophyte.

alveolus. 1. A blind-ending sac that occurs at the terminus of a bronchiole of the lung of reptiles and mammals and forms the respiratory surface. Exchange of gases between the air and the blood takes place across the moist thin vascular epithelium lining the alveoli.

2. The cavity in the jaw bone that encloses the root of a tooth.

3. A sac of secretory cells at the ending of a duct in some glands, especially the mammary gland.

amino acids. Organic compounds bearing both a free carboxyl group and an amino group. There are several hundred naturally occurring amino acids and their derivatives but only 20 are commonly found in proteins; they are listed as follows.

Hydrophobic amino acids

alanine
valine
leucine
isoleucine