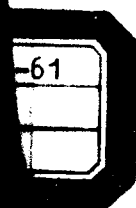


The Dictionary of  
**CELL  
BIOLOGY**

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# The Dictionary of **CELL BIOLOGY**

EDITED BY

J. M. Lackie AND

J. A. T. Dow

AUTHORS

C. J. Brett

A. S. G. Curtis

J. A. T. Dow

J. G. Edwards

J. M. Lackie

A. J. Lawrence

G. R. Moores

*At the Departments of Cell Biology and Botany,  
School of Biology, University of Glasgow,  
Glasgow, G12 8QQ, UK.*



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I. Lackie, J.M. (John Michael)

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## Preface

The stimulus to write this dictionary came originally from our teaching of a two-year Cell Biology Honours course to undergraduates in the University of Glasgow. All too often students did not seem to know the meanings of terms we felt were commonplace in cell biology, or were unable, for example, to find out what compounds in general use were supposed to do. But before long it became obvious that although we all considered ourselves to be cell biologists, individually we were similarly ignorant in areas only slightly removed from our own – though collectively the knowledge was there. It was also clear that many of the things we considered relevant were not easy to find, and that an extensive reference library was needed. In that we have found the exercise of preparing the Dictionary informative ourselves, we feel that it may serve a useful purpose.

An obvious problem was to decide upon the boundaries of the subject. We have not solved this problem; modern biology is a continuum and any attempt to subdivide it is bound to fail. "Cell Biology" implies different things to zoologists, to biochemists, and indeed to each of the other sub-species of biologists. There is no sensible way to set limits, nor would we wish to see our subject crammed into a well-defined niche. Inevitably, therefore the contents are somewhat idiosyncratic, reflecting our current teaching, reading, prejudices, and fancies.

It may be of some interest to explain how we set about preparing the Dictionary. The list of entry words was compiled largely from the index pages of several textbooks, and by scanning the subject indexes of cell-biological journals. To this were added entries for words we cross-referenced. The task of writing the basic entries was then divided amongst us roughly according to interests and expertise. We all wrote subsets of entries which were then compiled and alphabetized before being edited by one of us. Marked copies were then sent out to a panel of colleagues who scrutinised entries in their own fields. All entries were looked at by one or more of this panel, and then the annotated entries were re-edited, corrections made on disc, and the files copy-edited for consistency of style. A very substantial amount of the handling of the compiled text and the preparation of the final discs was done by Dr A M Lackie who also acted as copy-editor.

Glasgow is a major centre for Life Sciences, and we are fortunate in having many colleagues to whom we could turn for help. We are very grateful to them for the work which they put in and for the speed with which they checked the entries that we sent. Although we have tried hard to avoid errors and ambiguities, and to include everything that will be useful, we apologise at this stage for the mistakes and omissions, and emphasise that the blame lies with the authors and not with our panel (though they have saved us from many embarrassments).

Since there is no doubt that Cell Biology is developing rapidly as a field, it is inevitable that usages will change, that new terms will become commonplace, that new proteins will be christened on gels, and that the dictionary will soon have

omissions. Were the subject static this dictionary would not be worth compiling – and we cannot anticipate new words.

Because the text is on disc, it will be relatively easy to update; please let us have your comments, suggestions for entries (preferably with a definition), and (perhaps) your neologisms. A sheet is included at the back of the dictionary for this purpose.

### **A note regarding entries**

The main entry word is followed by synonyms in brackets. Words in bold in the definition are cross-references to other entries which might contribute usefully to the entry being consulted, although other words within the definition may well have entries.

Generally speaking compounds or substances which have a greek letter prefix have been alphabetized ignoring the greek prefix; where the prefix is spelled out, this is considered to be the more general usage. Numbers are ignored for purposes of alphabetization.

*John Lackie*

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# A

**A23187** A monocarboxylic acid extracted from *Streptomyces chartreusensis* that acts as a mobile-carrier calcium *ionophore*.

**A cells** ( $\alpha$  cells) Cells of the endocrine pancreas (*Islets of Langerhans*) that form approximately 20% of the population; their opaque spherical granules may contain *glucagon*. See *B cells*, *D cells*.

**A9 cells** Cells of an established line of heteroploid mouse fibroblasts which are deficient in *HGPRT*.

**A-band** That portion of the *sarcomere* in which the thick myosin filaments are located. It is anisotropic ("A") in polarised light.

**A-DNA** Right-handed double-helical DNA with approximately 11 residues per turn. Planes of base-pairs in the helix are tilted 20° away from perpendicular to the axis of the helix. Formed from *B-DNA* by dehydration.

**ABLV** The Abelson murine *leukaemia* virus, a species of mammalian *Retroviridae*. Its transforming gene, *abl*, encodes a protein with tyrosine-specific *protein kinase* activity closely related to the *src gene* product.

**AB toxin** Multi-subunit toxin in which there are two major components, an active (A) portion and a portion which is involved in binding (B) to the target cell. The A portion can be effective in the absence of the B subunit(s) if introduced directly into the cytoplasm. In the well-known examples, the A subunit has *ADP-ribosylating* activity. See *cholera toxin*, *diphtheria toxin*, *pertussis toxin*.

**abortive infection** Viral infection of a cell in which the virus fails to replicate fully, or produces defective progeny. Since part of the viral replicative cycle occurs, its effect on the host can still be cytopathogenic.

**abortive transformation** Temporary transformation of a cell by a virus which fails to integrate into the host DNA.

**abrin** Toxic *lectin* from seeds of *Abrus precatorius* that has a binding site for galactose

and related residues in carbohydrates but, because it is monovalent, is not an *agglutinin* for *erythrocytes*.

**abscess** A cavity within a tissue occupied by pus (chiefly composed of degenerating inflammatory cells), generally caused by bacteria which resist killing by phagocytes.

**abscisic acid** Mediator of plant cell activity found in vascular plants (a *plant growth substance*). Originally isolated from cotton bolls and identical to dormin. Although at first thought to be important in abscission (leaf fall) now known to be involved in a number of growth and developmental processes in plants including, in some circumstances, growth promotion.

**Acanthamoeba** Soil amoeba 20–30  $\mu$ m in diameter which can be grown *axenically* and has been extensively used in biochemical studies of cell motility. Some have been isolated from cultures of monkey kidney cells, and are pathogenic when injected into mice or monkeys.

**acanthosome** 1. Spinous membranous *organelle* found in skin *fibroblasts* from *nude mice* as a result of chronic ultraviolet irradiation. 2. Sometimes used as a synonym for *coated vesicle* (should be avoided).

**accessory cells** Cells which interact, usually by physical contact, with T-lymphocytes and which are necessary for induction of an immune response. Include antigen presenting cells, antigen processing cells etc. They are usually MHC Class II positive (see *histocompatibility antigens*). Monocytes, macrophages, dendritic cells, Langerhans cells, B-lymphocytes *inter alia* may all act as accessory cells.

**accessory chromosome** See *B-chromosome*.

**accessory pigments** In *photosynthesis*, pigments which collect light at different wavelengths and transfer the energy to the primary system.

**ACE** See *angiotensin*.

**acellular slime moulds** Protozoa of the Order Eumycetozoida (also termed true slime moulds), which have a multinucleate plasmodial phase in the life cycle and exhibit shuttle-flow (tidal) *cytoplasmic streaming*.

**acentric** Descriptive of pieces of *chromosome* which lack a *centromere*.

## Acetabularia

**Acetabularia** Giant single-celled *alga* of the Order Dasycycladaceae. The plant is 3–5cm long when mature and consists of *rhizoids* at the base of a stalk, at the other end of which is a cap that has a shape characteristic of each species. The giant cell has a single nucleus, located at the tip of one of its rhizoids; the nucleus can easily be removed by cutting off that rhizoid. Nuclei can also be transplanted from one cell to another.

**acetylation** Addition, either chemically or enzymically, of acetyl groups.

**acetylcholine (ACh)** Acetyl ester of choline. Perhaps the best characterised *neurotransmitter* released by vertebrate motoneurons, pre-ganglionic sympathetic and parasympathetic neurons. ACh can be either excitatory or inhibitory, and its receptors are classified as *nicotinic* or *muscarinic*, according to their pharmacology. In *chemical synapses* ACh is rapidly broken down by *acetylcholine esterase*, thereby ensuring the transience of the signal.

**acetylcholine esterase** An enzyme, found in the *synaptic clefts* of *cholinergic neurons*, which cleaves the *neurotransmitter acetylcholine* into its constituents, acetate and choline, thus limiting the size and duration of the *postsynaptic potential*. Many nerve gases and insecticides are potent acetylcholine esterase inhibitors, and thus prolong the timecourse of postsynaptic potentials.

**acetyl CoA** The acetylated form of coenzyme A, which is a carrier for acyl groups, particularly in the *tricarboxylic acid cycle*.

**N-acetyl glucosamine** (2-acetamido glucose) A sugar unit found in glycoproteins and various polysaccharides such as *chitin*, bacterial *peptidoglycan* and *hyaluronic acid*.

**N-acetyl muramic acid** Sugar unit of bacterial *peptidoglycan*, consisting of N-acetyl glucosamine bearing a lactyl residue in ether linkage to carbon 3. Repeating unit of the cell wall polysaccharide is N-acetyl muramic acid linked to N-acetyl glucosamine via a  $\beta(1-4)$ -glycosidic bond, which can be cleaved by the enzyme *lysozyme*.

**N-acetyl neuraminic acid** See *neuraminic acid*.

**achondroplasia** Failure of endochondral ossification responsible for a form of dwarfism; caused by an *autosomal* dominant mutation. Relatively high incidence (1:20,000 live births), mostly (90%) new

mutations. Also known as *chondrodystrophia fetalis*.

**acid growth theory** Theory explaining the growth-promoting effect of *auxins* in higher plants. Auxin is thought to activate, probably indirectly, a proton pump in the plasma membrane, leading to acidification of the cell wall. This causes cell-wall weakening, leading to cell-wall stretching under the influence of *turgor* pressure, and hence to cell growth (enlargement).

**acid hydrolases** Hydrolytic enzymes which have a low pH optimum. The name usually refers to the *phosphatases*, *glycosidases*, *nucleases* and *lipases* found in the *lysosomal* compartment. They are secreted during *phagocytosis*, but are considered to operate as intracellular digestive enzymes.

**acid phosphatase** (EC 3.1.3.2) Enzyme with acidic pH optimum, which catalyzes cleavage of inorganic phosphate from a variety of substrates. Found particularly in *lysosomes* and *secretory vesicles*. Can be localised histochemically using various forms of the *Gömori procedure*.

**acid protease** Proteolytic enzyme with an acid pH optimum, characteristically found in *lysosomes*. See *proteases*.

**acid secreting cells** Large specialised cells of the epithelial lining of the stomach (parietal or oxyntic cells) which secrete 0.1N hydrochloric acid; by means of  $K^+/H^+$  *antiport* ATPases on the luminal cell surface.

**acidophilla** Having an affinity for acidic dyes, particularly eosin; may be applied either to tissues or bacteria.

**acidophils** One class of cells found in the pars distalis of the adenohypophysis.

**acinar cells** Epithelial *secretory cells* arranged as a ball of cells around the lumen of a gland (as in the pancreas).

**acinus** Small sac or cavity surrounded by *secretory cells*.

**acquired immune deficiency syndrome** See *AIDS*.

**acquired immunity** Classically, the reaction of an organism to a new antigenic challenge and the retention of a memory of this, as opposed to innate immunity. In modern terms, the clonal expansion of a population of immune cells in response to a

specific antigenic stimulus and the persistence of this clone.

**acrasiales** See *Acrasidae*.

**Acrasidae** The cellular slime moulds. They normally exist as free-living phagocytic soil amoebae, but when bacterial prey become scarce, they aggregate to form a pseudoplasmodium (cf true *plasmodium* of acellular slime moulds, Eumycetozoida), which is capable of directed motion. The grex, or slug, migrates until stimulated by environmental conditions to form a fruiting body or sorocarp. The slug cells differentiate into elongated stalk cells and spores, where the cells are surrounded by a cellulose capsule. The spores are released from the sporangium at the tip of the stalk and, in favourable conditions, an *amoeba* emerges from the capsule, feeds, divides and so establishes a new population. They can be cultured in the laboratory and are widely used in studies of cell-cell adhesion, cellular differentiation, *chemotaxis* and *pattern formation*. The commonest species studied are *Dictyostelium discoideum*, *D. minutum* and *Polysphondylium violaceum*.

**acrasin** Name originally given to the *chemotactic* factor produced by cellular slime moulds (*Acrasidae*): now known to be *cyclic AMP* for *Dictyostelium discoideum*.

**acridine orange** A fluorescent vital dye, which intercalates into nucleic acids. The nuclei of stained cells fluoresce green; cytoplasmic RNA fluoresces orange. May be carcinogenic. Acridine orange also stains acid mucopolysaccharides, and is widely used as a pH-sensitive dye in studies of acid secretion.

**acromegaly** Enlargement of the extremities of the body as a result of the overproduction of *growth hormone* (somatotropin), eg. by a pituitary tumour.

**acrosin** Serine protease stored in the *acrosome* of a sperm as an inactive precursor.

**acrosomal process** A long process actively protruded from the acrosomal region of the spermatozoon following contact with the egg and which assists penetration of the gelatinous capsule.

**acrosome** The lysosomally-derived vesicle at the extreme anterior end of the spermatozoon.

**ACTH** See *adrenocorticotrophin*.

**actin** A protein (42kD) that is very abundant in eukaryotic cells (8–14% total cell protein) and one of the major components of the *actomyosin* motor and the cortical microfilament meshwork. First isolated from *striated muscle* and often referred to as one of the muscle proteins. G-actin is the globular monomeric form of actin ( $6.7 \times 4.0\text{nm}$ ); it polymerises to form filamentous F-actin.

**actin binding proteins** A diverse group of proteins which bind to *actin* and which may stabilise F-actin filaments, nucleate filament formation, cross-link filaments, lead to bundle formation etc. See Table A1.

**actin meshwork** *Microfilaments* inserted proximally into the plasma membrane and cross-linked by *actin binding proteins* to form a mechanically resistive network which may support protrusions such as *pseudopods* (sometimes referred to as the cortical meshwork).

**$\alpha$ -actinin** A protein (100kD) normally found as a dimer and which may link actin filaments end-to-end with opposite polarity. Originally described in the *Z-disc*, now known to occur in *stress-fibres* and at *focal adhesions*.

**$\beta$ -actinin** A protein (35kD, normally dimeric) which is thought to bind to the end of the *thin filament* furthest from the *Z-disc* serving to block disassembly. Might be homologous to *acumentin*.

**actinogelin** Protein (115kD) from *Ehrlich ascites* cells which gelates and bundles *microfilaments*.

**actinomycin D** Antibiotic from *Streptomyces* spp. which binds to DNA and thus blocks the movement of *RNA polymerase* and prevents RNA synthesis in both prokaryotes and eukaryotes.

**actinomycins** A family of chromopeptide antibiotics that differ solely in the peptide portion of the molecule. Produced by species of *Streptomyces*.

**actinotrichia** Aligned collagen fibres (ca  $2\mu\text{m}$  diameter) which provide a guidance cue for mesenchymal cells in the developing fin of teleost fish.

**action potential** Brief, regenerative, all-or-nothing potential that passes along the membranes of *excitable cells*, such as *neurons*, *muscle cells*, fertilised eggs and certain plant cells. The precise shape of action potentials varies, but action potentials

## Table A1. Actin binding proteins

Table A1. Actin binding proteins

### (I) Monomer sequestering (Bind G actin)

Protein	MW (kD)	Source
Profilin	12-15	Various
Vit D binding protein	57	Plasma
DNAase I	31	Pancreas
Depactin	19	Starfish oocytes
19kDa protein	19	Pig brain

### (II) End-blocking and nucleating

Protein	MW (kD)	End <sup>a</sup>	Calcium sensitivity <sup>b</sup>	Source
Gelsolin	90	+	+	Mammalian cells; same as brevin and ADF
Villin	95	+	+	Amphibian eggs, avian and mammalian epithelia
Fragmin/severin	40-45	+	+	<i>Physarum</i> , <i>Dictyostelium</i> , sea urchin eggs
Capping protein	31, 28	+	-	<i>Acanthamoeba</i>
Acumentin	65	-	-	Mammalian leucocytes
$\beta$ -actinin	37, 35	-	-	Kidney and striated muscle

### (III) Cross-linking

#### Isotropic gelation

Protein	Subunits (kD)	Source
Actin-binding protein	2 $\times$ 270	Macrophages, platelets, <i>Xenopus</i> eggs
Filamin	2 $\times$ 250	Smooth muscle
Spectrin	2 $\times$ 240, 2 $\times$ 220	Erythrocytes
Fodrin	2 $\times$ 260, 2 $\times$ 240	Brain
TW 260/240	2 $\times$ 260, 2 $\times$ 240	Intestinal epithelium

#### Anisotropic bundling

Protein	Subunits (kD)	Source
$\alpha$ -actinin	2 $\times$ 95	Various
Actinogelin	2 $\times$ 115	Ehrlich ascites tumour cells
Fascin	53-57	Pig brain, echinoderm gametes
Fimbrin	68	Intestinal epithelium
Villin	95	Intestinal epithelium (see ii)

### (iv) Miscellaneous

Protein	MW (kD)	Source
Gelactins	23-38	4 types; from <i>Acanthamoeba</i>
MAP2	300	Brain, microtubule associated
tau	50-68	Microtubule associated
Calpactins	35, 36	Various

<sup>a</sup>Microfilament end to which protein binds.

<sup>b</sup>At high calcium sever F-actin, at low calcium nucleate microfilaments.

always involve a large *depolarisation* of the cell membrane, from its normal *resting potential* of  $-50$  to  $-90$  mV. In a neuron, action potentials can reach  $+30$  mV, and last 1 ms. In muscles, action potentials can be much slower, lasting up to 1 s.

**action spectrum** The relationship between the frequency (wavelength) of a form of radiation, and its effectiveness in inducing a specific chemical or biological effect.

**activated macrophage** A *macrophage* (mononuclear phagocyte) which has been stimulated by *lymphokines* (especially  $\gamma$ -*interferon*) and which has greatly enhanced cytotoxic and bactericidal potential.

**activation** (of egg) Normally brought about by contact between spermatozoon and egg membrane. Activation is the first stage in development and occurs independently of nuclear fusion. The first observable change is usually the cortical reaction which may involve elevation of the fertilisation membrane; the net result is a block to further fusion and thus to polyspermy. In addition to the morphological changes, there are rapid changes in metabolic rate and an increase in protein synthesis from maternal mRNA.

**activation energy** The energy required to bring a system from the ground state to the level at which a reaction will proceed.

**active site** The region of a *protein* that binds to substrate molecule(s) and facilitates a specific chemical conversion. Produced by juxtaposition of amino acid residues as a consequence of the protein's *tertiary structure*.

**active transport** Often defined as transport up an electrochemical gradient. More precisely defined as unidirectional or vectorial transport produced within a membrane-bound protein complex by coupling an energy-yielding process to a transport process. In primary active transport systems the transport step is normally coupled to *ATP* hydrolysis within a single protein "complex". In secondary active transport the movement of one species is coupled to the movement of another species down an electrochemical gradient established by primary active transport.

**active zone** Special region of the *presynaptic cell* membrane which has projections of dense material on the cytoplasmic face. The

area in which fusion of *synaptic vesicles* is most likely to occur.

**activin** *FSH*-releasing protein: dimer of two *inhibin*  $\beta$ -chains.

**actomyosin** Generally: a motor system which is thought to be based on *actin* and *myosin*. The essence of the motor system is that myosin makes transient contact with the actin filaments and undergoes a conformational change before releasing contact. The hydrolysis of *ATP* is coupled to movement, through the requirement for *ATP* to restore the configuration of myosin prior to repeating the cycle. More specifically: a viscous solution formed when actin and myosin solutions are mixed at high salt concentrations. The viscosity diminishes if *ATP* is supplied and rises as the *ATP* is hydrolysed. Extruded threads of actomyosin will contract in response to *ATP*.

**acumentin** Protein (65kD) of analogous function to  $\beta$ -actinin, isolated from vertebrate *macrophages*.

**acute** 1. Sharp or pointed. 2. Of diseases; coming rapidly to a crisis — not persistent.

**acute inflammation** Response of vertebrate body to insult or infection; characterised by redness (*rubor*), heat (*calor*), swelling (*tumor*), pain (*dolor*), and sometimes loss of function. Changes occur in local blood flow, and *leucocytes* (particularly *neutrophils*) adhere to the walls of post-capillary venules (*margination*) and then move through the *endothelium* (*diapedesis*) towards the damaged tissue. Although usually an acute inflammation is relatively short-term, there are situations in which persistent acute-type inflammation, with neutrophils and macrophages as the dominant cell types (unlike *chronic inflammation*) occurs.

**acute phase proteins** Proteins found in increased quantities in the serum of animals showing *acute inflammation*. In particular *C-reactive protein* and *serum amyloid A* protein.

**acute lymphoblastic leukaemia** See *leukaemia*.

**acyclovir** Antiviral agent that is an analogue of *guanosine* and inhibits *DNA replication* of viruses. Particularly successful against herpes simplex infections.

**adaptation** A change in sensory or excitable cells upon repeated stimulation, which

reduces their sensitivity to continued stimulation. Those cells which show rapid adaptation are known as phasic; those which adapt slowly are known as tonic.

**ADCC** (antibody-dependent cell-mediated cytotoxicity) A phenomenon in which IgG-coated target cells are killed by non-sensitised effector cells (neutrophils, monocytes, NK cells) by a non-phagocytic mechanism which is independent of complement.

**Addison's disease** Chronic insufficiency of the adrenal cortex classically as a result of tuberculosis or, more interestingly, specific autoimmune destruction of the *adrenocorticotrophin*-secreting cells.

**addressins** Molecules expressed in an organ- or tissue-selective manner by cells or extracellular elements which are found in other locations (where they may express functionally-related counterparts). Their role seems to be to signal position or mark the address for the purpose of directing cell-cell interactions. A subset, the vascular addressins, are expressed in a tissue-specific manner by endothelium and are important in lymphocyte recirculation.

**adducin** *Calmodulin*-binding protein associated with the membrane skeleton of erythrocytes. A substrate for *protein kinase C*, it binds to *spectrin-actin* complexes (but only weakly to either alone) and promotes the assembly of spectrin onto spectrin-actin complexes unless micromolar calcium is present. Has subunits of 102 and 97kD and is distinguishable from Band 4.1.

**adenine** (6-aminopurine) One of the bases found in *nucleic acids* and *nucleotides*. In DNA, it pairs with *thymine*.

**adeno-** Prefix indicating association with, or similarity to, glandular tissue.

**adenocarcinoma** Malignant neoplasia of a glandular epithelium, or *carcinoma* showing gland-like organisation of cells.

**adenohypophysis** Anterior lobe of the pituitary gland; responsible for secreting a number of hormones and containing a comparable number of cell types.

**adenoma** *Benign tumour* of glandular epithelium.

**adenosine** (9- $\beta$ -D-ribofuranosyladenine) The *nucleoside* formed by linking *adenine* to *ribose*.

**adenosine diphosphate** See *ADP*.

**adenosine monophosphate** See *AMP*, *cyclic AMP*.

**adenosine triphosphate** See *ATP*.

**S-adenosyl methionine** (S-(5'-deoxyadenosine-5')-methionine) An activated derivative of *methionine*, which functions as a methyl group donor, in (for example) nucleic acid or phospholipid methylation and bacterial *chemotaxis*.

**Adenoviridae** Large group of viruses first isolated from cultures of adenoid tissue. The *capsid* is an icosahedron of 240 hexons and 12 pentons in the form of a base and a fibre; the genome consists of a single, linear molecule of double-stranded DNA. They cause various respiratory and gastrointestinal infections in humans. Some of the avian, bovine, human and simian adenoviruses cause tumours in newborn rodents, generally hamsters. They can be classified into highly, weakly and non-*oncogenic* viruses from their ability to induce tumours *in vivo* though all of these groups will transform cultured cells. The viruses are named after their host species and subdivided into many serological types.

**adenylate cyclase** Enzyme which produces *cyclic AMP* from *ATP*. The best known example is the adenylate cyclase which produces a *second messenger* (cAMP) in response to external signals. Receptors are coupled to the adenylate cyclase by stimulatory or inhibitory *GTP-binding proteins*.

**adhaerens junctions** (USA adherens junctions) Specialised cell-cell junctions into which are inserted *microfilaments* (also known as "*zonulae adhaerentes*") or *intermediate filaments* ("maculae adhaerentes" or "spot *desmosomes*").

**adhesins** General term for molecules involved in adhesion, but its use is restricted in Microbiology where it refers to bacterial surface components.

**adhesion** Attachment of two surfaces, mediated by molecular interactions. See *cell adhesion*.

**adhesion plaque** Another term for a *focal adhesion*, a discrete area of close contact between a cell and a non-cellular substratum, with cytoplasmic insertion of *microfilaments* and considerable electron-density adjacent to the contact area.

**adipocyte** *Connective tissue* cell specialised for the storage of fat. There may be distinct types in white and brown fat.

**adipofibroblasts** *Adipocytes* from subcutaneous fat will lose fat globules and develop a fibroblastic appearance when grown in culture. Unlike skin fibroblasts they will take up fat from serum taken from obese donors, and probably retain a distinct differentiated state.

**adipose tissue** Fibrous connective tissue with large numbers of fat-storing cells, *adipocytes*.

**adjuvant** Additional components added to a system to affect action of its main component, typically to increase the *immune response* to an *antigen*. See *Freund's adjuvant*.

**ADP** (adenosine diphosphate) Unless otherwise specified is the nucleotide 5'ADP, *adenosine* bearing a diphosphate (pyrophosphate) group in ribose-O-phosphate ester linkage at position 5 of the ribose moiety. Adenosine 2'5' and 3'5'diphosphates also exist, the former as part of *NADP* and the latter in *coenzyme A* and mRNA.

**ADP-ribosylation** A form of *post-translational modification* of protein structure involving the transfer to protein of the ADP-ribosyl moiety of *NAD*. Believed to play a part in normal cellular regulation as well as in the mode of action of several bacterial toxins.

**adrenal** Endocrine gland adjacent to the kidney. Distinct regions, the cortex and medulla, produce different ranges of hormones.

**adrenaline** (epinephrine) A *hormone* secreted by the medulla of the adrenal gland in response to stress, and by some *neurons*. The effects are those of the classic "fight or flight" response, including increased heart function, elevation in blood sugar levels, cutaneous vasoconstriction making the skin pale, and raising of hairs on the neck.

**adrenergic neuron** A neuron is adrenergic if it secretes *adrenaline* or *noradrenaline* at its terminals. Many neurons of the *sympathetic nervous system* are adrenergic.

**adrenocorticotrophin** (ACTH) A peptide hormone produced by the pituitary gland in response to stress (mediated by corticotrophin releasing factor, a 41 residue peptide,

from the hypothalamus). Stimulates the release of adrenal cortical hormones, mostly *glucocorticoids*. Derived from a larger precursor, *pro-opiomelanocortin*, by the action of an endopeptidase, which also releases  $\beta$ -*lipotropin*.

**adventitia** Outer coat of the wall of *vein* or *artery*, composed of loose *connective tissue* which is vascularised. Generally means outer covering of an organ.

**aequorin** Protein (30kD) extracted from jellyfish (*Aequorea aequorea*) which emits light in proportion to the concentration of calcium ions. Used to measure calcium concentrations, but has to be microinjected into cells. See also *bioluminescence*.

**aerenchyma** Form of *parenchyma* tissue containing particularly large intercellular air spaces, the cells being in contact at only a few points on their surfaces. Found chiefly in submerged roots and stems of plants growing in aquatic or marshy environments, permitting aeration of the tissues.

**aerobes** Organisms which rely on oxygen.

**aerotaxis** *Taxis* (tactic response) to oxygen (air).

**affinity** An expression of the strength of interaction between two entities, eg. between receptor and ligand or between enzyme and substrate. The affinity is usually characterised by the equilibrium constant (*association* or *dissociation constant*) for the binding, this being the concentration at which half the receptors are occupied.

**affinity chromatography** *Chromatography* in which the immobile phase (bed material) has a specific biological affinity for the substance to be separated or isolated, such as the affinity of an *antibody* for its *antigen*, or an enzyme for a substrate analogue.

**aflatoxins** A group of highly toxic substances produced by the fungus *Aspergillus flavus*, and other species of *Aspergillus*, in stored grain or mouldy peanuts. They cause enlargement and death of liver cells if ingested, and may be carcinogenic.

**agar** A polysaccharide complex extracted from seaweed (Rhodophyceae) and used as an inert support for the growth of cells, particularly bacteria and some cancer cell lines. Gels have the unusual property of melting at high temperature (ca 100°C) but

## agarose

\* not solidifying until the temperature is less than about 40°C.

**agarose** A galactan polymer purified from *agar* which forms a rigid gel with high free water content. Primarily used as an electrophoretic support for separation of macromolecules. Stabilised derivatives are used as "macroporous" supports in *affinity chromatography*. See *Sephargose*.

**agglutination** The formation of adhesions by particles or cells to build up multicomponent aggregates, otherwise termed agglutinates or flocs. Distinguished from *aggregation* by the fact that agglutination phenomena are usually very rapid. Usually caused by agents such as *antibodies*, *lectins* or other bi- or poly-valent reagents, and it is useful to reserve the term for situations in which an extrinsic agent is added to the system, in contrast to *aggregation*.

**agglutinins** Agents causing *agglutination*, eg. *antibodies*, *lectins*, *polylysine*.

**aggregation** The process of forming adhesions between particles such as cells. *Aggregation* is usually distinguished from *agglutination* by the slow nature of the process; not every encounter between the cells is effective in forming an adhesion. Useful to reserve the term for situations in which no cross-linking agglutinin is added to the system.

**agonist** 1. In neurobiology, of a *neuron* or *muscle*; one which aids the action of another. If the two effects oppose each other, then they are known as antagonistic. 2. In pharmacology, a compound which acts on a receptor to elicit a response. 3. In ethology, "agonistic behaviour" means aggressive behaviour towards a conspecific animal.

**agorins** Major structural proteins of the membrane matrix, constituting approximately 15% of total plasma membrane proteins of P815 mastocytoma cells. They form large detergent-insoluble structures when the membranes are extracted with Triton X-100 and EGTA. Agorin I, 20kD; Agorin II, 40kD.

**AGP** (arabinoglycan-protein) A class of extracellular *proteoglycan*, found in many higher-plant tissues, and secreted by many suspension-cultured plant cells. Contains 90-98% *arabinogalactan* and 2-10% protein. Related to arabinogalactan II of the cell wall.

**agranular vesicles** Synaptic vesicles which do not have a granular appearance in the electron microscope; 40-50nm in diameter, with membrane only 4-5nm thick. Characteristic of peripheral *cholinergic* synapses; some are located very close to the *presynaptic cell* membrane.

**agranulocytosis** Severe deficiency of *granulocytes* in blood.

**agrin** A protein isolated from the electric organ of the electric ray, *Torpedo californica*, that induces *myotubes* to form specialisations similar to those at the neuromuscular junction.

**Agrobacterium tumefaciens** A Gram negative, rod-shaped flagellated bacterium responsible for *crown gall* tumour in plants. Following infection the T1 *plasmid* from the bacterium becomes integrated into the host plant's DNA and the presence of the bacterium is no longer necessary for the continued growth of the tumour.

**AIDS** (Acquired Immune Deficiency Syndrome) Disease caused by infection with *HIV* (human immunodeficiency virus), causing a deficiency of *T-helper cells* with resulting *immunosuppression* phenomena; there is thus increased susceptibility to other infectious diseases and to certain types of tumour, particularly *Kaposi's sarcoma*.

**alanine** (Ala; A; MW 89) Normally refers to L- $\alpha$ -alanine, the aliphatic amino acid found in proteins. The isomer  $\beta$ -alanine is a component of the vitamin *pantothenic acid* and thus also of *coenzyme A*. See Table A2.

**albinism** Condition in which no *melanin* is synthesised.

**albumin** The term normally refers to serum albumins, the major protein components of the serum of vertebrates. They have a single polypeptide chain, with multidomain structure containing multiple binding sites for many lipophilic metabolites notably fatty acids and bile pigments. In the embryo their functions are fulfilled by  $\alpha$ -*foetoproteins*. The viability of analbuminaemic individuals (those deficient in albumin) suggests albumin is not indispensable.

**alcian blue** Water-soluble copper phthalocyanin stain used to demonstrate acid *mucopolysaccharides*. By varying the ionic strength some differentiation of various types is possible.

**aldosterone** A steroid hormone (mineralocorticoid), produced in the outermost of the three zones of the adrenal medulla, which controls salt and water balance in the kidney. Release is controlled by *angiotensin II*; excessive secretion occurs in Cushing's syndrome, decreased release in Addison's disease.

**aleurone grain** (aleurone body) Membrane-bounded *storage granule* within plant cells that usually contains protein. May be an *aleuroplast* or just a specialised *vacuole*.

**aleuroplast** A semi-autonomous organelle (*plastid*) within a plant cell, which stores protein.

**Aleutian disease of mink** A disease caused by a *slow virus* of the *Parvoviridae* family producing *autoimmune* symptoms, glomerulonephritis and immune complexes.

**algae** A non-taxonomic term used to group several phyla of the lower plants, including the *Rhodophyta* (red algae), *Chlorophyta* (green algae), *Phaeophyta* (brown algae) and *Chrysophyta* (diatoms). Many algae are unicellular or consist of simple undifferentiated colonies, but red and brown algae are complex multicellular organisms, familiar to most people as seaweeds. Blue-green algae (Cyanophyta) are a totally separate group of *prokaryotes*, more correctly known as *Cyanobacteria*.

**alkaline phosphatase** (EC 3.1.3.1) Enzyme catalyzing cleavage of inorganic phosphate non-specifically from a wide variety of phosphate esters, and having a high (8+) pH-optimum. Found in bacteria, fungi and animals but not in higher plants.

**alkaloid** A nitrogenous base. Usually refers to biologically active (toxic) molecules, produced as allelochemicals by plants to deter grazing. Examples: *ouabain*, *digitalis*.

**alkaptonuria** In humans, the congenital absence of homogentisic acid oxidase, an enzyme which breaks down tyrosine and phenylalanine. Accumulation of homogentisic acid in homozygotes causes brown pigmentation of skin and eyes and damage to joints; urine blackens on standing.

**alleles** Different forms or variants of a *gene* found at the same place, or *locus*, on a *chromosome*. Assumed to arise by *mutation*.

**allelic exclusion** The process whereby one or more loci on one of the *chromosome* sets in

a *diploid cell* is inactivated (or destroyed) so that the locus or loci is (are) not expressed in that cell or a clone founded by it. For example in mammals one of the *X chromosome* pairs of females is inactivated early in development (see *Lyon hypothesis*) so that individual cells express only one allelic form of the product of that locus. Since the choice of chromosome to be inactivated is random, different cells express one or other of the X chromosome products, resulting in mosaicism. The process is also known to occur in *immunoglobulin* genes so that a clone expresses only one of the two possible allelic forms of immunoglobulin.

**allelochemical** A little-used term, referring to substances effecting allelopathic reactions. See *allelopathy*.

**allelopathy** The deleterious interaction between two organisms or cell types which are *allogeneic* to each other (the term is often applied loosely to interactions between *xenogeneic* organisms). Allelopathy is seen between different species of plant, between various individual sponges, and between sponges and gorgonians.

**allergic encephalitis** See *experimental allergic encephalomyelitis*.

**allergy** An inexact term, usually referring to immediate (Type I) *hypersensitivity*.

**allogeneic** Two or more individuals (or strains) are stated to be allogeneic to one another when the genes at one or more loci are not identical in sequence in each organism. Allogenicity is usually specified with reference to the locus or loci involved.

**allograft** Graft between two or more individuals allogeneic at one or more loci (usually with reference to *histocompatibility* loci); cf *autograft* and *xenograft*.

**allopolyploidy** *Polyploid* condition in which the contributing genomes are dissimilar. When the genomes are doubled fertility is restored and the organism is an amphidiploid. Common in plants but not animals.

**allopurinol** A *xanthine oxidase* inhibitor used in the treatment of gout.

**allosomes** One or more chromosomes which can be distinguished from *autosomes* by their morphology and behaviour. Synonyms: accessory chromosomes, heterochromosomes, sex chromosomes.

## allosteric

**allosteric** Of a binding site in a protein, usually an enzyme. The catalytic function of an enzyme may be modified by interaction with small molecules, not only at the *active site*, but also at a spatially distinct (allosteric) site of different specificity. Of a protein, a protein possessing such a site. An allosteric effector is a molecule bound at such a site which increases or decreases the activity of the enzyme.

**allotope** (allotypic determinant) The structural region of an *antigen* which distinguishes it from another *allotype* of that antigen.

**allotype** Product of one or more *alleles* that can be detected as an inherited variant of a particular molecule. Generally the usage is restricted to those *immunoglobulins* that can be separately detected antigenically. See also *idiotype*. In humans light chain allotypes are known as Km (Inv) allotypes and heavy chain allotypes as Gm allotypes.

**alloxan** Used to produce *diabetes mellitus* in experimental animals. Destroys pancreatic *B cells* by a mechanism involving *superoxide* production.

**allozyme** Variant of an enzyme coded by a different allele. See *isoenzyme*.

**$\alpha_1$ -antitrypsin** Better named  $\alpha_1$ -antiprotease ( $\alpha_1$ -*protease inhibitor*). A major protein of blood *plasma* (3mg/ml in human), part of the  $\alpha$ -globulin fraction, and able to inhibit a wide spectrum of *serine proteases*.

**$\alpha$ -cell** See *A cells* of endocrine pancreas.  $\alpha$ -*acidophils* are cells from the adenohypophysis.

**$\alpha$ -foetoprotein** Protein from the serum of vertebrate embryos, which probably fulfils the function performed by *albumin* in the mature organism. Found in both glycosylated and nonglycosylated forms. Presence in the fluid of the *amniotic sac* is diagnostic of spina bifida in the human foetus.

**$\alpha$ -helix** (alpha helix) A particular helical folding of the polypeptide backbone in protein molecules (both fibrous and globular), in which the carbonyl oxygens are all hydrogen-bonded to amide nitrogen atoms four residues along the chain. The translation of amino acid residues along the long axis is 0.15nm, and the rotation per residue, 100°, which gives 3.6 residues/turn.

**$\alpha_1$ -protease inhibitor** ( $\alpha_1$ -PI) Plasma protein which inhibits elastase and other serine

proteases (a *serpin*). Susceptible to inactivation by oxidation or by protease attack; chronic inflammation in the lung may lead to local inactivation of  $\alpha_1$ -PI, potentiating elastase degradation of connective tissue thus contributing to the development of emphysema. Major component of what was once called  $\alpha_1$ -antitrypsin.

**altered self hypothesis** The hypothesis that the *T-cell* receptor in MHC-mediated phenomena recognises a *syngeneic* MHC Class I or Class II molecule in association with antigen. See *MHC restriction*, *histocompatibility antigen*.

**alternative oxidase pathway** (alternative terminal oxidase) See *alternative pathway 2*.

**alternative pathway 1**. See *complement 2*. Pathway of mitochondrial electron transport in higher plants, particularly fruits and seeds, which does not involve *cytochrome oxidase* and hence is resistant to cyanide.

**Alu** Type II *restriction endonuclease*, isolated from *Arthrobacter luteus*. The recognition sequence is 5'-AG/CT-3'. *Alu* sequences are highly repetitive sequences found in large numbers (100-500,000) in the human genome, and which are cleaved more than once within each sequence by the *Alu* endonuclease. The *Alu* sequences look like DNA copies of mRNA because they have a 3' *poly-A tail* and flanking repeats.



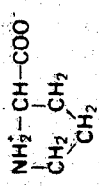


**alveolar cell** Cell of the air sac of the lung.

**alveolar macrophage** *Macrophage* found in pulmonary alveoli and which can be obtained by lung lavage; responsible for clearance of inhaled particles and lung *surfactant*. Metabolism slightly different (more oxidative metabolism) from peritoneal macrophages, often has *multivesicular bodies* which may represent residual undigested lung surfactant.

**Alzheimer's disease** A presenile dementia characterised by the appearance of unusual helical protein filaments in nerve cells, and by degeneration in cortical regions of brain, especially frontal and temporal lobes. May be associated with *slow virus* or selective loss or dysfunction of *cholinergic neurons*.

**amacrine cell** A class of *neuron* of the middle layer of the *retina*, with processes parallel to the plane of the retina; involved in image processing.

Table A2. Amino acids specified by the biological code for proteins.

Name	Abbreviation	Single letter	Side chain	pK <sub>a</sub> <sup>*</sup> (Stryer)	MW (D) (rounded)	Hydropathy index** (Kyte & Doolittle)	Codons
Alanine	ala	A	-CH <sub>3</sub>		89.1	1.8	GC(X)
Arginine	arg	R	-CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> NH (CONH <sub>2</sub> ) NH <sub>2</sub>	12	174.2	-4.5	CG(X) AGA AGG
Aspartic acid	asp	D	-CH <sub>2</sub> COO <sup>-</sup>	4.4	133.1	-3.5	GAU GAC
Asparagine	asn	N	-CH <sub>2</sub> CONH <sub>2</sub>		132.2	-3.5	AAU AAC
Cysteine	cys	C	-CH <sub>2</sub> SH	8.5	121.2	2.5	UGU UGC
Glutamic acid	glu	E	-CH <sub>2</sub> CH <sub>2</sub> COO <sup>-</sup>	4.4	147.2	-0.4	GG(X)
Glutamine	gln	Q	-CH <sub>2</sub> CH <sub>2</sub> CONH <sub>2</sub>		146.2	-3.5	CAA CAG
Glycine	gly	G	-H		75.1	-3.5	GG(X)
Histidine	his	H	-CH <sub>2</sub> 	6.5	155.2	-3.2	CAU CAC
Iso-leucine	ile	I	-CH (CH <sub>3</sub> ) CH <sub>2</sub> CH <sub>3</sub>		131.2	4.5	AUU AUC AUA
Leucine	leu	L	-CH <sub>2</sub> CH (CH <sub>3</sub> ) <sub>2</sub>		131.2	3.8	CU(X) UUA UUG
Lysine	lys	K	-CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> NH <sub>2</sub> <sup>+</sup>	10	146.2	-3.9	AAA AAG
Methionine	met	M	-CH <sub>2</sub> CH <sub>2</sub> SCH <sub>3</sub>		149.2	1.9	AUG
Phenylalanine	phe	F	-CH <sub>2</sub> 		165.2	2.8	UUU UUC
Proline	pro	P	 (whole molecule)		115.1	-1.6	CC(X)
Serine	ser	S	-CH <sub>2</sub> OH		105.1	-0.8	UC(X)
Threonine	thr	T	-CH (OH) CH <sub>3</sub>		119.1	-0.7	AC(X)
Tryptophan	trp	W	-CH <sub>2</sub> 		204.2	-0.9	UGG (UGA mitochondria)
Tyrosine	tyr	Y	-CH <sub>2</sub> 	10	181.2	-1.3	UAU UAC
Valine	val	V	-CH (CH <sub>3</sub> ) <sub>2</sub>		117.2	4.2	GU(X)

\* The value for side chain ionisation when the amino acid residue is present in a polypeptide.

\*\* A measure of the tendency for the residue to be buried within the interior of a folded protein.