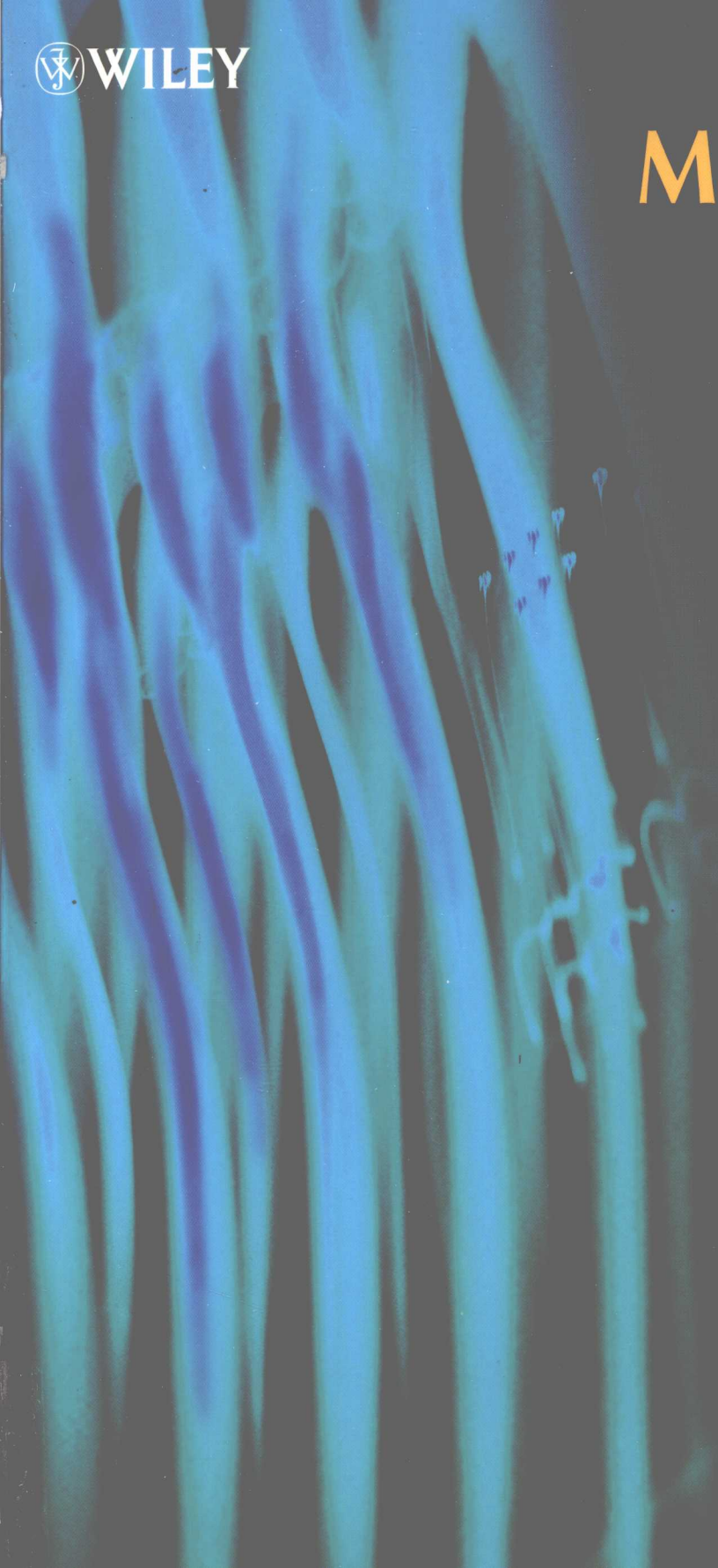

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Dictionary of Microbiology and Molecular Biology

3rd Edition
Revised

Paul **Singleton**
Diana **Sainsbury**

Dictionary of Microbiology and Molecular Biology

Third Edition, Revised

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Diana **Sainsbury**

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Preface

This edition follows the style of previous editions. It has similar aims, and was written with the same enthusiasm and care.

It is vital that readers be aware of the type of alphabetization used in the Dictionary. A glance at 'Notes for the User' – particularly the first paragraph – is essential.

September 2001

Preface to the Second Edition

In writing this new edition of the Dictionary we had several aims in mind. One of these was to provide clear and up-to-date definitions of the numerous terms and phrases which form the currency of communication in modern microbiology and molecular biology. In recent years the rapid advances in these disciplines have thrown up a plethora of new terms and designations which, although widely used in the literature, are seldom defined outside the book or paper in which they first appeared; moreover, ongoing advances in knowledge have frequently demanded changes in the definitions of older terms – a fact which is not always appreciated and which can therefore lead to misunderstanding. Accordingly, we have endeavoured to define all of these terms in a way which reflects their actual usage in current journals and texts, and have also given (where appropriate) former meanings, alternative meanings, and synonyms.

A second – but no less important – aim was to encapsulate and integrate, in a single volume, a body of knowledge covering the many and varied aspects of microbiology. Such a reference work would seem to be particularly useful in these days of increasing specialization in which the reader of a paper or review is often expected to have prior knowledge of both the terminology and the overall biological context of a given topic. It was with this in mind that we aimed to assemble a detailed, comprehensive and interlinked body of information ranging from the classical descriptive aspects of microbiology to current developments in related areas of bioenergetics, biochemistry and molecular biology. By using extensive cross-referencing we have been able to indicate many of the natural links which exist between different aspects of a particular topic, and between the diverse parts of the whole subject area of microbiology and molecular biology; hence the reader can extend his knowledge of a given topic in any of various directions by following up relevant cross-references, and in the same way he can come to see the topic in its broader contexts. The dictionary format is ideal for this purpose, offering a flexible, 'modular' approach to building up knowledge and updating specific areas of interest.

There are other more obvious advantages in a reference work with such a wide coverage. Microbiological data are currently disseminated among numerous books and journals, so that it can be difficult for a reader to know where to turn for information on a term or topic which is completely unfamiliar to him. As a simple example, the name of an unfamiliar genus, if mentioned out of context, might refer to a bacterium, a fungus, an alga or a protozoon, and many books on each of these groups of organisms may have to be consulted merely to establish its identity; the problem can be even more acute if the meaning of an unfamiliar term is required. A reader may therefore be saved many hours of frustrating literature-searching by a single volume to which he can turn for information on any aspect of microbiology.

An important new feature of this edition is the inclusion of a large number of references to recent papers, reviews and monographs in microbiology and allied subjects. Some of these references fulfil the conventional role of indicating sources of information, but many of them are intended to permit access to more detailed information on particular or general aspects of a topic – often in mainstream journals, but sometimes in publications to which the average microbiologist may seldom refer. Furthermore, most of the references cited are themselves good sources of references through which the reader can establish the background of, and follow developments in, a given area.

While writing this book we were very fortunate in having exceptional and invaluable cooperation from a number of libraries in South-West England. In particular, we would like to acknowledge the generous help of Mr B. P. Jones, B.A., F.L.A., of the Medical Library, University of Bristol, Mrs Jean Mitchell of the Library at Bicton College of Agriculture, Devon, and Maureen Hammett of Exeter Central Library, Devon. Finally,

we are grateful to Michael Dixon, Patricia Sharp, and Prue Theaker at John Wiley & Sons, Chichester, for their enthusiastic and efficient cooperation in the production of the book.

Paul Singleton & Diana Sainsbury
Clyst St Mary, Devon, April 1987

Notes for the User

1. *Alphabetization.* Alphabetization would need no comment if every term consisted of a single word; in practice, however, many terms consist of two or more words and often contain single letters, numbers, symbols etc. Terms consisting of two or more words can be alphabetized in either of two ways: on the basis of the first word, or on the basis that both or all of the words are run together and treated as one; thus, e.g., according to the 'first-word' ('nothing-before-something') system, *red tide* comes before *redox potential*, but according to the second system *redox potential* comes before *red tide*. Terms in this Dictionary have been alphabetized by the first-word system; in this system a single letter counts as a word (hence e.g. *R plasmid* comes before *rabies*), as does a group of letters (e.g. an abbreviation, or a gene designation). Examples:

air sacculitis	**atoxyl**	**black stem rust**	**RecA protein**
airlift fermenter	**ATP**	**black wart disease**	**recapitulation theory**
AIV process	**ATP synthase**	**black yeasts**	***recB* gene**
Ajellomyces	**ATPase**	**blackeye cowpea mosaic virus**	**RecBC pathway**

When a *hyphen* connects two complete words, or occurs between a letter (or group of letters) and a word, the hyphen is regarded as a space; however, if a hyphen is used to link a *prefix* to a word (i.e., if the letters preceding the hyphen form a part-word which cannot stand alone) the term is alphabetized as though it were a single, non-hyphenated word. (In a few cases an entry heading contains words which can be written as separate, hyphenated or non-hyphenated words, or closed up as a single word: e.g. *red water fever*, *red-water fever*, *redwater fever*; in such cases an entry or cross-reference has been included in both possible positions.) Examples:

BL-type starter	**M**	**nonsense mutation**	**preaxostyle**
***bla* gene**	**M antigen**	**nonsense suppressor**	**pre-B cell**
black beans	**M-associated protein**	**non-specific immunity**	**prebuccal area**
Black beetle virus	**M bands**	**non-specific immunization**	**precipitation**

When a *Greek letter* forms a significant part of an entry heading it is counted as a word and is alphabetized as spelt (i.e., α as alpha, β as beta, etc: see Appendix VI for the Greek alphabet). A Greek letter is ignored for the purposes of alphabetization if it is a relatively minor qualification: e.g., part of a chemical designation (which can usually be replaced by a number, as in β-hydroxybutyrate, = 3-hydroxybutyrate). Examples:

Delhi boil	**MTOC**	**pHisoHex**	**polyhedrosis**
Δ	**μ**	**ϕX phage group**	**poly-β-hydroxyalkanoate**
delta agent	**Mu**	***Phlebia***	**poly-β-hydroxybutyrate**
δ antigen	***mu* chain**	***Phlebotomus***	**Polyhymenophorea**

A *number* which forms part of an entry heading affects the position of that entry only if the number immediately follows a letter or word (but cf. chemical names, below). A number which precedes a letter or word is usually ignored, although in the few cases where a number is the first and *main* part of an entry heading it is alphabetized as spelt. Letter–number combinations come after a letter–space but before letter–letter combinations, as in the illustrative sequence A, A2, A2A, A3, A22, AA, ABA etc. Roman numerals are treated as ordinary numbers (I as 1, II as 2 etc). (The reader should bear in mind that, in an unfamiliar term, 'I' could be a letter I or a Roman one, and its location in the Dictionary will be affected accordingly; similarly, 'V' could be letter V or Roman five. O and 0 (zero) may also be confused. If in doubt check both possible positions.) Examples:

bacteriophage Pf2	**D loop**	**Fitz-Hugh–Curtis syndrome**	**T1 side-chains**
bacteriophage ϕI	**D period**	**five–five–five test**	**T-2 toxin**
bacteriophage ϕII	**12D process**	**five-kingdom classification**	**T2H test**
bacteriophage ϕ6	**D-type particles**	**five–three–two symmetry**	**T7 phage group**

Subscript/superscript numbers and letters are alphabetized as though they were ordinary numbers and letters (except in the case of ion designations: see below). Examples:

avoparcin	**B virus**	**C3 convertase**	**CO_2**
a_w	**B_{12} coenzymes**	**C_3 cycle**	**CO_2-stat**
axenic	**B663**	**C3bina**	**CoA**
axial fibrils	**Babes–Ernst granules**	**C5 convertase**	**coactin**

Primes, *apostrophes* and other *non-alphabetizable symbols* (including e.g. plus, minus and *% signs*) are ignored. Examples:

brown rust	**F antigens**	**Gautieriales**	**pluronic polyol F127**
Browne's tubes	**F^+ donor**	**Gazdar murine sarcoma virus**	**plus progamone**
Brownian movement	**F-duction**	**GC%**	**plus strand**
Brown's tubes	**F factor**	**GC type**	**Pluteaceae**

In *chemical names* qualifications such as D-, L-, *N*-, *o*-, *p*-, numbers and Greek letters, as well as hyphens between parts of chemical names, are all ignored for the purposes of alphabetization. Examples:

acetyl-CoA synthetase	**diazomycin A**	**methylmethane sulphonate**
***N*-acetyl-D-glucosamine**	**6-diazo-5-oxo-L-norleucine**	***N*-methyl-*N′*-nitro-*N*-nitrosoguanidine**
acetylmethylcarbinol	**diazotroph**	***N*-methyl-*N*-nitrosourea**
***N*-acetylmuramic acid**	**dibromoaplysiatoxin**	***Methylobacterium***

In entry headings which include an *ion designation*, the ion is treated as a word, the charge being ignored; thus, H^+ is regarded as H, Ca^{2+} as Ca, etc. Examples:

H antigens	**H^+/P ratio**	**K cells**	**Na^+-ATPase**
H^+-ATPase	**H^+-PPase**	**K^+ pump**	**Na^+-motive force**
$H^+/2e^-$ ratio	**H strand**	**K^+ transport**	**Na^+ pump**
H-lysin	**H-1 virus**	**K virus**	**nabam**

2. *Cross-references*. References from one entry to another within the Dictionary are indicated by SMALL CAPITAL letters. In order to effect maximum economy of space, information given in any particular entry is seldom repeated elsewhere, and cross-referencing has been extensively employed to ensure continuity of information. In some cases a complete understanding of an entry, or an appreciation of context, is dependent on a knowledge of information given in other entries; where it is particularly important to follow up a cross-reference, the cross-reference is followed by 'q.v.'. In other cases a cross-reference may be used to link one topic with another of related interest, or to extend the scope of a given topic in one or more directions; in such cases a cross-reference is usually preceded by 'see also' or 'cf.'. (N.B. For a variety of reasons, not every microbiological term or taxon used in the text is cross-referred – even though most of these terms and taxa are defined in the Dictionary; the reader is therefore urged to use the Dictionary for *any* unfamiliar term or taxon.)

When reading an entry for a genus, family or other taxon, it is especially important to follow up, when indicated, a cross-reference to the higher taxon to which it belongs. An entry for a given higher taxon gives the essential features applicable to all members of that taxon, and such features are usually *not* repeated in the entries for each of the constituent lower-ranked taxa; thus, in failing to follow up such cross-references, the reader will forfeit fundamental information relating to the lower taxon in question.

In some cases an entry heading is followed simply by 'See CROSS-REFERENCE'. This is *not* intended to indicate that the two terms are synonymous (usually they are not); such referral signifies only that the meaning of the term is given under the heading indicated. When the entry heading and cross-reference are synonymous, this is indicated by *Syn.*, thus: **entry heading** *Syn.* CROSS-REFERENCE.

3. *External references*. References to papers, articles etc in books or journals are given in square brackets. In order to save space, books are referred to by a 'Book ref.' number, and journal titles are abbreviated

somewhat more than is usual; keys to book reference numbers and journal title abbreviations can be found at the end of the Dictionary (after the Appendices).

A book reference is usually quoted as a source of general background information for the reader, while papers in journals are usually quoted for specific details of current information (or for reviews) and/or for their references to other literature in the field. We should emphasize that the papers we have cited are not necessarily (and are commonly not) those which were the first to report a particular fact, finding or theory; rather, we have chosen, where possible, to cite the most recent references available to us, so that the reader is referred to *current* information and can, if he wishes, trace the earlier literature via references given in the cited papers. We should also point out that the quoting of a single reference in an entry is not intended to indicate that the entry was written solely from information in that paper or book. In relatively few cases does the information in an entry derive from a single source; in the great majority of entries the information has been derived from, or checked against, a range of sources, but limitations of space have necessarily prevented us from citing all of them.

4. *Numbered definitions.* In some cases a term is used with different meanings by different authors, or it may have different meanings in different contexts; for such a term the various definitions are indicated by (1), (2), (3), etc. The order in which the numbered definitions occur is *not* intended to reflect in any way appropriateness or frequency of usage.

5. *Taxonomy.* See entries ALGAE, BACTERIA, FUNGI, PROTOZOA and VIRUS for some general comments on the taxonomy of each of these groups of microorganisms. Each of these entries (except that on bacteria) provides a starting point from which the reader can, via cross-references, follow through a hierarchical system down to the level of genus and, in many cases, species and below; similarly, the hierarchy can be ascended from genus upwards.

6. *The Greek alphabet.* See Appendix VI.

A

A (1) Adenine (or the corresponding nucleoside or nucleotide) in a nucleic acid. (2) Alanine (see AMINO ACIDS).

Å (Ångström unit) 10^{-10} m (= 10^{-1} nm).

2–5A See INTERFERONS.

A-DNA See DNA.

a-factor See MATING TYPE.

A layer An S LAYER associated with virulence in strains of *Aeromonas salmonicida*.

A-protein In TOBACCO MOSAIC VIRUS: a mixture of small oligomers and monomers of coat protein subunits which occur in equilibrium with the larger 'disc' aggregates under conditions of physiological pH and ionic strength; coat protein occurs mainly as A-protein under conditions of high pH and low ionic strength. (cf. PROTEIN A.)

A site (of a ribosome) See PROTEIN SYNTHESIS.

A-tubule (A-subfibre) See FLAGELLUM (b).

A-type inclusion body See POXVIRIDAE.

A-type particles Intracellular, non-infectious, retrovirus-like particles. Many embryonic and transformed mouse cells contain retrovirus-like 'intracisternal A-type particles' (IAPs) which form by budding at the endoplasmic reticulum; these particles have reverse transcriptase activity and an RNA genome coding for the structural protein of the particles. The mouse genome contains ca. 1000 copies (per haploid genome) of DNA sequences homologous to IAP-associated RNA; these sequences appear to be capable of transposition within the mouse genome – probably via an RNA intermediate [Book ref. 113, pp. 273–279], i.e., they may be RETROTRANSPOSONS. Some A-type particles are non-enveloped precursors of B-type particles (see TYPE B ONCOVIRUS GROUP).

A23187 An IONOPHORE which transports divalent cations, particularly Ca^{2+}; it can effect the transmembrane exchange of $1Ca^{2+}$ (or $1Mg^{2+}$) for $2H^{+}$ without causing perturbation in the gradients of other monovalent cations.

AAA ATPases 'ATPases associated with diverse cellular activities'. AAA ATPases occur e.g. in PEROXISOMES and as components of eukaryotic PROTEASOMES.

AAA pathway AMINOADIPIC ACID PATHWAY.

AAC Aminoglycoside acetyltransferase (see AMINOGLYCOSIDE ANTIBIOTICS).

AAD Aminoglycoside adenylyltransferase (see AMINOGLYCOSIDE ANTIBIOTICS).

AAS Aminoalkylsilane (3-aminopropyltriethoxy-silane, APES; 3(triethoxysilyl)-propylamine, TESPA): a reagent used for binding a tissue section to the surface of a glass slide (e.g. for in situ hybridization); it reacts with silica glass and provides aminoalkyl groups which bind to aldehyde or ketone groups in the tissue section.

***aat* gene** In *Escherichia coli*: a gene whose product promotes the early degradation of those proteins whose N-terminal amino acid is either arginine or lysine. *aat* encodes an 'amino acid transferase' which catalyses the addition of a leucine or phenylalanine residue to the N-terminus of the protein; this destabilizes the protein, facilitating its degradation. (See also N-END RULE.)

***Aat*II** See RESTRICTION ENDONUCLEASE (table).

Aaterra See ETRIDIAZOLE.

AAUAAA locus See MRNA (b).

AAV Adeno-associated virus: see DEPENDOVIRUS.

ab (*immunol.*) ANTIBODY.

AB-transhydrogenase See TRANSHYDROGENASE.

ABA ABSCISIC ACID.

abacavir A NUCLEOSIDE REVERSE TRANSCRIPTASE INHIBITOR.

abacterial pyuria See PYURIA.

Abbe condenser A simple two- or three-lens substage CONDENSER which is uncorrected for spherical or chromatic aberrations.

ABC (1) (*immunol.*) ANTIGEN-BINDING CELL. (2) See ABC TRANSPORTER.

ABC excinuclease See EXCISION REPAIR.

ABC exporter An ABC TRANSPORTER concerned with export/secretion. These systems are found in both prokaryotic and eukaryotic microorganisms and in higher animals, including man. (The mammalian transporters include P-glycoprotein ('multidrug-resistance protein') – a molecular pump by which some types of cancer cell can extrude anti-cancer drugs.) In *Saccharomyces cerevisiae*, an ABC exporter mediates secretion of a peptide PHEROMONE (the **a**-factor) which regulates sexual interaction.

In bacteria, ABC exporters transport various proteins (including enzymes and antibiotics) and, in some species, the polysaccharide components of the capsule; an exporter may be able to transport various related or similar molecules. [Bacterial ABC exporters: MR (1993) *57* 995–1017.]

In *Escherichia coli* the α-haemolysin is secreted via an ABC exporter – a one-step process direct from cytoplasm to environment; this exporter is in the *type I* class of protein secretory systems in Gram-negative bacteria (see PROTEIN SECRETION).

Other proteins secreted by these systems include the cyclolysin of *Bordetella pertussis* and the alkaline protease of *Pseudomonas aeruginosa*. In *Streptomyces antibioticus* an ABC exporter secretes the antibiotic OLEANDOMYCIN.

Bacterial proteins secreted by ABC exporters typically lack an N-terminal signal sequence (see SIGNAL HYPOTHESIS) but they have a C-terminal *secretion sequence* that may interact directly with the ABC protein. Exporters which transport molecules to the periplasm, or outer membrane, as the *final* destination may have fewer protein components than those exporters which *secrete* proteins.

In Gram-negative bacteria, at least some exporters appear to consist of (i) ABC proteins; (ii) a *membrane fusion protein* (MFP) (in the periplasm and cytoplasmic membrane); and (iii) an OUTER MEMBRANE component. Assembly seems to occur in a definite sequence which is promoted and/or initiated by the binding of substrate (i.e. the molecule to be secreted) to the ABC protein; in this scheme, substrate–ABC binding is followed by ABC–MFP interaction – MFP then binding to the outer membrane, presumably to complete the secretory channel [EMBO (1996) *15* 5804–5811].

ABC immunoperoxidase method An IMMUNOPEROXIDASE METHOD involving the use of a preformed avidin–biotin–peroxidase complex (ABC) which has surplus biotin-binding capacity. Initially, a ('primary') antiserum is raised against the required antigen; if the primary antiserum is derived from e.g. a rat, a 'secondary' anti-rat antiserum is prepared, and the anti-rat Ig antibodies are BIOTINylated. To locate a specific antigen, the section is treated with primary antiserum, washed, and then treated with secondary antiserum; the subsequent addition of ABC localizes peroxidase at the site of specific antigen (since the

ABC adheres non-specifically to biotin). Peroxidase (and hence antigen) is detected by incubating the section with e.g. H_2O_2 and diaminobenzidine (which results in the antigenic site being stained brown) or H_2O_2 and 4-chloro-1-naphthol (resulting in a blue stain).

The ABC method can be used for paraffin-embedded sections, frozen sections, and smears. Endogenous (tissue or cell) peroxidase may be quenched e.g. with H_2O_2 in methanol.

ABC protein See ABC TRANSPORTER.

ABC transporter (traffic ATPase) A type of TRANSPORT SYSTEM which, in bacteria, consists typically of a multiprotein complex in the cell envelope, two of the proteins having a specific ATP-binding site (termed the *ATP-binding cassette*; ABC) on their cytoplasmic surface; a (bacterial) protein with an ABC site has been called an 'ABC protein' or an 'ABC subunit'. In eukaryotes, an ABC transporter generally consists of a single polypeptide chain – which also has two ATP-binding sites. Transport mediated by an ABC transporter is energized by ATP hydrolysis at the ABC sites. [ATP-hydrolysing regions of ABC transporters: FEMS Reviews (1998) *22* 1–20.] (See also PROTEIN SECRETION.)

A given type of ABC transporter imports or exports/secretes certain type(s) of ion or molecule. Collectively, these transporters import or secrete a wide range of substances, including ions, sugars and proteins; for example, some import nutrients, or ions for OSMOREGULATION, while others secrete antibiotics or protein toxins. The LmrA transporter in *Lactococcus lactis* mediates an efflux system that extrudes amphiphilic compounds and appears to be functionally identical to the mammalian P-glycoprotein that mediates multidrug-resistance [Nature (1998) *391* 291–295]. The AtrB transporter of *Aspergillus nidulans* mediates energy-dependent efflux of a range of fungicides [Microbiology (2000) *146* 1987–1997].

ABC transporters occur e.g. in Gram-positive and Gram-negative bacteria, members of the Archaea, and in higher animals, including man. In man, certain inheritable diseases (e.g. CYSTIC FIBROSIS and adrenoleukodystrophy) result from defective ABC transporters.

The bacterial *ABC importer* is commonly called a BINDING PROTEIN-DEPENDENT TRANSPORT SYSTEM (q.v.). (See also ABC EXPORTER.)

ABE process An industrial process in which acetone, butanol and ethanol are produced by the fermentation of e.g. molasses by *Clostridium acetobutylicum*. (See also ACETONE–BUTANOL FERMENTATION.)

Abelson murine leukaemia virus (Ab-MuLV) A replication-defective, v-*onc*$^+$ MURINE LEUKAEMIA VIRUS isolated from a prednisolone-treated BALB/c mouse inoculated with Moloney murine leukaemia virus (Mo-MuLV). Ab-MuLV apparently arose by recombination between Mo-MuLV and mouse c-*abl* sequences; the v-*abl* product has tyrosine kinase activity. (See also ABL.) Ab-MuLV induces B-cell lymphoid leukaemia with a short latent period (3–4 weeks). [Abelson virus–cell interactions: Adv. Imm. (1985) *37* 73–98.]

abequose (3,6-dideoxy-D-galactose) A sugar, first isolated from *Salmonella abortusequi*, which occurs in the O-specific chains of the LIPOPOLYSACCHARIDE in certain *Salmonella* serotypes and which contributes to the specificity of O antigen 4 in group B salmonellae (see KAUFFMANN–WHITE CLASSIFICATION).

aberration (chromosomal) See CHROMOSOME ABERRATION.

abhymenial Of or pertaining to a region opposite or away from the HYMENIUM.

abiogenesis (spontaneous generation) The spontaneous formation of living organisms from non-living material; apart from its application to the evolutionary origin of life, this doctrine has long been abandoned.

abiotic Non-living; of non-biological origin.

abl An ONCOGENE originally identified as the transforming determinant of ABELSON MURINE LEUKAEMIA VIRUS (Ab-MuLV). The v-*abl* product has tyrosine kinase activity. In humans, c-*abl* normally occurs on chromosome 9, but is translocated to chromosome 22q- (the Philadelphia chromosome) in cells from patients with chronic myelogenous leukaemia (CML); in chromosome 22 it forms a chimeric fusion gene, *bcr-abl*, encoding a tumour-specific tyrosine kinase designated P210.

ablastin Antibody which specifically inhibits reproduction of epimastigote forms of *Trypanosoma lewisi* in the vertebrate host.

abomasitis Inflammation of the abomasum. (See also BRAXY; cf. RUMENITIS.)

abomasum See RUMEN.

aboral Away from, or opposite to, the mouth.

abortifacient Able to cause abortion.

abortive infection (*virol.*) A viral infection of (*non-permissive*) cells which does not result in the formation of infectious progeny virions, even though some viral genes (e.g. early genes) may be expressed. (cf. PERMISSIVE CELL.)

abortive transduction See TRANSDUCTION.

abortus Bang reaction (abortus Bang ring-probe) *Syn.* MILK RING TEST.

ABR See MILK RING TEST.

***abrB* gene** See ENDOSPORE (figure (a) legend).

abscess A localized collection of PUS surrounded by inflamed and necrotic tissue; it may subside spontaneously or may rupture and drain before healing. Abscesses may occur in any tissue and may be caused by any of a variety of organisms. Abscesses in internal organs (e.g. liver, kidney, brain) may follow bacteraemia or septicaemia and may be due to staphylococci, streptococci, coliforms, etc. A *cold* (or *chronic*) abscess is one with little inflammation, often due to tubercle bacilli. (See also DYSENTERY (b) and QUINSY.)

abscisic acid (ABA) A terpenoid PHYTOHORMONE which acts e.g. as a growth inhibitor, as an inhibitor of germination, and as an accelerator of e.g. leaf abscission. ABA is also formed (as a secondary metabolite) e.g. by the fungus *Cercospora rosicola*.

Absidia See MUCORALES.

absorption (*serol.*) The removal or effective removal of particular antibodies, antigens, or other agents from a given sample (e.g. serum) by the addition of particular antigens, antibodies, or agents to that sample; the resulting antigen–antibody (or other) complexes may or may not be physically removed from the sample. Absorption is used e.g. to remove HETEROPHIL ANTIBODIES.

absorptive pinocytosis See PINOCYTOSIS.

7-ACA 7-Aminocephalosporanic acid (see CEPHALOSPORINS).

Acanthamoeba A genus of amoebae (order AMOEBIDA) in which the pseudopodia each have a broad hyaline zone (see PSEUDOPODIUM) from which arise several to many slender, tapering, flexible, and sometimes forked projections (*acanthopodia*). Polyhedral or roughly circular cysts with cellulose-containing walls are formed. Species are widespread and common in soil and fresh water, where they prey on e.g. bacteria, yeasts etc. [Adhesion of *Acanthamoeba castellanii* to bacterial flagella: JGM (1984) *130* 1449–1458; bacterial endosymbionts of *Acanthamoeba*: J. Parasitol. (1985) *71* 89–95.] Some strains can cause e.g. eye infections, MENINGOENCEPHALITIS [pathogenicity: RMM (1994) *5* 12–20]. (cf. HARTMANNELLA.)

Acantharea A class of marine, mostly planktonic protozoa (superclass ACTINOPODA) which have elaborate 'skeletons' composed of strontium sulphate; typically, the skeleton consists of 10 spines arranged diametrically in the (more or less spherical) cell, or 20 spines which radiate from the cell centre (where they may or may not be joined at their bases, according to species). In many species the cell contains a central capsule (cf. RADIOLARIA); many species contain zooxanthellae. Five orders are recognized; genera include e.g. *Acanthochiasma*, *Acanthometra*, *Astrolophus*, *Gigartacon*.

Acanthochiasma See ACANTHAREA.

Acanthocystis See CENTROHELIDA.

Acanthoeca See CHOANOFLAGELLIDA.

Acanthometra See ACANTHAREA.

acanthopodia See ACANTHAMOEBA.

acaricide Any chemical which kills mites and ticks (order Acarina).

Acarospora A genus of LICHENS (order LECANORALES). Thallus: crustose, areolate, with prominent areolae. Apothecia are embedded in the areolae; ascospores: very small, many per ascus. All species are saxicolous, some are ENDOLITHIC; *A. smaragdula* occurs on rocks and slag rich in heavy metals.

Acarpomyxea A class of protozoa (superclass RHIZOPODA) with characteristics intermediate between those of the naked amoebae and the plasmodial slime moulds: they form small plasmodia (or large uninucleate plasmodium-like forms) which are usually branched and which sometimes anastomose to form a coarse reticulum. Spores, fruiting bodies and tests are absent; cysts are produced by some species. Orders: Leptomyxida (soil and freshwater organisms, e.g. *Leptomyxa* [Book ref. 133, pp. 143–144], *Rhizamoeba*) and Stereomyxida (marine organisms, e.g., *Corallomyxa*, *Stereomyxa*).

Acaryophrya See GYMNOSTOMATIA.

Acaulopage See e.g. NEMATOPHAGOUS FUNGI.

Acaulospora See ENDOGONALES.

acceptor site (of a ribosome) See PROTEIN SYNTHESIS.

acceptor splice site See SPLIT GENE (a).

accessory cells (*immunol.*) Those cells which, together with B LYMPHOCYTES and/or T LYMPHOCYTES, are involved in the expression of humoral and/or cell-mediated immune responses; they include e.g. MACROPHAGES, DENDRITIC CELLS, and LANGERHANS' CELLS.

accessory pigments In PHOTOSYNTHESIS: those pigments contained in LIGHT-HARVESTING COMPLEXES.

AcCoA Acetyl-COENZYME A.

Ace toxin (*Vibrio cholerae*) See BACTERIOPHAGE CTXΦ.

acellular (non-cellular) (1) Refers to an organism, usually a protozoon, which consists essentially of a single cell but in which occur functionally specialized regions sometimes regarded as analogous to the organs and tissues of a differentiated multicellular organism. (2) Refers to an organism (e.g. a VIRUS) or structure (e.g. the stalk of ACYTOSTELIUM) which is not CELLULAR in any sense. (3) Not divided into cells (as e.g. in a PLASMODIUM).

acellular slime moulds See MYXOMYCETES.

acentric (of a chromosome) Having no CENTROMERE.

acephaline gregarines See GREGARINASINA.

acer tar spot See RHYTISMA.

acervulus A flat or saucer-shaped fungal STROMA supporting a mass of typically short and densely-packed conidiophores; acervuli commonly develop subcuticularly or subepidermally in a plant host, becoming erumpent at maturity, i.e., rupturing the overlying plant tissue to allow dispersal of the conidia. Some acervuli bear setae (see SETA).

Acetabularia A genus of DASYCLADALEAN ALGAE. The vegetative thallus consists of a single cell in which the CELL WALL contains MANNAN as a major component and is generally more or less heavily calcified; the cell is differentiated into an erect stalk or axis (up to several centimetres tall) anchored to the substratum by a branching rhizoid. The single nucleus is located in one branch of the rhizoid. As the stalk grows, whorls of sterile 'hairs' develop around the tip; these hairs are eventually shed, leaving rings of scars around the stalk. When the thallus is mature, gametangia develop as an apical whorl of elongated sac-like structures which, depending on species, may or may not be joined to form a characteristic *cap* (giving rise to the popular name 'mermaid's wine-glass'). Once the gametangial sacs have developed, the primary nucleus in the rhizoid grows to ca. 20 times its original size; it then undergoes meiosis, and numerous small secondary nuclei are formed. These migrate from the rhizoid to the gametangia by cytoplasmic streaming. Within a gametangial sac, each nucleus becomes surrounded by a resistant wall, resulting in the formation of many resistant cysts; the cyst walls contain cellulose rather than mannan, and are often heavily calcified. The cysts are liberated into the sea and then undergo a period of dormancy before liberating numerous biflagellate isogametes; pairs of gametes fuse to form zygotes which then develop into new vegetative thalli.

acetate formation See e.g. ACETIFICATION and ACETOGENESIS.

acetate thiokinase See METHANOGENESIS.

acetate utilization See e.g. METHANOGENESIS and TCA CYCLE.

Acetator See VINEGAR.

acetic acid bacteria (1) *Acetobacter* spp. (2) Any bacteria capable of ACETIFICATION, including *Acetobacter* spp and *Gluconobacter* sp.

aceticlastic Able to catabolize acetate.

acetification The aerobic conversion of ethanol to acetic acid by bacteria (usually *Acetobacter* spp). Ethanol is converted to hydrated acetaldehyde ($CH_3CH(OH)_2$) which is then dehydrogenated to give acetic acid. Acetification is an exothermic process. (See also e.g. VINEGAR, BEER SPOILAGE, WINE SPOILAGE.)

Acetivibrio A genus of bacteria (family BACTEROIDACEAE) whose natural habitat is unknown. Cells: straight to slightly curved rods, 0.5–0.9 × 1.5–10.0 μm; in motile species the concave side of the cell has either a single flagellum or a number of flagella which arise in a line along the longitudinal axis of the cell. The cells stain Gram-negatively but the cell wall of the type species resembles those of Gram-positive bacteria. The major products of carbohydrate fermentation typically include acetic acid, ethanol, CO_2 and H_2; butyric, lactic, propionic and succinic acids are not formed. GC%: ca. 37–40. Type species: *A. cellulolyticus*.

A. cellulolyticus. Monotrichous. Substrates include cellobiose, cellulose and salicin; aesculin is not hydrolysed. The type strain was isolated from a methanogenic enrichment culture.

A. cellulosolvens. A non-motile species (isolated from sewage sludge) which can hydrolyse cellulose, cellobiose, aesculin and salicin; the cells apparently have an outer membrane. [IJSB (1984) *34* 419–422.]

A. ethanolgignens. Multitrichous. Substrates include fructose, galactose, lactose, maltose, mannitol and mannose – but not cellobiose, cellulose or aesculin. *A. ethanolgignens* is consistently present in the colons of pigs suffering from SWINE DYSENTERY.

Acetobacter A genus of Gram type-negative bacteria of the family ACETOBACTERACEAE; the organisms occur e.g. on certain fruits and flowers, are responsible for some types of BEER SPOILAGE and WINE SPOILAGE, and are used e.g. in the manufacture of VINEGAR.

Cells: typically ovoid or rod-shaped, 0.6–0.8 × 1.0–4.0 μm, non-motile or with peritrichous or lateral flagella. Most strains are catalase-positive. Typically, ethanol is oxidized to acetic acid, and acetic acid is oxidized ('overoxidation') to CO_2 (cf. GLUCONOBACTER). Principal substrates include e.g. ethanol, glycerol and lactate; most strains grow well on glucose–yeast extract–$CaCO_3$ agar (GYC agar), forming round pale colonies. (See also CARR MEDIUM.) Some strains form CELLULOSE (see PELLICLE (1)). Sugars appear to be metabolized primarily via the HEXOSE MONOPHOSPHATE PATHWAY and the TCA CYCLE; phosphofructokinase seems to be absent (cf. Appendix I(a)). The ENTNER–DOUDOROFF PATHWAY appears to occur only in cellulose-synthesizing strains. Growth on HOYER'S MEDIUM appears to involve enzymes of the glyoxylate shunt. Optimum growth temperature: 25–30°C. GC%: ca. 51–65. Type species: *A. aceti*.

A. aceti. Ketogenic with glycerol or sorbitol substrates; 5-ketogluconic acid (but not 2,5-diketogluconic acid) formed from D-glucose. No diffusible brown pigments are formed on GYC agar. Grows on sodium acetate.

A. hansenii. Ketogenic with glycerol or sorbitol substrates; 5-ketogluconic acid (but not 2,5-diketogluconic acid) is formed by some strains from D-glucose. No growth on sodium acetate. No diffusible brown pigments are formed on GYC agar. (cf. *A. xylinum*.)

A. liquefaciens. Brown diffusible pigments are formed on GYC agar. 2,5-Diketogluconic acid is formed from D-glucose. Ketogenic with glycerol as substrate.

A. pasteurianus. Ketogluconic acids are not formed from D-glucose. No brown diffusible pigments are formed on GYC agar. Some strains (formerly called *A. peroxydans*) are catalase-negative. (cf. *A. xylinum*.)

A. peroxydans. See *A. pasteurianus*.

A. suboxydans. See GLUCONOBACTER.

A. xylinum. Cellulose-producing strains formerly classified as a subspecies of *A. aceti*, then distributed between the two species *A. hansenii* and *A. pasteurianus*; *A. xylinum* has now been accepted as a revived name for cellulose-forming and cellulose-less, acetate-oxidizing strains [IJSB (1984) *34* 270–271].

[Book ref. 22, pp. 268–274.]

Acetobacteraceae A family of aerobic, oxidase-negative, chemoorganotrophic, Gram type-negative bacteria which typically oxidize ethanol to acetic acid. Metabolism: strictly respiratory (oxidative), with O_2 as terminal electron acceptor. Growth occurs optimally at ca. pH 5–6. The organisms occur e.g. in acidic, ethanol-containing habitats. GC%: ca. 51–65. Two genera: ACETOBACTER (type genus), GLUCONOBACTER [Book ref. 22, pp. 267–278].

Acetobacterium A genus of Gram-negative, obligately anaerobic bacteria which occur in marine and freshwater sediments [IJSB (1977) *27* 355–361]. Cells: polarly flagellated ovoid rods, ca. 1.0 × 2.0 μm, often in pairs. The type species, *A. woodii*, can carry out a homoacetate fermentation of e.g. fructose, glucose or lactate, or can grow chemolithoautotrophically (see ACETOGENESIS); it contains group B PEPTIDOGLYCAN. Optimum growth temperature: 30°C. GC%: ca. 39. (See also ANAEROBIC DIGESTION.)

acetogen (1) Any bacterium (e.g. *Acetobacterium woodii*, *Clostridium aceticum*, *C. thermoaceticum*) which produces acetate – as the *main* product – from certain sugars (via homoacetate fermentation and reduction of carbon dioxide) and (in some strains) from carbon dioxide and hydrogen (see ACETOGENESIS).

(2) (hydrogenogen; proton-reducing acetogen) Any bacterium which can use protons as electron acceptors for the oxidation of certain substrates (e.g. ethanol, lactate, fatty acids) to acetate with concomitant formation of hydrogen. Obligate hydrogenogens include e.g. SYNTROPHOMONAS (see also ANAEROBIC DIGESTION). Some SULPHATE-REDUCING BACTERIA appear to be facultative hydrogenogens. The synthesis of acetate by hydrogenogens is thermodynamically favourable only when the partial pressure of hydrogen is very low – e.g. in the presence of a hydrogen-utilizing methanogen.

acetogenesis Acetate formation. A variety of microorganisms can form acetate, as a major or minor product, e.g. via the MIXED ACID FERMENTATION or PROPIONIC ACID FERMENTATION. (cf. ACETIFICATION.)

The term is also used more specifically to refer to the *particular* pathways used by the ACETOGENS (sense 1). These organisms form acetate, as the *main* product, from e.g. certain hexoses in a process (*homoacetate fermentation*) in which the hexose is metabolized to pyruvate (via the EMBDEN–MEYERHOF–PARNAS PATHWAY) and thence to acetate and carbon dioxide.

Additional acetate is formed as follows. Some of the carbon dioxide is reduced to formate; this formate is bound to tetrahydrofolate (THF) and is further reduced (in an ATP-dependent reaction) to yield 5-methyl-THF. The methyl group is then transferred to coenzyme B_{12}. The remainder of the carbon dioxide is reduced to carbon monoxide (by CO dehydrogenase). Carbon monoxide reacts with methyl-coenzyme B_{12} in the presence of coenzyme A and CO dehydrogenase disulphide reductase to yield acetyl-CoA. Acetyl-CoA is converted to acetate and CoASH with concomitant substrate-level phosphorylation to yield ATP.

Some acetogens (e.g. *A. woodii*, *C. aceticum*, some strains of *C. thermoaceticum*) can form acetate from carbon dioxide and hydrogen [autotrophic pathways in acetogens: JBC (1986) *261* 1609–1615]. This process resembles the latter part of the pathway above: CO is derived from carbon dioxide, $2H^+$ and $2e^-$, and 5-methyl-THF from THF, carbon dioxide and hydrogen.

acetoin ($CH_3.CHOH.CO.CH_3$; acetylmethylcarbinol) See e.g. Appendix III(c); BUTANEDIOL FERMENTATION; VOGES–PROSKAUER TEST.

Acetomonas Former name of GLUCONOBACTER.

acetone–butanol fermentation (solvent fermentation) A FERMENTATION (sense 1), carried out by certain saccharolytic species of *Clostridium* (e.g. *C. acetobutylicum*), in which the products include acetone (or isopropanol) and *n*-butanol (collectively referred to as 'solvent'). Glucose is initially metabolized via the BUTYRIC ACID FERMENTATION, but subsequently the pH drops to ca. 4.5–5.0 and acetone and *n*-butanol are formed as major end products [Appendix III (g)]. This fermentation is carried out on an industrial scale to a limited extent. [Review: AAM (1986) *31* 24–33, 61–92.]

acetosyringone See CROWN GALL.

3-acetoxyindole See INDOXYL ACETATE.

acetylcholine (neurotransmitter) See BOTULINUM TOXIN.

acetyl-CoA synthetase See TCA CYCLE.

***N*-acetyl-L-cysteine** See MUCOLYTIC AGENT.

***N*-acetyl-D-glucosamine** (GlcNAc) *N*-Acetyl-(2-amino-2-deoxy-D-glucose): an amino sugar present in various polysaccharides – see e.g. CHITIN, HYALURONIC ACID, LIPOPOLYSACCHARIDE, PEPTIDOGLYCAN (q.v. for formula), TEICHOIC ACIDS.

acetylmethylcarbinol *Syn.* ACETOIN.

***N*-acetylmuramic acid** See PEPTIDOGLYCAN.

***N*-acetylmuramidase** *Syn.* LYSOZYME.

***N*-acetylneuraminic acid** See NEURAMINIC ACID.

A-CGT See IMMUNOSORBENT ELECTRON MICROSCOPY.

achlorophyllous *Syn.* ACHLOROTIC.

achlorotic (achlorophyllous) Lacking chlorophyll. (cf. APOCHLOROTIC.)

Achlya A genus of aquatic fungi (order SAPROLEGNIALES) in which the thallus is characteristically a branched, coenocytic mycelium; the width of the hyphae varies with species. Although *Achlya* species are typically saprotrophic some have been reported to parasitize rice plants. (See also DIPLANETISM, HETEROTHALLISM and PHEROMONE.)

Achnanthes See DIATOMS.

Acholeplasma A genus of facultatively anaerobic, urease-negative bacteria (family ACHOLEPLASMATACEAE) which are associated with various vertebrates (and possibly with invertebrates and plants), and which also occur e.g. in soil and sewage and as contaminants in TISSUE CULTURES. Cells: non-motile cocci (minimum diam. ca. 300 nm) or filaments (typically ca. 2–5 μm in length); carotenoid pigments occur in some species. The organisms resemble *Mycoplasma* spp in their general properties, but differ e.g. in that their growth is sterol-independent, and in that NADH oxidase occurs in the cytoplasmic membrane rather than in the cytoplasm. *Acholeplasma* spp are susceptible to various ACHOLEPLASMAVIRUSES. GC%: ca. 26–36. Type species: *A. laidlawii*; other species: *A. axanthum*, *A. equifetale*, *A. granularum*, *A. hippikon*, *A. modicum*, *A. morum*, *A. oculi*. [Book ref. 22, pp. 775–781.]

Acholeplasmataceae A family of bacteria of the order MYCOPLASMATALES; species of the sole genus, ACHOLEPLASMA, differ from the other members of the order e.g. in that their growth is not sterol-dependent. [Proposal for re-classifying Acholeplasmataceae as the order Acholeplasmatales: IJSB (1984) *34* 346–349.]

acholeplasmaviruses BACTERIOPHAGES which infect *Acholeplasma* species: see PLECTROVIRUS, PLASMAVIRIDAE, MV-L3 PHAGE GROUP.

achromat (achromatic objective) An objective lens (see MICROSCOPY) in which chromatic aberration has been corrected for two colours (usually red and blue), and spherical aberration has been corrected for one colour (usually yellow–green). (cf. APOCHROMAT.) A FLAT-FIELD OBJECTIVE LENS of this type is called a *planachromat*.

Achromobacter An obsolete bacterial genus.

achromogenic Refers to an organism (or e.g. reagent) which does not produce pigment (or colour); used e.g. of non-pigmented strains of normally CHROMOGENIC organisms.

achromycin See TETRACYCLINES.

aciclovir A spelling used by some authors for the drug ACYCLOVIR.

acicular Needle-shaped.

Aciculoconidium A genus of fungi (class HYPHOMYCETES) which form budding ovoid or ellipsoidal cells (occurring singly or in short chains or clusters) as well as branched septate hyphae. Conidia are formed terminally and are acicular, rounded at one end and pointed at the other. NO_3^- is not assimilated. One species: *A. aculeatum* (formerly *Trichosporon aculeatum*), isolated from *Drosophila* spp. [Book ref. 100, pp. 558–561.]

acid dye See DYE.

acid-fast organisms Organisms (e.g. *Mycobacterium* spp) which, once stained with an ACID-FAST STAIN, cannot be decolorized by mineral acids or by mixtures of acid and ethanol.

acid-fast stain Any stain used to detect or demonstrate ACID-FAST ORGANISMS – e.g. ZIEHL–NEELSEN'S STAIN, AURAMINE–RHODAMINE STAIN.

acid fuchsin See FUCHSIN.

acid phosphatase See PHOSPHATASE.

Acidaminococcus A genus of Gram-negative bacteria (family VEILLONELLACEAE) which occur e.g. in the intestine in humans and pigs. Cells: typically kidney-shaped cocci, 0.6–1.0 μm diam, occurring in pairs. Amino acids are the main sources of carbon and energy; all strains need e.g. arginine, glutamate, tryptophan and valine, and most need e.g. cysteine and histidine. In general, the organisms metabolize carbohydrates weakly or not at all. Optimum growth temperature: 30–37°C. Optimum pH: 7.0. GC%: ca. 57. Type species: *A. fermentans*.

acidophile An organism which grows optimally under acidic conditions, having an optimum growth pH below 6 (and sometimes as low as 1, or below), and which typically grows poorly, or not at all, at or above pH 7: see e.g. SULFOLOBUS, THERMOPLASMA, THIOBACILLUS. (cf. ALKALOPHILE and NEUTROPHILE; see also LEACHING.)

acidophilus milk A sour, medicinal beverage made by fermenting heat-treated, partially skimmed milk with *Lactobacillus acidophilus*. (Viable *L. acidophilus* appears to have a therapeutic effect on some intestinal disorders.) The main fermentation product is lactic acid which reaches a level of ca. 1.0%. A more palatable preparation, 'sweet acidophilus milk', is made by adding *L. acidophilus* to milk at ca. 5°C; under these conditions the cells remain viable but lactic acid is not produced. (See also DAIRY PRODUCTS.)

acidosis (1) (lactic acidosis) (*vet.*) A (sometimes fatal) condition which may occur in ruminants fed excessive amounts of readily fermentable carbohydrates (e.g. starch, sugars – found e.g. in grain and beet, respectively) or when the transfer from a roughage to a 'concentrate' diet is made too quickly. Under these conditions the rate of acid production in the RUMEN is very high; the resulting fall in pH in the rumen (due mainly to the accumulation of lactic acid) inhibits cellulolytic bacteria and protozoa, and favours the growth of certain LACTIC ACID BACTERIA – so that the pH falls still further. (See also RUMENITIS.) A gradual transition from roughage to concentrate may permit the somewhat more acid-tolerant bacterium *Megasphaera elsdenii* to metabolize the lactic acid and maintain a normal pH in the rumen. (See also THIOPEPTIN.)

(2) (*med., vet.*) A pathological condition characterized by an abnormally low pH in the blood and tissues.

Acidothermus A proposed genus of aerobic, thermophilic (growing at 37–70°C), acidophilic (growing at pH 3.5–7.0), cellulolytic, non-motile, rod-shaped to filamentous bacteria isolated from acidic hot springs; GC%: ca. 60.7. [IJSB (1986) *36* 435–443.]

aciduric Tolerant of acidic conditions. (cf. ACIDOPHILE.)

Acineria See GYMNOSTOMATIA.

Acineta See SUCTORIA.

Acinetobacter A genus of strictly aerobic, oxidase −ve, catalase +ve Gram-type-negative bacteria of the family MORAXELLACEAE (within the gamma subdivision of PROTEOBACTERIA); the organisms occur e.g. in soil and water and may act as opportunist pathogens in man. (See also MEAT SPOILAGE and SEWAGE TREATMENT.)

Cells: short rods, 0.9–1.6 × 1.5–2.5 μm, or coccobacilli (coccoid in stationary-phase cultures); cells often in pairs. Non-motile, but may exhibit TWITCHING MOTILITY. Non-pigmented.

Metabolism is respiratory (oxidative), with oxygen as terminal electron acceptor; no growth occurs anaerobically, with or without nitrate.

Most strains can grow on a mineral salts medium containing an organic carbon source such as acetate, ethanol or lactate as the sole source of carbon and energy; some can use amino acids (e.g. L-leucine, ornithine) and/or pentoses (e.g. L-arabinose, D-xylose), and some are able to degrade e.g. benzoate, *n*-hexadecane and alicyclic compounds (see HYDROCARBONS). Acinetobacters appear to contain all the enzymes of the TCA CYCLE and the glyoxylate cycle. Many carbohydrates can be used. Most strains in the *A. calcoaceticus–A. baumannii* complex (and in certain other groups) can form acid from glucose (oxidatively), but many (e.g. most strains designated *A. lwoffii*) cannot. The optimal growth temperature is typically 33–35°C. GC%: ~38–47. Type species: *A. calcoaceticus*.

The taxonomy of *Acinetobacter* is confused and unsatisfactory. Emended descriptions of the two species *A. calcoaceticus* and *A. lwoffii*, and proposals for four new species (*A. baumannii*, *A. haemolyticus*, *A. johnsonii* and *A. junii*), were published in 1986 [IJSB (1986) *36* 228–240]. Since then, a number of adjustments have been made to the taxonomic structure of the genus. [Taxonomy, and epidemiology of *Acinetobacter* infections: RMM (1995) *6* 186–195.]

Acinetobacters have been isolated in a number of hospital-associated (and other) outbreaks of disease, often as part of a mixed infection; in most cases such infections involve glucolytic strains of the *A. calcoaceticus–A. baumannii* complex – particularly *A. baumannii* (also called group 2, or genospecies 2). The most common manifestations of disease include septicaemia and infections of the urinary tract, lower respiratory tract and central nervous system. Transmission may occur by direct contact or may involve the airborne route. Acinetobacters have been reported to survive on dry surfaces for at least as long as e.g. *Staphylococcus aureus*.

One problem associated with the pathogenic role of *Acinetobacter* is that these organisms appear easily to acquire resistance to antibiotics – so that they have the potential to develop as multiresistant pathogens; currently, for example, acinetobacters are reported to be resistant to most β-lactam antibiotics, particularly penicillins and cephalosporins, and to chloramphenicol and trimethoprim–sulphamethoxazole. [Mechanisms of antimicrobial resistance in *A. baumannii*: RMM (1998) *9* 87–97.]

AcLVs AVIAN ACUTE LEUKAEMIA VIRUSES.

acne A chronic skin disorder characterized by increased sebum production and the formation of comedones ('blackheads' and 'whiteheads') which plug the hair follicles. *Propionibacterium acnes*, present in the pilosebaceous canal (see SKIN MICROFLORA), may play a causal role; it produces a lipase that hydrolyses sebum triglycerides to free fatty acids, and these can cause inflammation and comedones [JPed (1983) *103* 849–854]. *Treatment*: e.g. topical SALICYLIC ACID or benzoyl peroxide; the latter has keratinolytic activity and exerts bactericidal action on *P. acnes* by releasing free-radical oxygen.

Aconchulinida See FILOSEA.

aconitase See Appendix II(a) and NITRIC OXIDE.

Aconta Algae of the RHODOPHYTA. (cf. CONTOPHORA.)

acquired immune deficiency syndrome See AIDS.

acquired immunity (1) SPECIFIC IMMUNITY acquired through exposure to a given antigen. (2) PASSIVE IMMUNITY. (3) NON-SPECIFIC IMMUNITY acquired through exposure to certain viruses (see e.g. INTERFERONS) or by immunization with BCG.

Acrasea See ACRASIOMYCETES.

acrasids See ACRASIOMYCETES.

acrasin In cellular slime moulds: a generic term for a chemotactic substance which is produced by cells and which serves as a chemoattractant for cell aggregation. Acrasins are a diverse group of substances; they include cAMP in *Dictyostelium discoideum* (q.v.), a pterin in *Dictyostelium lacteum* [PNAS (1982) *79* 6270–6274], and a dipeptide, 'glorin', in *Polysphondylium violaceum* (q.v.).

Acrasiomycetes (acrasid cellular slime moulds; acrasids) A class of cellular SLIME MOULDS (division MYXOMYCOTA) in which the vegetative phase consists of amoeboid cells that form lobose pseudopodia; the amoebae aggregate (without streaming) to form a pseudoplasmodium which is not slug-like and does not migrate (cf. DICTYOSTELIOMYCETES). The pseudoplasmodium gives rise to multispored fruiting bodies which may have long or short stalks (but no cellulosic stalk tube) bearing e.g. simple globular sori or branched or unbranched chains of spores. Flagellated cells have been observed in only one species (*Pocheina rosea*). Sexual processes are unknown. Acrasids occur in various habitats: e.g. dung, tree-bark, dead plant materials, etc. Genera include *Acrasis*, *Copromyxa*, *Copromyxella*, *Fonticula*, *Guttulinopsis*, *Pocheina* (formerly *Guttulina*).

(Zoological taxonomic equivalents of the Acrasiomycetes include the class Acrasea of the MYCETOZOA, and the class Acrasea of the RHIZOPODA.)

Acrasis See ACRASIOMYCETES.

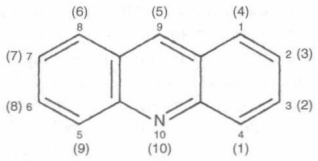
Acremonium A genus of fungi of the class HYPHOMYCETES; teleomorphs occur in e.g. *Emericellopsis* and *Nectria*. The genus includes organisms formerly classified as species of *Cephalosporium* [for references see MS (1986) *3* 169–170]. *Acremonium* spp form septate mycelium; conidia, often in gelatinous masses, are produced from phialides which develop from simple, single branches of the vegetative hyphae. *A. kiliense* (= *Cephalosporium acremonium*) produces cephalosporin C (see CEPHALOSPORINS). (See also MADUROMYCOSIS.)

acridine orange (basic orange, or euchrysine; 3,6-bis(dimethylamino)-acridinium chloride) A basic dye and FLUOROCHROME used e.g. in fluorescence MICROSCOPY to distinguish between dsDNA (which fluoresces green) and ss nucleic acids (which fluoresce orange-red). Sublethal concentrations of the dye are used for CURING plasmids. (See also ACRIDINES.)

acridines Heterocyclic compounds which include acridine and its derivatives. At low concentrations, aminoacridines (e.g. proflavine (3,6-diaminoacridine), QUINACRINE) appear to bind to dsDNA (or to double-stranded regions of ssDNA) primarily as INTERCALATING AGENTS. At higher concentrations there is also a weaker, secondary type of binding in which the acridine binds to the outside of dsDNA or to ssDNA or ssRNA; the two types of binding may account for the differential staining of DNA and RNA by ACRIDINE ORANGE. [Book ref. 14, pp. 274–306.] Acridines inhibit DNA and RNA synthesis and cause e.g. FRAMESHIFT MUTATIONS. They are used e.g. as antimicrobial agents (see e.g. ACRIFLAVINE), as mutagens, and as fluorescent stains for nucleic acids; they also have potential antitumour activity. (See also CURING (2).)

As *antimicrobial agents*, acridines are active against a wide range of bacteria, but they are not sporicidal; some are active against certain parasitic protozoa (see e.g. QUINACRINE and KINETOPLAST) and inhibit the replication of certain viruses. Activity is not significantly affected by proteinaceous matter. [Acridines as antibacterials (review): JAC (2001) *47* 1–13.]

As *mutagens*, acridines may be effective in replicating bacteriophages but are generally not effective in bacteria. However, compounds in which an acridine nucleus is linked to an alkylating side-chain – *ICR compounds* (ICR = Institute for Cancer Research) – can induce frameshift and other mutations in bacteria.



ACRIDINE. The numbering system used in this dictionary is indicated by the numbers which are not in parentheses; an alternative numbering system (numbers in parentheses) is used by some authors.

acriflavine (acriflavin; *syn.* euflavin) 3,6-Diamino-10-methylacridinium chloride *or* (according to some authors) a mixture of this compound and 3,6-diaminoacridine (proflavine). Acriflavine is soluble in water and in ethanol, and has been used as an ANTISEPTIC. (See also ACRIDINES.)

acro- Prefix meaning tip or outermost part.

Acrocordia See PYRENULALES.

acrolein (CH_2=CH–CHO) An aldehyde used e.g. for PREFIXATION; it penetrates tissues more rapidly than GLUTARALDEHYDE.

acronematic Refers to a eukaryotic FLAGELLUM which is smooth and tapers to a fine point.

acropetal development Development from the base, or point of attachment, towards the tip; e.g., in a chain of acropetally developing spores the first-formed spores occupy positions in the chain nearest the base of the spore-bearing structure, while spores formed later occupy positions in the distal parts of the chain. (cf. BASIPETAL DEVELOPMENT.)

acropleurogenous Located both at the tip and on the sides of an elongated structure.

Acrosiphonia A genus of branched, filamentous, siphonocladous green algae (division CHLOROPHYTA).

Acrospermum See CLAVICIPITALES.

acrylate pathway See PROPIONIC ACID FERMENTATION.

ActA protein (*Listeria monocytogenes*) See LISTERIOSIS.

actaplanin See VANCOMYCIN.

Actidione *Syn.* CYCLOHEXIMIDE.

actin (1) A protein, found in most types of eukaryotic cell, which can polymerize (reversibly) to form non-contractile filaments (*microfilaments*) that are involved e.g. in maintaining cell shape and structure (see e.g. CYTOSKELETON) and (together with MYOSIN) in CAPPING (sense 3), amoeboid movement (see PSEUDOPODIUM), CYTOPLASMIC STREAMING, PHAGOCYTOSIS, and (in higher animals) muscle contraction.

Actins from various sources are similar in structure. The monomeric form (*G-actin*) is a globular protein (MWt ca. 42000) consisting of ca. 375 amino acid residues; each molecule can bind one molecule of ATP. In most non-muscle cells, G-actin occurs in dynamic equilibrium with the polymerized (filamentous) form, *F-actin*, which consists of a helical, double-stranded chain of monomers ca. 7 nm thick. Although F-actin is itself non-contractile, its interaction with myosin can cause microfilaments to slide relative to one another – thereby bringing about movements and contractions in structures bound to the microfilaments. During the polymerization of G-actin ATP is hydrolysed; as in the assembly of MICROTUBULES, energy is not essential for – but increases the rate of – polymerization. Polymerization and depolymerization can occur at both ends of a microfilament, but one of the ends may grow (or depolymerize) at a greater rate than the other. (See also CAPPING sense 2.)

The formation and fate of microfilaments are regulated in vivo e.g. by various proteins. *Profilin* binds to G-actin, inhibiting polymerization. *Gelsolin* (in e.g. macrophages), *severin* (in *Dictyostelium*), *fragmin* (in *Physarum*), and *villin* (in microvilli) can each cleave F-actin into fragments in a Ca^{2+}-dependent reaction, thereby e.g. effecting a gel-to-sol transition. *Filamin* and *α-actinin* can cross-link microfilaments, promoting gel formation. *β-Actinin* can act as a CAPPING (sense 2) protein. *Vinculin* may help to anchor microfilaments to other cell components. [Binding of microfilaments to the cytoplasmic membrane in *Dictyostelium discoideum*: JCB (1986) *102* 2067–2075.] *Fimbrin* binds together longitudinally adjacent microfilaments to form bundles.

Actin polymerization/depolymerization is affected e.g. by agents such as CYTOCHALASINS and by phalloidin (see PHALLOTOXINS).

(2) See MACROTETRALIDES.

actin-based motility See DYSENTERY (1a) and LISTERIOSIS.

Actinichona See HYPOSTOMATIA.

α-actinin See ACTIN.

β-actinin See ACTIN.

actino- Prefix signifying a ray or rays.

actinobacillosis Any animal (or human) disease caused by a species of *Actinobacillus*. *A. lignieresii* causes granulomatous lesions in and around the mouth – particularly the tongue ('wooden tongue') – in cattle; in sheep *A. lignieresii* is associated with suppurative lesions in the skin and internal organs. *A. equuli* is pathogenic for horses (see SLEEPY FOAL DISEASE) and pigs; in pigs symptoms may include fever, haemorrhagic or necrotic skin lesions, arthritis and endocarditis. *A. suis* causes septicaemia and localized lesions in pigs. (See also PERIODONTITIS.)

Actinobacillus A genus of Gram-negative bacteria of the PASTEURELLACEAE. Cells: mostly rod-shaped (ca. 0.3–0.5 × 0.6–1.4 μm), but a coccal form often occurs at the end of a rod, giving a characteristic 'Morse code' form; filaments may occur in media containing glucose or maltose. Extracellular slime is often produced. Cells stain irregularly. Glucose, fructose, xylose, and (most strains) lactose are fermented (no gas). Growth occurs only on complex media; all species (except *A. actinomycetemcomitans*) can grow on MacConkey's agar. Most species are non-haemolytic, but *A. suis* and some strains of *A. equuli* exhibit clear haemolysis on sheep blood agar; *A. suis* causes partial haemolysis on horse blood agar. GC%: 40–43. Type species: *A. lignieresii*.

Actinobacilli occur as commensals in the alimentary, respiratory and/or genital tracts of animals: *A. lignieresii* in cattle and sheep, *A. equuli* in horses, *A. suis* in pigs(?) and horses, *A. capsulatus* in rabbits(?), *A. actinomycetemcomitans* in man. All can be opportunist pathogens (see ACTINOBACILLOSIS). (*A. muris* = *Streptobacillus moniliformis*; *A. mallei* = *Pseudomonas mallei*; *A. ureae*: see PASTEURELLA.)

[Book ref. 22, pp. 570–575; proposal to re-classify *A. actinomycetemcomitans* as *Haemophilus actinomycetemcomitans*: IJSB (1985) *35* 337–341.]

Actinobifida An obsolete genus of actinomycetes which included species with dichotomously-branching sporophores; at least some strains were transferred to THERMOMONOSPORA.

Actinobolina A genus of carnivorous ciliates (subclass GYMNOSTOMATIA). Cells: roughly ovoid, with uniform somatic ciliature, an apical cytostome, TOXICYSTS, and retractable tentacles distributed evenly over the body.

Actinocephalus See GREGARINASINA.

actinoidin See VANCOMYCIN.

Actinomadura A genus of bacteria (order ACTINOMYCETALES, wall type III; group: maduromycetes) which occur e.g. in soil; some species (*A. madurae*, *A. pelletieri*) can be pathogenic in man (see MADUROMYCOSIS). The organisms form a branching, usually stable, substrate mycelium, but (spore-forming) aerial mycelium may be common or rare according to species; some species contain only trace amounts of madurose, or none at all. GC%: reported to be within the range 65–78. Type species: *A. madurae*. [Taxonomic studies on *Actinomadura* and *Nocardiopsis*: JGM (1983) *129* 3433–3446; ecology, isolation and cultivation: Book ref. 46, pp. 2103–2117.]

Actinomucor See MUCORALES.

Actinomyces A genus of asporogenous bacteria (order ACTINOMYCETALES; wall type varies with species); species occur in warm-blooded animals e.g. as part of the microflora of the mucous membranes (particularly in the mouth) and can act as opportunist pathogens. The organisms occur as rods, branched rods or filaments, or as a rudimentary mycelium. All species can grow anaerobically, or under reduced partial pressure of oxygen; growth in vitro occurs readily on rich media at 37°C, and is typically enhanced if the partial pressure of carbon dioxide is increased. Carbohydrates are fermented anaerogenically – acetic, lactic and succinic acids being the main acidic end products of glucose fermentation in PYG MEDIUM. Most species are catalase-negative; *A. viscosus* is catalase-positive. GC%: ca. 57–73. Type species: *A. bovis*.

A. bovis (wall type VI) and *A. israelii* (wall type V) can cause chronic disease in animals and man (see ACTINOMYCOSIS); *A. naeslundii* and *A. viscosus* (both wall type V) can cause periodontitis e.g. in rodents. (See also COAGGREGATION.) *A. pyogenes* (formerly *Corynebacterium pyogenes* [JGM (1982) *128* 901–903]) is the cause of 'summer mastitis' in cattle, and is often isolated from pyogenic lesions in cattle, pigs and other animals; *A. pyogenes* typically occurs as short rods or coryneforms which secrete a soluble haemolysin. *A. hordeovulneris* [IJSB (1984) *34* 439–443] is a causal agent of actinomycosis in dogs.

Actinomycetales An order of GRAM TYPE-positive, typically aerobic bacteria; species range from those which occur as cocci and/or rods to those which form a well-developed, branching SUBSTRATE MYCELIUM and/or AERIAL MYCELIUM, and which may form sophisticated structures such as sclerotia, sporangia and synnemata. (cf. ACTINOMYCETE.) Most members of the order have a GC%>55, thus distinguishing them from species of the other major subbranch of Gram-positive bacteria: the *Clostridium–Bacillus–Thermoactinomyces* line (but cf. CORYNEBACTERIUM, RENIBACTERIUM and THERMOACTINOMYCES). Phylogenetic relationships between actinomycetes are indicated by 16S rRNA oligonucleotide cataloguing and nucleic acid hybridization; within the order, groups of genera can be distinguished on the basis of e.g. the chemical nature of the cell wall and the lipid profiles of the organisms. [The system of classification adopted in the Dictionary is based on the scheme proposed in Book ref. 73, pp. 7–164.]

Actinomycetes are widespread in nature, occurring typically in soil, composts (see COMPOSTING) and aquatic habitats; most species are free-living and saprotrophic, but some form symbiotic associations (see e.g. ACTINORRHIZA) and others are pathogenic in man, other animals, and plants (see e.g. ACTINOMYCOSIS, DERMATOPHILOSIS, JOHNE'S DISEASE, POTATO SCAB, and TUBERCULOSIS). The organisms are chemoorganotrophs; collectively they can degrade a wide range of substances which include e.g. agar, cellulose, chitin, keratin, paraffins and rubber. Some species produce important antibiotics (see e.g. STREPTOMYCES).

Ultrastructure and staining. The cell structure is that of a Gram-positive prokaryote; most species give an unequivocally positive reaction in the Gram stain (but see e.g. CELLULOMONAS), and some species are acid-fast (see e.g. MYCOBACTERIUM, NOCARDIA, RHODOCOCCUS). Cytoplasmic inclusions observed in at least some species include e.g. granules of poly-β-hydroxybutyrate, polyphosphate, and polysaccharide, and globules of lipid. The cell wall commonly appears to be either uniformly electron-dense or three-layered, the electron-density of the middle layer being somewhat less than that of the layer on either side of it. The wall contains PEPTIDOGLYCAN and other polymers, e.g. TEICHOIC ACIDS – although the latter appear not to occur in the NOCARDIOFORM ACTINOMYCETES; the cell wall is commonly surrounded by a layer of diffuse or (in sporoactinomycetes) fibrous material. Depending on the presence of certain amino acids in the peptidoglycan, and the identity of the cell wall sugars, eight wall types (chemotypes I–VIII) of actinomycetes can be distinguished [Book ref. 46, pp. 1915–1922]:

I. LL-DAP (LL-diaminopimelic acid), glycine.
II. *meso*-DAP, glycine.
III. *meso*-DAP.
IV. *meso*-DAP, arabinose, galactose.
V. Lysine, ornithine.
VI. Lysine; aspartic acid and galactose sometimes present.
VII. DAB (2,4-diaminobutyric acid), glycine; lysine sometimes present.
VIII. Ornithine.

A further wall type (IX), characterized by *meso*-DAP and numerous amino acids, was defined for species of MYCOPLANA.

In most species which form non-fragmenting mycelium (e.g. *Streptomyces* spp) the vegetative hyphae are largely aseptate, although septa (cross-walls) can be present – particularly in the older parts of the mycelium. The septa in non-fragmenting mycelium have been designated type 1 septa; each septum consists of a single layer which develops centripetally from the cell wall. Such septa may contain microplasmodesmata, each 4–10 nm in diameter.

In fragmenting mycelium each septum consists of two distinct layers, each layer eventually forming a terminal wall of one of the two neighbouring cells; such septa are designated type 2 septa.

Spore formation. Spores are formed by the septation and fragmentation of hyphae, the spore wall being formed, at least in part, from all the wall layers of the sporogenous hypha. Spore-delimiting septa are of various types, and different types may occur even within a given genus; such septa have been designated type I (two layers developing centripetally), type II (two layers which develop centripetally on a single, initially-formed annulus), and type III (a single, thick layer which develops centripetally). Spore chains are reported to develop acropetally (in e.g. *Pseudonocardia*), basipetally (in e.g. *Micropolyspora*), randomly (in e.g. *Nocardiopsis*), or more or less simultaneously (in e.g. *Streptomyces*).

In some actinomycetes the spores are formed within sporangia: see e.g. ACTINOPLANES, AMORPHOSPORANGIUM, AMPULLARIELLA, DACTYLOSPORANGIUM, FRANKIA and PILIMELIA.

Genetic aspects. Genetic exchange has been studied in various actinomycetes, particularly *Streptomyces* spp [*Streptomyces* genetics: Book ref. 73, pp. 229–286; genetics of nocardioform actinomycetes: Book ref. 73, pp. 201–228]. Actinomycetes are hosts to a number of ACTINOPHAGES, and generalized transduction with phage ϕSV1 has been recorded in strains of *Streptomyces* [JGM (1979) *110* 479–482]. Actinomycetes can contain various transmissible or non-transmissible plasmids, some of which