A - C

A Abbreviation for adenine.

Ab Abbreviation for antibody.

**ABC model** Widely accepted model of flower organ identity that appears generally applicable to distantly related **dicotyledonous**, although less well to **monocotyledonous** plants. The model incorporates the **Arabidopsis** genes required for flower organ identity.

abiotic Absence of living organisms.

**abscisic acid** A **phytohormone** implicated in the control of many plant responses to **abiotic** stress, such as extent of stomatal opening under water deficit (i.e. drought) conditions.

**abzyme** See: **catalytic antibody**.

**acaricide** A **pesticide** used to kill or control mites or ticks.

**ACC synthase** Abbreviation for 1-aminocyclopropane-1-carboxylase. The enzyme catalyses the rate limiting step in the **ethylene** biosynthetic pathway, and is particularly significant in the fruit ripening process. Plants typically carry a number of distinct **ACC synthase** genes, which are differentially regulated in response to a variety of developmental, environmental and chemical factors.

**acceptor control** The regulation of the rate of respiration by the availability of **ADP** as a phosphate acceptor.
**acceptor junction site** The junction between the 3’ end of an **intron** and the 5’ end of an **exon**. See: donor junction site.

**accessory bud** A lateral bud occurring at the base of a **terminal bud** or at the side of an **axillary bud**.

**acclimatization** The **adaptation** of a living **organism** (plant, animal or micro-organism) to a changed environment that subjects it to physiological stress. Acclimatization should not be confused with **adaptation**.

**acellular** Tissues or organisms that are not made up of separate cells but often have more than one nucleus.

**acentric chromosome** Chromosome fragment lacking a **centromere**.

**acetyl CoA** Abbreviation for acetyl co-enzyme A.

**acetyl co-enzyme A** (Abbreviation: acetyl CoA) A compound formed in the mitochondria when an acetyl group (CH$_3$CO-) - derived from breakdown of fats, **proteins**, or carbohydrates - combines with the thiol group (-SH) of co-enzyme A.

ACP Abbreviation for **acyl carrier protein**.

**acquired** Developed in response to the environment, not inherited, such as a character trait (acquired characteristic) resulting from environmental effect(s). cf acclimatization.

**acridine dyes** A class of positively charged polycyclic molecules that intercalate into DNA and induce frameshift mutations.

**acrocentric** A chromosome that has its **centromere** near the end.

**acropetal** Arising or developing in a longitudinal sequence beginning at the base and proceeding towards the apex. Opposite: **basipetal**.

**activated carbon** See activated charcoal.

**activated charcoal** Charcoal that has been treated to remove hydrocarbons and to increase its adsorptive properties. It acts by condensing and holding a gas or solute onto its surface; thus inhibitory substances in nutrient medium may be adsorbed to charcoal included in the medium.

**active transport** The movement of a molecule or groups of molecules across a cell membrane, which requires the expenditure of cellular energy, because the direction of movement is against the prevailing concentration gradient.

**acute transfection** Short-term **transfection**.

**acyl carrier protein** (Abbreviation: ACP). A class of molecules that bind acyl intermediates during the formation of long-chain fatty acids. ACPs are important because of their involvement in many of the reactions necessary for **in vivo** fatty acid synthesis.

**adaptation** Adjustment of a population to changes in environment over generations, associated (at least in part) with genetic changes resulting from selection imposed by the changed environment. Not acclimatization.
additive genes Genes whose net effect is the sum of their individual allelic effects, i.e. they show neither dominance nor epistasis.

additive genetic variance The net effect of the expression of additive genes, and thus the chief cause of the resemblance between relatives. It represents the main determinant of the response of a population to selection. Formally, the variance of breeding values.

adenine (Abbreviation: A). One the bases found in DNA and RNA. See: adenosine.

adenosine The (ribo)nucleoside resulting from the combination of the base adenine (A) and the sugar D-ribose. The corresponding deoxyribonucleoside is called deoxyadenosine. See: adenosine triphosphate, adenylic acid, dATP.

adenosine diphosphate (adenosine 5'-diphosphate) (Abbreviation: ADP). See: adenosine triphosphate.

adenosine monophosphate (adenosine 5'-monophosphate) (Abbreviation: AMP). See: adenylic acid, adenosine triphosphate.

adenosine triphosphate (adenosine 5'-triphosphate) (Abbreviation: ATP). A nucleotide of fundamental importance as the major carrier of chemical energy in all living organisms. It is also required for RNA synthesis since it is a direct precursor molecule. ATP consists of adenosine with three phosphate groups, linked together linearly. The phosphates are attached to adenosine through the 5'-hydroxyl of its ribose (sugar) portion. Upon hydrolysis, these bonds yield either one molecule of adenosine 5'-diphosphate (ADP) and the inorganic phosphate ion, or one molecule of adenosine 5'-monophosphate (AMP) and pyrophosphate; in both cases releasing energy that is used to power biological processes. ATP is regenerated by the phosphorylation of AMP and ADP.

adenovirus One of a group of DNA-containing viruses found in rodents, fowl, cattle, monkeys, and man. In man they are responsible for respiratory tract infections, but they have been exploited as a vector in gene therapy, especially for genes targeted at the lungs.

adenylic acid Synonym for adenosine monophosphate, a (ribo)nucleotide containing the nucleoside adenosine. The corresponding deoxyribonucleotide is called deoxyadenosine 5'-monophosphate or deoxyadenylic acid.

adoptive immunization The transfer of an immune state from one animal to another by means of lymphocyte transfusions.

ADP Abbreviation for adenosine diphosphate.

adventitious A structure arising at sites other than the usual ones, e.g. shoots from roots or leaves, and embryos from any cell other than a zygote.

aerobe A micro-organism that grows in the presence of oxygen. Opposite: anaerobe.

aerobic Active in the presence of free oxygen, e.g. aerobic bacteria that can live in the presence of oxygen.

aerobic respiration A type of respiration in which foodstuffs are completely oxidized to carbon dioxide and water, with the release of chemical energy, in a process requiring atmospheric oxygen.
affinity chromatography A method for purifying specific components in a solution by exploiting their specific binding to known molecule(s). The mixed solution is passed through a column containing a solid medium to which the binding molecule is covalently attached. See: immunoadfinity chromatography; metal affinity chromatography; pseudo-affinity chromatography.

affinity tag An amino acid sequence that has been engineered into a protein to make its purification easier. The tag could be another protein or a short amino acid sequence, allowing purification by affinity chromatography. Synonym: purification tag.

aflatoxins A group of toxic compounds, produced by Aspergillus flavus, that bind to DNA and prevent replication and transcription. Aflatoxins can cause acute liver damage and cancer. A health hazard in certain stored foods or feed.

AFLP Abbreviation for amplified fragment length polymorphism.

Ag Abbreviation for antigen.

agar A polysaccharide gelifying agent used in nutrient media preparations and obtained from Rhodophyta (red algae). Both the type of agar and its concentration can affect the growth and appearance of cultured explants.

agarose The main functional constituent of agar.

agarose gel electrophoresis A method to separate DNA and RNA molecules on the basis of their size, in which samples are subjected to an electric field applied to a gel made with agarose.

aggregate 1. A clump or mass formed by gathering or collecting units. 2. A body of loosely associated cells, such as a friable callus or cell suspension. 3. Coarse inert material, such as gravel, that is mixed with soil to increase its porosity. 4. A serological reaction in which the antibody and antigen react and precipitate.

agonist A drug, hormone or transmitter substance that forms a complex with a receptor site. The formation of the complex triggers an active response from a cell.

Agrobacterium A genus of bacteria that includes several plant pathogenic species, causing tumour-like symptoms. See: Agrobacterium rhizogenes, Agrobacterium tumefaciens.

Agrobacterium rhizogenes A bacterium that causes hairy root disease in some plants. Similar to the crown gall disease caused by Agrobacterium tumefaciens, this is achieved by the mobilization of the bacterial Ri plasmid with the transfer to the plant of some of the genetic material from the plasmid. This process has been used to insert foreign genes into plant cells, but to a lesser extent than the Agrobacterium tumefaciens-mediated transformation system, because regeneration of whole plants from hairy root cultures is problematical.

Agrobacterium tumefaciens A bacterium that causes crown gall disease in some plants. The bacterium characteristically infects a wound, and incorporates a segment of Ti plasmid DNA into the host genome. This DNA causes the host cell to grow into a tumour-like structure that synthesizes specific opines that only the pathogen can metabolize. This DNA-transfer mechanism is exploited in the genetic engineering of plants. See: T-DNA.

Agrobacterium tumefaciens-mediated transformation The process of DNA transfer from Agrobacterium tumefaciens to plants, that occurs naturally during crown gall disease, and can be used as a method of transformation.
AHG Abbreviation for antihaemophilic globulin.

AI Abbreviation for artificial insemination.

airlift fermenter A cylindrical fermentation vessel in which the cells are mixed by air introduced at the base of the vessel and that rises through the column of culture medium. The cell suspension circulates around the column as a consequence of the gradient of air bubbles in different parts of the reactor.

albinism Hereditary absence of pigment in an organism. Albino animals have no colour in their skin, hair and eyes. Albino plants lack chlorophyll.

albino 1. An organism lacking pigmentation, due to genetic factors. The condition is albinism 2. A conspicuous plastid mutant involving loss of chlorophyll.

aleurone The outermost layer of the endosperm in a seed, and the site of enzymes concerned with endosperm digestion during seedling growth.

algal biomass Single-celled plants (e.g. Chlorella spp. and Spirulina spp.) grown commercially in ponds to make feed materials for zooplankton, which are in turn harvested as feed for fish farms.

alginate Polysaccharide gelling agent.

alkylating agent A class of chemicals that transfer alkyl (methyl, ethyl, etc.) groups; for example to the bases in DNA. Some of these (especially ethyl methane sulphonate, abbreviated EMS) have been much used as mutagens.

allele A variant form of a gene. In a diploid cell there are two alleles of every gene (one inherited from each parent, although they could be identical). Within a population there may be many alleles of a gene. Alleles are symbolized with a capital letter to denote dominance, and lower case for recessive. In heterozygotes with co-dominant alleles, both are expressed. See: multiple alleles. Synonym: allelomorph.

allele frequency The relative number of copies of an allele in a population, expressed as a proportion of the total number of copies of all alleles at a given locus in a population.

allelic (adj.) See allele.

allele-specific amplification (Abbreviation: ASA). The use of the polymerase chain reaction at a sufficiently high stringency that only one allele is amplified. A powerful means of genotyping for single-locus disorders that have been characterized at the molecular level.

allelic exclusion A phenomenon whereby only one functional allele of an antibody gene can be assembled in a given B lymphocyte.

allelomorph See: allele.

allelopathy The secretion of chemicals, such as phenolic and terpenoid compounds, by a plant’s roots, which inhibit the growth or reproduction of competitor plants.

allergen An antigen that provokes an immune response.

allogamy Cross fertilization in plants. See: fertilization.
**allogenic** Differing at one or more loci, although belonging to the same species. Thus an organ transplant from one human donor to another is allogeneic, whereas a transplant from a baboon to a human would be **xenogeneic**.

**allometric** When the growth rate of one part of an organism differs from that of another part or of the rest of the body.

**allopatric** In the context of natural populations of animals or plants, inhabiting distinct and separate areas.

**allopatric speciation** Speciation occurring at least in part because of geographic isolation.

**allopolyplod** A polyploid organism with sets of chromosomes derived from different species. Opposite: **autopolyploid**.

**allosome** Synonym for **sex chromosome**.

**allosteric control** See: **allosteric regulation**.

**allosteric enzyme** An enzyme that has two structurally distinct forms, one of which is active and the other inactive. Active forms tend to catalyse the initial step in a pathway leading to the synthesis of molecules. The end product of this synthesis can act as a feedback inhibitor, converting the enzyme to the inactive form, thus controlling the amount of product synthesized. Synonym: **allozyme**.

**allosteric regulation** A catalysis-regulating process in which the binding of a small effector molecule to one site on an enzyme affects the activity at another site.

**allosteric site** That part of an enzyme molecule where the non-covalent binding of an effector molecule can affect the enzyme’s catalytic activity. See: **conformation, ligand**.

**allosteric transition** A reversible interaction of a small molecule with a protein molecule, resulting in a change in the shape of the protein and consequent alteration of the interaction of that protein with a third molecule.

**allopolyploid** An **allopolyploid** having two different progenitor genomes.

**allotype** A classification of antibody molecules according to the antigenicity of the constant regions; a variation that is determined by a single allele.

**allozygote** A individual that is heterozygous for two different mutant alleles.

**allozyme** See: **allosteric enzyme**.

**alpha globulin** See: **haptoglobin**.

**alternative mRNA splicing** The inclusion or exclusion of different exons to form different mRNA transcripts from a single transcription unit.

**Alu sequences** A highly repeated family of 300-bp long sequences dispersed throughout the human genome, so named because they are released by the digestion of genomic DNA with the **restriction endonuclease** Alu.

**amber stop codon** See: **stop codon**.
amino acid A compound containing both amino (−NH₂) and carboxyl (−COOH) groups. In particular, any of 20 basic building blocks of proteins having the formula NH₂−CR−COOH, where R is different for each specific amino acid. See: annex 3.

aminoacyl site (Abbreviation: A-site). One of two sites on ribosomes to which the aminoacyl tRNA molecules can bind.

aminoacyl tRNA synthetase An enzyme that catalyses the attachment of an amino acid to its specific tRNA molecule.

amitosis A cell division (including nuclear division through constriction of the nucleus) that occurs without chromosome differentiation as in mitosis. The mechanism whereby the genetic integrity is maintained during amitosis is uncertain.

amniocentesis A procedure for obtaining foetal cells for prenatal diagnosis by sampling the amniotic fluid from a pregnant mammal. Cells are cultured, and the karyotype is checked for known irregularities (e.g. Down's syndrome and spina bifida in humans).

amnion The thin membrane that lines the fluid-filled sac in which the embryo develops in higher vertebrates, reptiles and birds.

amniotic fluid Liquid contents of the amniotic sac of higher vertebrates, containing foetal, but not maternal cells.


AMP Abbreviation for adenosine monophosphate.

amphidiploid A plant derived from doubling the chromosome number of an interspecific F₁ hybrid. Naturally found hybrids of this sort are referred to as allopolyploid.

 amphimixis True sexual reproduction involving the fusion of male and female gametes and the formation of a zygote.

ampicillin A penicillin-type antibiotic that prevents bacterial growth by interfering with synthesis of the cell wall. Commonly used as a selectable marker in the creation of transgenic plants.

amplicon The product of a DNA amplification reaction. See: polymerase chain reaction.

amplification 1. Creation of many copies of a segment of DNA by the polymerase chain reaction. 2. Treatment (e.g. use of chloramphenicol) designed to increase the proportion of plasmid DNA relative to that of bacterial (host) DNA. 3. Evolutionary expansion in copy number of a repetitive DNA sequence through a process of repeated duplication.

amplified fragment length polymorphism (Abbreviation: AFLP). A type of DNA marker, generated by the PCR amplification of restriction endonuclease treated DNA. A small proportion of all restriction fragments is amplified in any one reaction, so that AFLP profiles can be analysed by gel electrophoresis. This has the important characteristic that many markers can be generated with relatively little effort.

amplify To increase the number of copies of a DNA sequence, either in vivo by inserting into a cloning vector that replicates within a host cell, or in vitro by polymerase chain reaction.

ampometric See: electrochemical sensor
amylase Describing a wide class of enzymes that catalyse the hydrolysis of starch.

amylolytic The capability of enzymatically degrading starch into sugars.

amyllopectin A polysaccharide comprising highly branched chains of glucose residues. The water-insoluble portion of starch.

amyllose A polysaccharide consisting of linear chains of 100-1000 glucose residues. The water-soluble portion of starch.

anabolic pathway A pathway by which a metabolite is synthesized; a biosynthetic pathway.

anabolism One of the two subcategories of metabolism, referring to the building up of complex organic molecules from simpler precursors.

anaerobe An organism that can grow in the absence of oxygen. Opposite: aerobe.

anaerobic An environment or condition in which molecular oxygen is not available for chemical, physical or biological processes.

anaerobic digestion Digestion of materials in the absence of oxygen. See: anaerobic respiration.

anaerobic respiration Respiration in which foodstuffs are partially oxidized, with the release of chemical energy, in a process not involving atmospheric oxygen. A notable example is in alcoholic fermentation, where sugar is metabolized into ethanol.

analogous Features of organisms or molecules that are superficially or functionally similar but have evolved in a different way or contain different compounds.

anaphase The stage of mitosis or meiosis during which the daughter chromosomes migrate to opposite poles of the cell (toward the ends of the spindle). Anaphase follows metaphase and precedes telophase.

anchor gene A gene that has been positioned on both the physical map and the linkage map of a chromosome, and thereby allows their mutual alignment.

androgen Any hormone that stimulates the development of male secondary sexual characteristics, and contributes to the control of sexual activity in vertebrate animals. Usually synthesized in the testis.

androgenesis Male parthenogenesis, i.e. the development of a haploid embryo from a male nucleus. The maternal nucleus is eliminated or inactivated subsequent to fertilization of the ovum, and the haploid individual (referred to as androgenetic) contains in its cells the genome of the male gamete only. See: anther culture; gynogenesis.

aneuploid An organism or cell having a chromosome number other than the normal somatic number. Aneuploid gametes have a chromosome number other than the normal haploid number. The condition is aneuploidy.

angiogenesis The formation and development of new blood vessels in the body, stimulated by growth factors, such as angiogenin. The process is required for the spread of malignant tumours.
**angiogenin** One of the human angiogenic growth factors. In addition to stimulating (normal) blood vessel formation, angiogenin levels are correlated with placenta formation and tumour growth.

**angiosperm** A division of the plant kingdom that includes all flowering plants, i.e. *vascular* plants in which double fertilization occurs resulting in development of fruit containing seeds. Divided into two major groups, *monocotyledons* and *dicotyledons*. See: gymnosperm

**animal cell immobilization** Entrapment of animal cells in some solid material in order to produce some natural product or genetically engineered *protein*. Animal cells have the advantage that they already produce many *proteins* of pharmacological interest, and that genetically engineered *proteins* are produced by them with the post-translation modifications normal to animals. However, because animal cells are much more fragile than bacterial ones, they cannot tolerate a commercial *fermentation* process.

**animal cloning** See: cloning.

**anneal** The pairing of *complementary* DNA or RNA sequences, via hydrogen bonding, to form a double-stranded *polynucleotide*. *Opposite*: denature.

**annual** 1. (adj:) Taking one year, or occurring at intervals of one year. 2. A plant that completes its life cycle within one year. See biennial, perennial.

**anonymous DNA marker** A *DNA marker* detectable by virtue of variation in its sequence. The function (if any) of the sequence is unknown. *Microsatellites* and *AFLPs* are typical anonymous *DNA* markers.

**antagonism** An interaction between two organisms (e.g. moulds or bacteria) in which the growth of one is inhibited by the other. *Opposite*: synergism.

**antagonist** A compound that inhibits the effect of an *agonist* in such a way that the combined biological effect of the two becomes smaller than the sum of their individual effects.

**anther** The upper part of a *stamen*, containing pollen sacs within which the *pollen* develops and matures.

**anther culture** The aseptic culture of immature *anthers* to generate *haploid* plants from microspores via *androgenesis*.

**anthesis** The period during which *anthers* bear mature and functional pollen.

**anthocyanin** A water-soluble blue, purple or red flavonoid pigments found in vacuoles of cells of certain plants.

**antiauxin** A chemical that interferes with the *auxin* response, sometimes by the prevention of auxin transport. Some antiauxins may promote *morphogenesis in vitro* (e.g. 2,3,5-tri-iodobenzoate (TIBA) and 2,4,5-trichlorophenoxyacetate (2,4,5-T)) and are therefore used to stimulate the growth of some cultures.

**antibiosis** The prevention of growth or *development* of an organism by a substance or another organism.

**antibiotic** A class of natural and synthetic compounds that inhibit the growth of, or kill some micro-organisms. Antibiotics are widely used medicinally to control bacterial pathogens, but *resistance* in bacteria to particular antibiotics is often rapidly acquired through *mutation*.
**antibiotic resistance** The ability of a micro-organism to disable an antibiotic or prevent its transport into the cell.

**antibiotic resistance marker gene** (Abbreviation: ARMG). Genes (usually of bacterial origin) used as selection markers in transgenesis, because their presence allows cell survival in the presence of normally toxic antibiotic agents. These genes were commonly used in the development and release of first generation transgenic organisms (particularly crop plants), but are no longer favoured because of perceived risks associated with the unintentional transfer of antibiotic resistance to other organisms. See kan, neo.

**antibody** (Abbreviation: Ab). An immunological protein produced by the lymphocytes in response to contact with an antigen. Each antibody recognizes just one antigenic determinant of one antigen and acts by specifically binding to it, thus rendering it harmless. Those from the IgG antibody class are found in the bloodstream and used in immunoassay. Synonym: immunoglobulin. See: monoclonal antibody, polyclonal antibody.

**antibody binding site** The part of an antibody that binds to the antigenic determinant. See: complementarity-determining regions. Synonym: paratope.

**antibody class** The class to which an antibody belongs, depending on the type of heavy chain present. In mammals, there are five classes of antibodies: IgA, IgD, IgE, IgG, and IgM.

**antibody structure** Describes the molecular architecture of an antibody, which consists of two identical "light" chains and two identical "heavy" chains and has two antigen-binding sites. Each chain consists of a constant region which is the same between antibodies of the same class and sub-class, and a variable region that is antibody-specific.

**antibody-mediated immune response** The synthesis of antibodies by B cells in response to an encounter of the cells of the immune system with a foreign antigen. Synonym: humoral immune response.

**anticlinal** The orientation of cell wall or plane of cell division perpendicular to the surface. Opposite: periclinal.

**anticoding strand** The DNA strand used as template for transcription. The resulting mRNA is complementary in sequence to that of the anticoding strand. Synonym: template strand.

**anticodon** A triplet of tRNA nucleotides that corresponds to a complementary codon in an mRNA molecule during translation.

**antigen** (Abbreviation: Ag). A macromolecule (usually a protein foreign to the organism), which elicits an immune response on first exposure to the immune system by stimulating the production of antibodies specific to its various antigenic determinants. During subsequent exposures, the antigen is bound and inactivated by these antibodies. Synonym: immunogen.

**antigenic determinant** The individual surface feature of an antigen, that elicits the production of a specific antibody in the course of the immune response. Each antigenic determinant, typically a few amino acids in size, causes the synthesis of a different antibody and thus exposure to a single antigen may result in the expression of a number of antibodies. See: monoclonal antibody, polyclonal antibody. Synonym: epitope.

**antigenic switching** The altering of a micro-organism's surface antigens through genetic rearrangement, to elude detection by the host's immune system.
antihaemophilic factor VIII  See: antihaemophilic globulin.

antihaemophilic globulin (Abbreviation AHG). One of the blood clotting factors, a soluble protein that causes the fibrin matrix of a blood clot to form. Used as a treatment for haemophilia, AHG is usually obtained from genetically engineered cell cultures. *Synonym:* antihaemophilic factor VIII.

anti-idiotypic antibody An antibody, produced by an organism, which specifically binds to the binding site of an antibody developed by that organism against a foreign antigen. Involved with the regulation of the immune response. Some allergic responses are in part due to the breakdown of this sort of regulation.

antimicrobial agent Any chemical or biological agent that inhibits the growth and/or survival of micro-organisms. *See: antibiotic.*

antinutrient Compounds that inhibit the normal uptake or utilization of nutrients.

anti-oncogene A gene whose product prevents the normal growth of tissue.

antioxidant Compounds that slow the rate of oxidation reactions.

antiparallel orientation The normal arrangement of the two strands of a double-stranded DNA molecule, and of other nucleic-acid duplexes (DNA-RNA, RNA-RNA), in which the two strands are oriented in opposite directions so that the 5'-phosphate end of one strand is aligned with the 3'-hydroxyl end of the complementary strand.

antisense DNA One of the two strands of double-stranded DNA, usually that which is complementary (hence “anti”) to the mRNA, i.e. the non-transcribed strand. However, there is not universal agreement on this convention, and the preferred designations are coding strand for the strand whose sequence matches that of the mRNA, and non-coding strand or template strand for the complementary strand (i.e. the transcription template).

antisense gene A gene that produces an mRNA complementary to the transcript of a normal gene (usually constructed by inverting the coding region relative to the promoter).

antisense RNA An RNA sequence that is complementary to all or part of a functional mRNA molecule, to which it binds, blocking its translation.

antisense therapy The *in vivo* treatment of a genetic disease by blocking translation of a protein with a DNA or an RNA sequence that is complementary to a specific mRNA.

antiseptic Any substance that kills or inhibits the growth of disease-causing micro-organism (a micro-organism capable of causing sepsis), but is essentially non-toxic to cells of the body.

antiserum The fluid portion of the blood of an immunized animal (after coagulation of the blood), which retains any antibodies.

anti-terminator A protein which enables RNA polymerase to ignore certain transcriptional stop or termination signals and thereby produce longer than normal transcripts.

antitranspirant A compound designed to reduce plant transpiration. Applied to the leaves of newly transplanted trees, shrubs etc., or cuttings in lieu of misting. Can interfere with photosynthesis and respiration if the coating is too thick or is unbroken.
antixenosis The modification of the behaviour of an organism by a substance or another organism. Particularly used in the context of a plant's apparent resistance against insect feeding, when the insects are presented with a choice of plant genotypes.

apex The portion of a root or shoot containing the primary or apical meristem.

apical cell A meristematic initial in the apical meristem of shoots or roots of plants.

apical dominance The phenomenon where growth of lateral (axillary) buds in a plant is inhibited by the presence of the terminal (apical) bud on the branch. Explained by the export of auxins from the apical bud.

apical meristem A region of the tip of each shoot and root of a plant in which cell division is continually occurring to produce new stem and root tissue, respectively. Two regions are visible in the apical meristem: An outer 1-4-cell layered region (the tunica), where cell divisions are anticlinal; and below the tunica, (ii) the corpus, where the cells divide in all directions, and increase in volume.

apoenzyme Inactive enzyme that has to be associated with a co-enzyme in order to function. The apoenzyme/co-enzyme complex is called a holoenzyme.

apomixis The production of an embryo in the absence of meiosis. Apomictic higher plants produce asexual seeds, derived only from maternal tissue. See: parthenogenesis.

apoptosis The process of programmed cell death, which occurs naturally as a part of normal development, maintenance and renewal of tissue. Differs from necrosis, in which cell death is caused by external factors (stress or toxin).

AP-PCR See: arbitrarily primed polymerase chain reaction.

aptamer A polynucleotide molecule that binds to a specific molecule, often a protein.

aquaculture Farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants.

Arabidopsis A genus of flowering plants in the Cruciferae. A. thaliana is used in research as a model plant because it has a small fully sequenced genome, can be cultured and transformed easily, and has a rapid generation time.

arbitrarily primed polymerase chain reaction (Abbreviation: AP-PCR) An application of the polymerase chain reaction to generate DNA fingerprints. The technique uses arbitrary primers to amplify anonymous stretches of DNA. See: DNA amplification fingerprinting, random amplified polymorphic DNA.

arbitrary primer An oligonucleotide primer whose sequence is chosen at random, rather than one whose sequence matches that of a known locus. These primers therefore amplify DNA fragments which have not been pre-selected.

Archaea Single-celled life forms adapted to existence in high pressure, anaerobic, environments such as at extreme ocean depths. These organisms are seen as a promising source of enzymes robust enough for a number of demanding industrial processes.

ARMG Abbreviation for antibiotic resistance marker gene.

ARS Abbreviation for autonomous(ly) replicating segment (or sequence).
artificial inembryonation  Non-surgical transfer of embryo(s) to a recipient female. As in vitro embryo technology develops, artificial inembryonation may replace artificial insemination.

artificial insemination (Abbreviation: AI). The deposition of semen, using a syringe, at the mouth of the uterus to make conception possible.

artificial medium See: culture medium.

artificial seed Encapsulated or coated somatic embryos that are planted and treated like seed.

artificial selection The practice of choosing individuals from a population for reproduction, usually because these individuals possess one or more desirable traits.

ASA Abbreviation for allele-specific amplification.

ascites Abnormal accumulation of fluid in the peritoneal cavity, occurring naturally as a complication of cirrhosis of the liver, among other conditions. In the context of monoclonal antibody production, hybridoma cells are injected into mice to induce their proliferation in the resulting ascites. This method has been largely superseded by in vitro culture of hybridomas.

ascospore One of the spores contained in the ascus of certain fungi.

ascus (pl.: asci) Reproductive sac in the sexual stage of a type of fungi (Ascomycetes) in which ascospores are produced.

aseptic Sterile, free of contaminating organisms (bacteria, fungi, algae but not generally including viruses, and particularly not internal symbionts).

asexual Reproduction not involving meiosis or the union of gametes.

asexual embryogenesis See: somatic cell embryogenesis.

asexual propagation Vegetative, somatic, non-sexual reproduction of a plant without fertilization.

asexual reproduction Reproduction that does not involve the formation and union of gametes from the different sexes or mating types. It occurs mainly in lower animals, microorganisms and plants. In plants, asexual reproduction is by vegetative propagation (e.g. bulbs, tubers, corms) and by formation of spores.

A-site Abbreviation for aminoacyl site.

assay 1. To test or evaluate. 2. The procedure for measuring the quantity of a given substance in a sample (chemically or by other means).

assortative mating Mating in which the partners are chosen on the basis of phenotypic similarity.

assortment See: segregation.

asymmetric hybrid A hybrid formed, usually via protoplast fusion, between two donors, where the chromosome complement of one of the donors is incomplete. This chromosome loss can be induced by irradiation or chemical treatment, or can occur naturally.
asynapsis The failure or partial failure in the pairing of homologous chromosomes during the first meiotic prophase.

ATP Abbreviation for **adenosine triphosphate**.

**ATP-ase** An enzyme that brings about the hydrolysis of **adenosine triphosphate**, by the cleavage of either one phosphate groups with the formation of ADP and inorganic phosphate, or of two phosphate groups, with the formation of AMP and pyrophosphate.

attenuated vaccine A virulent organism that has been modified to produce a less virulent form, but nevertheless retains the ability to elicit antibodies against the virulent form. See: inactivated agent.

attenuation A mechanism for controlling **gene expression** in prokaryotes that involves premature termination of transcription.

attenuator A nucleotide sequence in the 5’ region of a prokaryotic gene (or in its RNA) that causes premature termination of **transcription**, possibly by forming a secondary structure.

aureofacin An antifungal **antibiotic** produced by a strain of *Streptomyces aureofaciens*. A possible candidate for the **transgenic** control of plant fungal disease.

authentic protein A recombinant **protein** that has all the properties - including any post-translational modifications - of its naturally occurring counterpart.

autocatalysis Catalysis in which one of the products of the reaction is a catalyst for the reaction.

autocatalytic reaction See: autocatalysis.

autoclave 1. An enclosed chamber in which materials can be heated under pressure to sterilize utensils, liquids, glassware, etc., using steam.

autogenous control The action of a gene product to inhibit (negative autogenous control) or enhance (positive autogenous control) the expression of the gene that codes for it.

auto-immune disease Disorder in which the immune systems of affected individuals produce antibodies against molecules that are normally produced by those individuals (called self **antigens**).

auto-immunity A disorder in the body's defence mechanism in which an **immune response** is elicited against its own (self) tissues.

autologous cells Cells taken from an individual, cultured (or stored), and, possibly, genetically manipulated before being transferred back into the original donor.

autolysis The process of self destruction of a **cell**, cell organelle, or tissue, through the action of lysosomic enzymes.

autonomous A term applied to any biological unit that can function on its own, i.e. without the help of another unit, such as a transposable element that encodes an enzyme for its own transposition.

**autonomous(ly) replicating segment (or sequence)** (Abbreviation: ARS). Any eukaryotic DNA sequence that initiates and supports chromosomal replication; they have been isolated in **yeast** cells.
**autopolyploid** A polyploid whose constituent genomes are derived from the same or nearly the same progenitor. In an autotetraploid, each chromosome is present in four copies, so meiotic configurations may include many (or exclusively) quadrivalents (four paired chromosomes), and the inheritance of alleles will be quadruplex. Quadrivalents do not always segregate normally at meiosis, resulting in lowered fertility, so some established autotetraploid species that reproduce sexually have restricted quadrivalent formation.

**autoradiograph** A technique for visualizing the presence, location and intensity of radioactivity in histological preparations, paper chromatograms or electrophoretic gel separations, obtained by overlaying the surface with X-ray film and allowing the radiation to form an image on the film.

**autosomal** Any of the chromosomes except the sex chromosomes.

**autotroph** Organism capable of self-nourishment utilizing carbon dioxide or carbonates as the sole source of carbon and obtaining energy from radiant energy or from the oxidation of inorganic elements, or compounds such as iron, sulphur, hydrogen, ammonium and nitrites. *Opposite:* heterotroph.

**autotrophic** (adj.) See: autotroph.

**auxin** A group of plant growth regulators (natural or synthetic) which stimulate cell division, enlargement, apical dominance, root initiation, and flowering.

**auxin-cytokinin ratio** The relative proportion of auxin to cytokinin present in plant tissue culture media. Varying the relative amounts of these two hormones affects the proportional growth of shoots and roots.

**auxotroph** A mutant cell or micro-organism lacking one metabolic pathway present in the parental strain, and that consequently will not multiply on a minimal medium, but requires for growth the addition of a specific compound, such as an amino acid or a vitamin.

**availability** A reflection of the form and location of nutritional elements and their suitability for absorption.

**avidin** A glycoprotein present in egg white, which has a strong affinity to biotin. Can lead to biotin deficiency if given in large quantities. Used as a biological reagent in the same way as streptavidin.

**avidity** A measure of the binding strength of an antibody to its antigen.

**avirulence gene** (Abbreviation: *avr* gene). Many plants contain *R* genes, which confer simply-inherited resistance to a specific pathogen race. The plants are able to recognize the presence of the pathogen by an interaction between their *R* gene and the matching pathogen's avirulence gene. Successful recognition triggers a cascade of further genes, often leading to a hypersensitive response.

**avr gene** Abbreviation for avirulence gene.

**axenic culture** Free of external contaminants and internal symbionts; generally not possible with surface sterilization alone, sometimes used incorrectly to indicate aseptic culture.

**axillary bud** A bud found at the axil of a leaf. *Synonym:* lateral bud.

**axillary bud proliferation** Propagation of plant tissue *in vitro* to promote axillary growth, to generate large numbers of plantlets in culture.
**B cell** An important class of **lymphocytes** that mature in bone marrow (in mammals) and the **Bursa of Fabricius** (in birds) and produce **antibodies**. Largely responsible for the antibody-mediated or humoral immune response, giving rise to the antibody-producing **plasma cells** and some other cells of the immune system. **Synonym**: **B lymphocyte**.

**B chromosome** A supernumerary chromosome present in some individuals (both plant and animal). They are smaller than the normal chromosomes, behave abnormally in both **mitosis** and **meiosis**, can vary in number between somatic cells and are not thought to have any significant gene content.

**B lymphocyte** See: **B cell**.

**BABS** Abbreviation for **biosynthetic antibody binding sites**.

**BAC** Abbreviation for **bacterial artificial chromosome**.

**bacillus** A rod-shaped **bacterium**.

**Bacillus thuringiensis** (Abbreviation: Bt). A bacterium that produces a toxin against certain insects, particularly **Coloeoptera** and **Lepidoptera**; a major means of **insecticide** for organic farming. Some of the toxin genes are important for **transgenic** approaches to crop protection.

**back mutation** A second mutation at the same site in a **gene** as the original mutation. The second mutation restores the wild-type **protein** sequence.

**backcross** Crossing an individual with one of its parents or with the genetically equivalent organism. The **offspring** of such a cross are referred to as the backcross generation or backcross progeny.

**bacterial artificial chromosome** A **plasmid** vector that can be used to clone large inserts of **DNA** (up to 500 kb). **See**: **yeast artificial chromosome**.

**bacterial toxin** A toxin produced by a bacterium, such as **Bt toxin** of **Bacillus thuringiensis**.

**bacteriocide** A chemical or drug that kills bacterial cells.

**bacteriocin** A **protein** produced by bacteria of one **strain** and active against those of a closely related strain.

**bacteriophage** (Abbreviation: phage). A **virus** that infects bacteria. Altered forms are used as cloning **vectors**. **See**: **lambda phage**, **M13**.

**bacteriostat** A substance that inhibits or slows down growth and reproduction of bacteria.

**bacterium** (pl.: bacteria) unicellular prokaryotic organisms, without a distinct nucleus. Major distinctive groups are defined by **Gram staining**. Also classified on the basis of oxygen requirement (aerobic vs anaerobic) and shape (spherical = coccus; rodlike = bacillus; spiral = spirillum; comma-shaped = vibrio; corkscrew-shaped = spirochaete; filamentous).

**baculovirus** A class of insect virus used to make **DNA cloning vectors** for gene expression in eukaryotic cells. Production of a target **protein** can be up to 50% of the cells’ **protein** content, and several **proteins** can be made simultaneously, so that multi-sub-unit enzymes can be made by this system.
**baculovirus expression vector** (Abbreviation: BEV). A method for the *in vitro* production of complex recombinant eukaryotic proteins. A genetically engineered baculovirus (a virus that infects certain types of insects) is introduced into appropriate cultured insect cells, which then express the recombinant protein.

**balanced lethal system** A system for maintaining a recessive lethal allele at each of two loci on the same pair of chromosomes. In a closed population with no crossing-over between the loci, only the double heterozygotes for the lethal mutations survive.

**balanced polymorphism** Two or more phenotypes maintained in the same breeding population.

**bank** See: gene bank.

**bar gene** See: *pat* gene.

**barnase** A bacterial ribonuclease, which, when transformed into plants and expressed in the anthers, generates a male sterile phenotype. Thus it is a technology applicable to F₁ hybrid seed production, which relies on the ability to genetically stabilize genotypes to ensure that all seed borne on the plant are the result of outcrossing. The sterility phenotype is suppressed by the *barstar protein*, which can therefore be used to reverse the sterility where this is necessary.

**Barr body** A condensed mass of chromatin found in the nuclei of female mammals. It is a late-replicating, inactive X-chromosome. See: dosage compensation, sex linkage

**barstar protein** A polypeptide inhibitor of barnase.

**basal** 1. Located at the base of a plant or a plant organ. 2. A fundamental formulation of a tissue culture medium containing nutrients but no growth promoting agents.

**base** One of the components of nucleosides, nucleotides and nucleic acids. Four different bases are found in naturally occurring DNA - the purines A (adenine) and G (guanine); and the pyrimidines C (cytosine) and T (thymine, the common name for 5-methyluracil). In RNA, T is replaced by U (uracil). See: base pair.

**base analogue** A non-natural purine or pyrimidine base that differs slightly in structure from the normal bases, but can be incorporated into nucleic acids. They are often mutagenic.

**base pair** (Abbreviation: bp). The two separate strands of a nucleic acid double helix are held together by specific hydrogen bonding between a purine and a pyrimidine, one from each strand. The base A pairs with T in DNA (with U in RNA); while G pairs with C in both DNA and RNA. The length of a nucleic acid molecule is often given in terms of the number of base pairs it contains.

**base substitution** Replacement of one base by another in a DNA molecule. See: transition; transversion.

**basic fibroblast growth factor** (Abbreviation: BFGF). See: fibroblasts.

**basipetal** Developing, in sequence, from the apex towards the base. See: acropetal.

**basophil** A type of leukocyte produced by stem cells in the red bone marrow.
**batch culture** A suspension culture in which cells grow in a finite volume of liquid nutrient medium and follow a sigmoid pattern of growth. All cells are harvested at the same time. *See: continuous culture. Synonym: batch fermentation.*

**batch fermentation** *See: batch culture.*

**bench-scale process** A small- or laboratory-scale process; commonly used in connection with fermentation.

**beta-DNA** The form of DNA generally found in nature. A right-handed helix.

**beta-galactosidase** A bacterial enzyme that catalyses the cleavage of lactose into glucose and galactose, commonly used as a marker in DNA cloning.

**beta-glucuronidase** (Abbreviation: GUS). An enzyme produced by certain bacteria, which catalyses the cleavage of a whole range of beta-glucuronides. Because this activity is largely absent in plants, the encoding bacterial gene has been widely used as a reporter gene in plant transgenesis.

**beta-lactamase** An enzyme that detoxifies penicillin group antibiotics, such as ampicillin. The â-lactamase gene is commonly used as a marker for successful transformation, where only transformed cells are able to tolerate the presence of ampicillin. *See: selectable marker.*

**beta-sitosterol** *See: phytosterol.*

**BEV** Abbreviation for baculovirus expression vector.

**BFGF** Abbreviation for basic fibroblast growth factor.

**biennial** A plant which completes its life cycle within two years and then dies.

**bifunctional vector** *See: shuttle vector.*

**binary vector system** A two plasmid system in *Agrobacterium tumefaciens* designed to transfer T-DNA into plant cells, while avoiding the formation of crown gall tumours. One plasmid contains the virulence gene (responsible for transfer of the T-DNA), and the other the T-DNA borders, the selectable marker and the DNA to be transferred.

**binding** The ability of molecules to bind each other non-covalently because of the exact shape and chemical nature of parts of their surfaces. A common biological phenomenon, as e.g. an *enzyme* to its *substrate*; an *antibody* to its *antigen*; a *DNA* strand to its complementary strand. *See: ligand.*

**bio-** A prefix used in scientific words to associate the concept of "living organisms." Usually written with a hyphen before vowels, for emphasis or in neologisms.

**bio-accumulation** A problem that can arise when a stable chemical such as a heavy metal or DDT is introduced into a natural environment. Where there are no agents present able to biodegrade it, its concentration can increase as it passes up the food chain and higher organisms may suffer toxic effects. This phenomenon may be employed beneficially for the removal of toxic metals from wastewater, and for bioremediation. *See: biosorbents.*
bio-assay 1. The assessment of a substance’s activity on living cells or on organisms. Animals have been used extensively in drug research in bio-assays in the pharmaceutical and cosmetics industries. Current trends are to develop bio-assays using bacteria or animal or plant cells, as these are easier to handle than whole animals or plants, are cheaper to make and keep, and avoid the ethical problems associated with testing of animals. 2. An indirect method to detect sub-measurable amounts of a specific substance by observing a sample’s influence on the growth of live material.

bio-augmentation Increasing the activity of bacteria that decompose pollutants; a technique used in bioremediation.

bioavailability The proportion of a nutrient or administered drug etc. that can be taken up by an organism in a biologically effective form. For example, some soils high in phosphorus have a low level of P availability because the pH of the soil renders much of the P insoluble.

biocatalysis The use of enzymes to improve the efficiency of chemical reactions.

biochip See: DNA chip.

biocontrol Pest control by biological means. Any process using deliberately introduced living organisms to restrain the growth and development of other organisms, such as the introduction of predatory insects to control an insect pest. Synonym: biological control.

bioconversion Conversion of one chemical into another by living organisms, as opposed to their conversion by isolated enzymes or fixed cells, or by chemical processes. Particularly useful for introducing chemical changes at specific points in large and complex molecules.

biodegradable Capable of being biodegraded.

biodegrade The breakdown by micro-organisms of a compound to simpler chemicals. Materials that are easily biodegraded are colloquially termed biodegradable.

biodesulphurization The removal of organic and inorganic sulphur from coal by bacterial and soil micro-organisms. Certain bacteria can oxidize insoluble sulphur compounds into soluble sulphates, which can be washed away with the bacteria. See: bioleaching.

biodiversity The variability among living organisms from all sources, including, inter alia, terrestrial, marine and other ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Synonyms: biological diversity, ecological diversity.

bio-energetics The study of the flow and the transformation of energy that occur in living organisms.

bio-engineering The use of artificial tissues, organs and organ components to replace parts of the body that are damaged, lost or malfunctioning.

bio-enrichment Adding nutrients or oxygen to increase microbial breakdown of pollutants.

bio-ethics The branch of ethics that deals with the life sciences and their potential impact on society.

biofilms A layer of micro-organisms growing on a surface, in a bed of polymeric material which they themselves have made. Biofilms tend to form wherever a surface on which bacteria can grow is exposed to some suitable medium and a supply of bacteria.
biofuel A gaseous, liquid or solid fuel derived from a biological source, e.g. ethanol, rapeseed oil or fish liver oil.

biogas A mixture of methane and carbon dioxide resulting from the anaerobic decomposition of waste such as domestic, industrial and agricultural sewage.

bio-informatics The use and organization of information of biological interest. In particular, concerned with organizing bio-molecular databases (particularly DNA sequences), utilizing computers for analysing this information, and integrating information from disparate biological sources. See: in silico.

bioleaching The recovery of metals from their ores, using the action of micro-organisms, rather than chemical or physical treatment. For example, Thiobacillus ferroxidans has been used to extract gold from refractory ores. See: biorecovery.

biolistics A technique to generate transgenic cells, in which DNA-coated small metal particles (tungsten or gold) are propelled by various means fast enough to puncture target cells. Provided that the cell is not irretrievably damaged, the DNA is frequently taken up by the cell. The technique has been successfully used to transform animal, plant and fungal cells, and even mitochondria inside cells. Synonym: microprojectile bombardment.

biological ageing See: senescence.

biological containment Restricting the movement of organisms from the laboratory. Can take two forms: making the organism unable to survive in the outside environment, or making the outside environment inhospitable to the organism. For micro-organisms, the favoured approach is to engineer organisms to require a supply of a specific nutrient that is usually available only in the laboratory. For higher organisms (plants and animals), it is more possible to ensure that the outside environment is unsuited to growth, spread and reproduction.

biological control See: biocontrol.

biological diversity See: biodiversity.

biological oxygen demand (Abbreviation: BOD). The dissolved oxygen required for the respiration of a population of aerobic organisms present in water. Expressed in terms of the oxygen consumed in water at a temperature of 20°C per unit time. The BOD is used as an indication of the degree to which the sample of water is polluted, particularly by inorganic nutrients for plants.

biologics Agents, such as vaccines, that give immunity to diseases or harmful biotic stresses.

bioluminescence The enzyme-catalyzed production of light by a number of diverse organisms (e.g. fireflies and many deep ocean marine organisms). Utilized as a reporter gene in plant transgenesis, and for the detection of food-borne pathogenic bacteria.

biomagnification See: bio-accumulation.

biomass 1. The cell mass produced by a population of living organisms. 2. The organic matter that can be used either as a source of energy or for its chemical components. 3. All the organic matter that derives from the photosynthetic conversion of solar energy.

biomass concentration The amount of biological material in a specific volume.
biome A major ecological community or complex of communities, extending over a large geographical area and characterized by a dominant type of vegetation.

biometry The application of statistical methods to the analysis of continuous variation in biological systems. Synonym: biometrics.

biomimetic materials Employed to describe synthetic analogues of natural materials with advantageous properties. For instance, some synthetic molecules act chemically like natural proteins, but are not as easily degraded by the digestive system. Other systems such as reverse micelles and/or liposomes exhibit certain properties that mimic certain aspects of living systems.

biopesticide A compound that kills organisms by virtue of specific biological effects rather than as a broader chemical poison. Differ from biocontrol agents in being passive agents, whereas biocontrol agents actively seek the pest. The rationale behind replacing conventional pesticides with biopesticides is that the latter are more likely to be selective and biodegradable.

biopharming The use of genetically transformed crop plants and livestock animals to produce valuable compounds, especially pharmaceuticals. Synonym: molecular pharming.

biopiracy The patenting of genetic stocks, and the subsequent privatization of genetic resources collections. The term implies a lack of consent on the part of the originator.

biopolymer Any large polymer (protein, nucleic acid, polysaccharide) produced by a living organism. Includes some materials (such as polyhydroxybutyrate) suitable for use as plastics. Synonym: biological polymer.

bioprocess Any process that uses complete living cells or their components (e.g. enzymes, chloroplasts) to effect desired physical or chemical changes.

bioreactor A tank in which cells, cell extracts or enzymes carry out a biological reaction. Often refers to a fermentation vessel for cells or micro-organisms.

biorecovery The use of micro-organisms for the recovery of valuable materials (metals or particular organic compounds) from complex mixtures. See: biodesulphurization, bioleaching.

bioremediation A process that uses living organisms to remove contaminants, pollutants or unwanted substances from soil or water. See: remediation, bio-accumulation, bio-augmentation.

biosafety Referring to the avoidance of risk to human health and safety, and to the conservation of the environment, as a result of the use for research and commerce of infectious or genetically modified organisms.

biosafety protocol An inteRNAtionally agreed protocol set up to protect biological diversity from the potential risks posed by the release of genetically modified organisms. It establishes a procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory. Synonym: Cartagena protocol. See: Convention on biological diversity.

biosensor A device that uses an immobilized biologically-related agent (such as an enzyme, antibiotic, organelle or whole cell) to detect or measure a chemical compound. Reactions between the immobilized agent and the molecule being analysed are converted into an electric signal.
biosilk A biomimetic fibre produced by the expression of the relevant orb-weaving spider genes in yeast or bacteria, followed by the spinning of the expressed protein into a fibre.

biosorbents Micro-organisms which, either by themselves or in conjunction with a substrate are able to extract and/or concentrate a desired molecule by means of its selective retention. See: bio-accumulation.

biosphere The part of the earth and its atmosphere that is inhabited by living organisms.

biosynthesis Synthesis of compounds by living cells, which is the essential feature of anabolism.

biosynthetic antibody binding sites (Abbreviation: BABS). See: dAb.

biotechnology 1. "Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (Convention on Biological Diversity). 2. "Interpreted in a narrow sense, ..... a range of different molecular technologies such as gene manipulation and gene transfer, DNA typing and cloning of plants and animals" (FAO's statement on biotechnology)

biotic factor Other living organisms that are a component of an organism's environment, and form the biotic environment, affecting the organism in many ways.

biotic stress Stress resulting from attack by pathogenic organisms.

biotin A vitamin of the B complex, it acts as a co-enzyme for various enzymes that catalyse the incorporation of carbon dioxide into various compounds, and is essential for the metabolism of fats. Adequate amounts are normally produced by the intestinal bacteria in animals. Significant as a molecular biology reagent due to its high affinity with avidin and streptavidin. Synonym: vitamin H.

biotin labelling The attachment of biotin to another molecule, especially DNA.

biotinylated-DNA A DNA molecule labelled with biotin by incorporation of a biotinylated nucleotide (usually uracil) into a DNA molecule. The detection of the labelled DNA is achieved by complexing it with streptavidin to which is attached a colour-generating agent such as horseradish peroxidase that gives a fluorescent green colour upon reaction with various organic reagents.

biotope A small habitat in a large community.

biotoxin A naturally produced compound which shows pronounced biological activity, toxic to some or many organisms.

biotransformation The conversion of one chemical or material into another using a biological catalyst: a near synonym is biocatalysis, and hence the catalyst used is called a biocatalyst. Usually the catalyst is an enzyme, or a fixed whole, dead micro-organism that contains an enzyme or several enzymes.

bivalent Two paired homologous chromosomes (one of maternal origin; the other of paternal origin) at prophase to anaphase of the first meiotic division. Because DNA is replicated in prophase, each duplicated chromosome comprises two chromatids, and thus a bivalent comprises four chromatids.

blast cell A large, rapidly dividing cell that develops from a B cell in response to an antigenic stimulus. The blast cell then becomes an antibody-producing plasma cell.
**blastocyst** A mammalian embryo (fertilized ovum) in the early stages of development, approximately up to the time of implantation. It consists of a hollow ball of cells.

**blastomere** Any one of the cells formed from the first few cleavages in animal embryology. The embryo usually divides into two, then four, then eight blastomeres, and so on.

**blastula** In animals, an early embryo form that follows the morula stage; typically, a single-layered sheet (blastoderm) or ball of cells (**blastocyst**).

**bleeding** 1. Collection of blood from immunized animals. 2. Used to describe the occasional purplish-black colouration of media due to phenolic products given off by (usually fresh) transfers.

**blot** As a verb, to transfer DNA, RNA or protein to an immobilizing matrix. As a noun, the immobilizing matrix carrying DNA, RNA or protein. The various types of blot are named according to the probe and/or the probed molecules: **Southern blot** (DNA/DNA), **northern blot** (DNA/mRNA), **western blot** (antibody/protein), southwestern blot (DNA/protein). Only "Southern" is written with an initial capital, as it is named after Ed Southern, the inventor of the technique.

**blunt end** The end of a double-stranded DNA molecule in which neither strand extends beyond the other. **Synonym**: flush end.

**blunt-end cut** To cut a double-stranded DNA with a restriction endonuclease which generates blunt ends. **Synonym**: flush-end cut.

**blunt-end ligation** The joining of two blunt-ended double-stranded DNA molecules.

**BOD** Abbreviation for biological oxygen demand.

**boring platform** Sterile bottom half of a Petri dish used for preparing explants with a cork borer.

**bound water** Cellular water not released into the intercellular space upon freezing and thawing. **Opposite**: free water.

**bovine growth hormone** See: bovine somatotrophin

**bovine somatotrophin** (Abbreviation: BST) A natural protein in cattle. It has been cloned, using recombinant DNA technology, expressed in large amounts and marketed as an agricultural product to improve the growth rate and protein:fat ratios in farm cattle, and to improve milk yield. Its use is banned in some countries. **Synonyms**: bovine growth hormone.

**bovine somatotropin** See: bovine somatotrophin.

**bovine spongiform encephalopathy** (Abbreviation: BSE) Cattle disease (colloquially called mad cow disease) caused by proteinaceous infectious particles.

**bp** Abbreviation for base pair.

**bract** A modified leaf that subtends flowers or inflorescences and may appear to be a petal.
**breed** 1. a sub-specific group of domestic livestock with definable and identifiable external characteristics that enable it to be separated by visual appraisal from other similarly defined groups within the same species. 2. a group of domestic livestock for which geographical and/or cultural separation from phenotypically similar groups has led to acceptance of its separate identity.

**breed at risk** An animal breed that is in danger of becoming extinct because its population has fallen below a critical number.

**breeding** The process of sexual reproduction and production of offspring.

**breeding value** A quantitative genetics term, describing that part of the deviation of an individual phenotype from the population mean that is due to the additive effects of alleles. Thus, if an individual is mated with a random sample of individuals from a population, its breeding value for a given trait is twice the average deviation of its offspring from the population mean for that trait.

**brewer's yeast** Strains of the yeast *Saccharomyces cerevisiae* that are used for the production of beer.

**bridge** A filter paper or other substrate used as a wick and support structure for a plant tissue in culture when a liquid medium is used.

**broad-host-range plasmid** A plasmid that can replicate in a number of different bacterial species.

**broad-sense heritability** The proportion of the total phenotypic variation which results from genetic variation or interaction between the genotype and the environment.

**broodstock** The group of males and females from which fish are bred.

**browning** Discolouration of freshly cut surfaces of plant tissue due to phenolic oxidation. In plant tissue culture, it may indicate a nutritional or pathogenic problem, generally leading to necrosis.

**BSA** Abbreviation for bovine serum albumin.

**BSE** Abbreviation for bovine spongiform encephalopathy. See proteinaceous infectious particle.

**BST** Abbreviation for bovine somatotrophin.

**Bt** Abbreviation for *Bacillus thuringiensis*.

**bubble column fermenter** A bioreactor in which the cells or micro-organisms are kept suspended in a tall cylinder by rising air, which is introduced at the base of the vessel.

**bud** A region of meristematic tissue with the potential for developing into leaves, shoots, flowers or combinations of these; generally protected by modified scale leaves.

**bud sport** A somatic mutation arising in a bud, generating a genetically different shoot. Includes changes due to gene mutation, chromosomal mutation or polyploidy.
budding 1. A method of asexual reproduction in which a new individual is derived from an outgrowth (bud) that becomes detached from the body of the parent. 2. Among fungi, budding is characteristic of the brewers yeast _Saccharomyces cerevisiae_. 3. A form of graft in which a single vegetative bud is taken from one plant and inserted into stem tissue of another plant so that the two will grow together. The inserted bud develops into a new shoot.

bulked segregant analysis A method to obtain markers linked to a target trait, in which DNA samples, prepared from a number of individuals of each of two contrasting phenotypes, are separately pooled and used to generate contrasting DNA fingerprints. DNA fragments unique to one pool become candidates for a marker linked to the gene controlling the trait.

buoyant density The intrinsic density which a molecule, virus or sub-cellular particle has when suspended in an aqueous solution of a salt, such as CsCl, or a sugar, such as sucrose. DNA from different species has different characteristic buoyant densities, determined largely by the relative proportion of the base-pairs G+C, to A+T.

C Abbreviation for cytosine.

CAAT box A conserved DNA sequence found within the promoter region of the protein-encoding genes of many eukaryotic organisms. So-called because of its consensus sequence GGCCAATCT, it occurs around 75 bases prior to the transcription initiation site; and is one of several sites for the recognition and binding of transcription factors. 

Synonym: CAT box.

cabinet See: growth cabinet.

callipyge An inherited trait in livestock (e.g. sheep) that results in thicker, meatier hind-quarters, and hence a higher meat yield per animal.

callus (pl.: calli) A protective tissue, consisting of parenchyma cells, that develops over a cut or damaged plant surface. 2. Mass of undifferentiated, thin-walled parenchyma cells induced by hormone treatment. 3. Actively dividing non-organized masses of undifferentiated and differentiated cells often developing from injury (wounding) or in tissue culture in the presence of growth regulators.

callus culture A technique of plant tissue culture, usually on solidified medium and initiated by inoculation of small explants. Used as the basis for organogenic (shoot or root forming) cultures, cell cultures or proliferation of embryoids. Callus cultures can be indefinitely maintained through regular sub-culturing.

cambial zone Region in stems and roots consisting of the cambium and its recent derivatives.

cambium (pl.: cambia) A one or two cells thick layer of plant meristematic tissue, between the xylem and phloem tissues, which gives rise to secondary tissues, thus resulting in an increase in the diameter of the stem or root. The two most important cambia are the vascular (fascicular) cambium and the cork cambium.

cAMP Abbreviation for cyclic adenosine monophosphate.

CaMV Abbreviation for cauliflower mosaic virus.

CaMV 35S Abbreviation for cauliflower mosaic virus 35S ribosomal DNA promoter. See: cauliflower mosaic virus.

candidate gene A gene whose deduced function (on the basis of DNA sequence) suggests that it may be involved in the genetic control of an aspect of phenotype.
candidate-gene strategy An experimental approach in which knowledge of the biochemistry and/or physiology of a trait is used to identify candidate genes. *Synonym: functional gene cloning.*

canola A specific subgroup of oilseed rape cultivars; canola oil is the highly mono-unsaturated fatty acid and low in erucic acid product produced in the seed of these cultivars.

cap The structure found on the 5´-end of eukaryotic mRNA, and consisting of an inverted, methylated guanosine residue. See G cap, cap site.

CAP Abbreviation for catabolite activator protein.

cap site The site on a DNA template where transcription begins. It corresponds to the nucleotide at the 5´ end of the RNA transcript which accepts the G cap.

capacitation The final stage, inside the female genital tract, in the maturation process of a spermatozoon, as it penetrates the ovum.

capillary electrophoresis A form of electrophoresis used widely in current large-scale DNA sequencing facilities, where the sample is passed through a long, very-narrow-bore tube containing a re-usable matrix.

CAPS See: cleaved amplified polymorphic sequence.

capsid The protein coat of a virus. The capsid often determines the shape of the virus. *Synonym: coat protein.*

capsule Carbohydrate coverings that have antigenic specificity, present on some types of bacteria and other micro-organisms. The capsule is usually composed of polysaccharides, polypeptides, or polysaccharide-protein complexes. These materials are arranged in a compact manner around the cell surface.

carbohydrate See: polysaccharide.

carboxypeptidase A class of enzymes which catalyse the cleavage of peptide bonds, requiring a free carboxyl group in the substrate. The peptide bond adjacent to this group is cleaved and a free amino acid is released. Used for deriving the amino acid sequence of peptides.

carcinogen A substance capable of inducing cancer in an organism.

carcinoma A malignant tumour derived from epithelial tissue, which forms the skin and the outer cell layers of internal organs.

carotene A reddish-orange plastid pigment involved in photosynthesis. A carotenoid and precursor of vitamin A.

carotenoid A group of chemically similar red to yellow pigments responsible for the characteristic colour of many plant organs or fruits, such as tomatoes, carrots, etc. Oxygen-containing carotenoids are called xanthophylls. Carotenoids serve as light-harvesting molecules in photosynthetic assemblies and also play a role in protecting prokaryotes from the deleterious effects of light. See: carotene.

carpel Female reproductive organ of flowering plants, consisting of stigma, style and ovary.
**carrier** A heterozygous individual bearing a **recessive** mutant **allele** for a defective condition that is "masked" by the presence of the **dominant** normal allele; the phenotype is normal, but the individual passes the defective (recessive) allele to half of its offspring.

**carrier DNA** DNA of undefined sequence which is added to the transforming (plasmid) DNA used in physical DNA-transfer procedures. This additional DNA increases the efficiency of transformation in **electroporation** and chemically-mediated DNA delivery systems. The mechanism responsible is not known.

**carrier molecule** 1. A molecule that plays a role in moving electrons through the electron transport chain. They are usually **proteins** bound to non-protein groups and able to undergo oxidation and reduction relatively easily, thus allowing electrons to flow. 2. A lipid-soluble molecule that can bind to lipid-insoluble molecules and transport them across membranes. Carrier molecules have specific sites that interact with the molecules they transport. The efficiency of carrier molecules may be modified by changing the interacting sites through genetic engineering.

**Cartagena protocol** See: **biosafety protocol**.

**casein** A group of milk **proteins**.

**casein hydrolysate** The mixture of **amino acids** and **peptides** produced by enzymatic or acid hydrolysis of **casein**.

**cassette** See: **construct**.

**CAT box** See: CAAT box.

**catabolic pathway** A pathway by which an organic molecule is degraded in order to release energy for growth and other cellular processes.

**catabolism** The breakdown of large molecules in living organisms, with the accompanying release of energy.

**catabolite activator protein** (Abbreviation: CAP). A **protein** which combines with **cyclic AMP**. The cAMP-CAP complex binds to the promoter regions of **E. coli** and stimulates transcription of the relevant **operon**. **Synonyms**: catabolite regulator protein (CRP), cyclic AMP receptor protein.

**catabolite repression** Glucose-mediated reduction in the rates of **transcription** of genes that encode enzymes involved in **catabolic pathways** (e.g. the lac operon).

**catalase** A **metalloenzyme**, present in both plants and animals, that catalyzes the decomposition of hydrogen peroxide to water and oxygen. This activity is important in the detoxification of reactive oxygen generated as part of the response to stress.

**catalysis** The process of increasing the rate of a chemical reaction by the addition of a substance that is not itself changed by the reaction (the **catalyst**).

**catalyst** A substance that promotes a chemical reaction by lowering the activation energy of a chemical reaction, without itself undergoing any permanent chemical change.

**catalytic antibody** An antibody selected for its ability to catalyse a chemical reaction by binding to and stabilizing the transition-state intermediate. **Synonym**: abzyme.

**catalytic RNA** See: **ribozyme**.
catalytic site  The part of the surface of an enzyme molecule (usually only a small portion of the total) necessary for the catalytic process.

cauliflower mosaic virus  (Abbreviation CaMV). A DNA virus affecting cauliflower and many other dicot species. Its importance is due to the promoter of its 35S ribosomal DNA, which is constitutively active in most plant tissues, and has therefore been widely used as a promoter for the expression of transgenes.

cauliflower mosaic virus 35S promoter  (Abbreviation CaMV 35S). A promoter sequence isolated from the ribosomal gene of the cauliflower mosaic virus

caulogenesis  Stem organogenesis; induction of shoot development from callus.

CBD  Abbreviation for Convention on Biological Diversity.

ccc DNA  Abbreviation for covalently-closed circle DNA. See: circularization.

CD molecules  Abbreviation for: cluster of differentiation molecules. Any group of surface antigens associated with a specific sub-population of T cells.

cDNA  Abbreviation for complementary DNA.

cDNA clone  A double-stranded cDNA molecule propagated in a vector, and used as a probe in RFLP analyses, as template for the production of EST sequences, and for gene expression studies.

cDNA cloning  A method of cloning the coding sequence of a gene, starting with its mRNA transcript.

cDNA library  An collection of cDNA clones.

CDR  Abbreviation for complementarity-determining regions.

cell  The fundamental level of structural organization in complex organisms. Eukaryotic cells contain a nucleus (with chromosomes) and cytoplasm with the protein synthesis machinery, bounded by a membrane. Prokaryotic cells have no nucleus.

cell culture  The in vitro growth of cells isolated from multi-cellular organisms.

cell cycle  The sequence of stages that a cell passes through between one division and the next. The cell cycle oscillates between mitosis (M) and the interphase, which is divided into the G₁ phase (involving a high rate of biosynthesis and growth), the S phase (in which the DNA content is doubled as a consequence of chromosome replication), and the G₂ phase (preparatory for cell division).

cell differentiation  The transition of cells (by the programmed activation and de-activation of the necessary genes) from an tissue-unspecific type, in which daughter cells are similarly undifferentiated, to a committed type in which the cell line specializes to become a recognizable tissue or organ.

cell division  Formation of two or more daughter cells from a single parent cell. The nucleus divides first, followed by the formation of a cell membrane between the daughter nuclei. Division of somatic cells is termed mitosis; egg and sperm precursors are formed following meiosis.
**cell fusion** Formation *in vitro* of a single **hybrid cell** from the coalescence of two cells of different species origin. In the hybrid cell, the donor nuclei may remain separate, or may fuse, but during subsequent cell divisions, a single **spindle** is formed so that each daughter cell has a single **nucleus** containing complete or partial sets of chromosomes from each parental line. **Synonym:** cell hybridization.

**cell generation time** The interval between the beginning of consecutive divisions of a cell, equivalent to the time that it takes for a population of single-celled organisms to double its cell number.

**cell hybridization** See: cell fusion.

**cell line** 1. A cell **lineage** that can be maintained *in vitro*. Significant genetic changes can occur during lengthy periods in culture, so that the genotype of long-term cell lines may not be the same as that of the starter cell. 2. A cell lineage that can be recognized *in vivo*.

**cell membrane** See: plasmalemma.

**cell number** The number of cells per unit volume of a culture.

**cell plate** The precursor of the cell wall, formed at the beginning of cell division. The cell plate develops in the region of the equatorial **plate** and arises from membranes in the **cytoplasm**.

**cell sap** Water and dissolved substances, sugar, amino acids, waste substances, etc., in the plant cell **vacuole**.

**cell selection** The process of selecting cells exhibiting specific traits within a group of genetically different cells. Selected cells are often sub-cultured onto fresh medium for continued selection and exposed to an increased level of the selection agent to eliminate false positives.

**cell sorter** See: fluorescence-activated cell sorting, **flow cytometry**.

**cell strain** An *in vitro* culture initiated by asexual reproduction from a single cell. Such cell lines should represent a **population** of genetically homogenous cells. Strains are defined by specific properties or markers used for their selection. **Synonym:** single-cell line.

**cell suspension** Cells in culture in moving or shaking liquid medium, often used to describe suspension cultures of single cells and cell aggregates.

**cell wall** A rigid external structure which surrounds plant cells. It is formed outside the plasmalemma and consists primarily of **cellulose**.

**cell-free protein synthesis** See: *in vitro* translation.

**cell-free transcription** See: *in vitro* transcription.

**cell-free translation** See: *in vitro* translation.

**cell-mediated (cellular) immune response** See: T-cell-mediated (cellular) immune response.

**cellular oncogene** See: proto-oncogene.

**cellulase** Enzyme catalysing the breakdown of **cellulose**.
**cellulose** A complex polysaccharide composed of long linear chains of glucose residues. It comprises 40% to 55% by weight of the plant cell wall.

**cellulose nitrate** See: nitrocellulose.

**cellulosome** A multi-protein aggregate present in some micro-organisms which degrade cellulose. It contains multiple copies of the enzymes necessary for this process, and is often found on the outer surface of the micro-organism cell.

**centiMorgan** (Abbreviation: cM). Unit of map distance. For small recombination fractions, cM and % recombination frequency are equivalent.

**central dogma** The basic concept that, in nature, genetic information generally flows from DNA to RNA to protein. However, information contained in the RNA molecules of retroviruses can also flow back to DNA.

**central mother cell** A subsurface cell located in a plant apical meristem and characterized by a large vacuole.

**centre of origin** The geographic locations where a particular domesticated plant species originated. These areas are the likeliest source of natural genetic variation, and represent ideal targets for in situ conservation.

**centrifugation** Separating molecules by size or density using centrifugal forces generated by a spinning rotor. G-forces of several hundred thousand times gravity are generated in ultracentrifugation. See: density gradient centrifugation.

**centrifuge** A mechanical device which delivers the centrifugal forces necessary for centrifugation.

**centriole** An organelle in many animal cells that appears to be involved in the formation of the spindle during mitosis. During cell division, the two centrioles move to opposite sides of the nucleus to form the ends of the spindle.

**centromere** The eukaryotic chromosome structure, which appears as a constriction in karyotype analysis, to which the spindle fibres attach during mitotic and meiotic division. Composed of highly repetitive DNA.

**centrosome** A specialized region of a living cell, situated next to the nucleus, where microtubules are assembled and broken down during cell division. The centrosome of most animal cells contains a pair of centrioles.

**cephem-type antibiotic** An antibiotic that shares the basic chemical structure of cephalosporin.

**chain terminator** 1. See: stop codon. 2. In the Sanger method of DNA sequencing, refers to the labelled di-deoxynucleotide triphosphates which are added to disrupt DNA polymerase extension.

**Chakrabarty decision** A landmark legal case in the U.S.A., in which it was held that the inventor of a new micro-organism whose invention otherwise met the legal requirements for obtaining a patent, could not be denied a patent solely because the invention was alive. This has set the precedent for the patenting of life forms.
Chaperone A family of proteins that ensure the correct assembly and conformation of other polypeptides in vivo as they emerge from the ribosome, but are not themselves components of the functional assembled structures. The prokaryotic equivalents are known as chaperonins. See: heat shock protein.

Chaperonin See: chaperone.

Character See: trait.

Characterization Description of the essential properties of an organism or system.

Charcoal The black porous residue of partly burnt wood, bones, etc; a form of carbon. See: activated charcoal.

Chelate A cation bound to an organic molecule through electron pair donation from nitrogen and/or oxygen atoms in its structure. Ethylenediamine tetraacetic acid is a typical and frequently employed chelating agent. Soluble chelates can supply plants with micronutrients which would otherwise be unavailable because of precipitation.

Chemical mutagen A chemical capable of inducing mutations in living organisms.

Chemically-defined medium When all of the chemical components of a culture medium are fully known and defined.

Chemiluminescence The emission of light during the course of a chemical reaction.

Chemostat A continuous and open culture in which growth rate and cell density are maintained constant by a fixed rate of input of a growth-limiting nutrient.

Chemotaxis The movement of a cell, or the whole or part of an organism, towards or away from an increasing concentration of a particular substance.

Chemotherapy The treatment of disease, especially infections or cancer, by means of chemicals.

Chiasma (pl.: chiasmata) A visible point of junction between two non-sister chromatids of homologous chromosomes during the first meiotic prophase. Synonym: cross-over.

Chimera (or chimaera) 1. An organism whose cells are not all genotypically identical. This can occur as a result of: somatic mutation; grafting (see: graft chimera); or because the individual is derived from two or more embryos or zygotes. 2. A recombinant DNA molecule that contains sequences from different organisms.

Chimeraplasty A method designed to create defined alterations in DNA sequence at a target locus, with potential both for gene therapy and for investigating gene function. A synthetic nucleic acid that contains DNA interspersed with small amounts of RNA is introduced into the target cell, where it pairs with its target gene sequence and then triggers the cell's DNA repair machinery, resulting in the replacement of the native sequence by the synthetic one.

Chimeric DNA See: chimera (2).

Chimeric gene An engineered gene, where a coding sequence is fused to promoter and/or other sequences derived from a different gene. Most genes used in transformation are chimeric. Synonym: fusion gene.
chimeric protein See: fusion protein.

chimeric selectable marker gene A gene that is constructed from parts of two or more different genes and allows the host cell to survive under conditions where it would otherwise die.

chip See: micro-array.

chitin A nitrogenous polysaccharide that gives structural strength to the exoskeleton of insects and the cell walls of fungi.

chitinase An enzyme which breaks down chitin.

chloramphenicol An antibiotic that interferes with protein synthesis.

chlorenchyma Plant tissue (leaf mesophyll and other parenchyma cells) containing chloroplasts.

chlorophyll One of the two pigments responsible for the green colour of most plants. It is an essential component of the machinery to absorb light energy for photosynthesis. See: chloroplast.

chloroplast Specialized plastid that contains chlorophyll. Lens-shaped and bounded by a double membrane, chloroplasts contain membranous structures (thylakoids) piled up into stacks, surrounded by a gel-like matrix (stroma). They are the site of solar energy transfer and some important reactions involved in starch or sugar synthesis. Chloroplasts have their own DNA; these genes are inherited only through the female parent, and are independent of nuclear genes.

chloroplast DNA The DNA present in the chloroplast. Although the chloroplast has a small genome, the large number of chloroplasts per cell ensures that chloroplast DNA is a significant proportion of the total DNA in a plant cell.

chloroplast transit peptide (Abbreviation: CTP). A transit peptide that, when fused to a protein, acts to transport that protein into plant chloroplasts. Once inside the chloroplast, the transit peptide is cleaved off the protein. Used to target transgene expression to the chloroplast, where this is appropriate.

chlorosis The appearance of yellow colour in plants, due to the failure of development or the breakdown of chlorophyll. This is generally a symptom of either nutritional disturbance or of pathogen infection.

chromatid Each of the two strands of chromatin comprising a duplicated chromosome. The term is applied only while the two chromatids are joined at the centromere. As soon as the centromere divides, setting the two chromatids adrift (during anaphase of mitosis; and during anaphase II of meiosis), they are called chromosomes.

chromatin Substance of which eukaryotic chromosomes are composed. It consists of a complex of DNA, histone and non-histone chromosomal proteins (mainly histones), and a small amount of RNA.

chromatin fibre The standard structural conformation of chromatin in strands of 30 nm average diameter.
**chromatography** A method for separating the components of mixtures of molecules by partitioning them between two phases, one stationary and the other mobile. Appropriate selection of partitioning mechanism can produce separation of very closely-related molecules.

**chromocentre** Body produced by fusion of the heterochromatic regions of the chromosomes in the polytene tissues (e.g. the salivary glands) of certain Diptera.

**chromogenic substrate** A compound or substance that contains a colour-forming group.

**chromomereres** Small dense bodies identified by their characteristic size and linear arrangement along a chromosome.

**chromonema** (pl.: chromonemata) An optically single thread forming an axial structure within each chromosome.

**chromoplast** Plastid containing pigments other than chlorophyll. See: chloroplast.

**chromosomal aberration** An abnormal change in chromosome structure or number, including deficiency, duplication, inversion, translocation, aneuploidy, polyploidy, or any other change from the normal pattern. Although it can be a mechanism for enhancing genetic diversity, most alterations are fatal or debilitating, especially in animals. See: chromosome mutation.

**chromosomal integration site** A chromosomal location where foreign DNA can be integrated, often without impairing any essential function in the host organism.

**chromosomal polymorphism** The occurrence of one to several chromosomes in two or more alternative structural forms within a population; the structurally changed chromosomes are the result of chromosome mutations (i.e. any structural change involving the gain, loss or re-location of chromosome segments).

**chromosome** In eukaryotic cells, chromosomes are the nuclear bodies containing most of the genes largely responsible for the differentiation and activity of the cell. Chromosomes are most easily studied in their contracted state, which occurs around the metaphase of mitosis or meiosis; they contain most of the cell's DNA in the form of chromatin. Each eukaryotic species has a characteristic number of chromosomes. Bacterial and viral cells contain only one chromosome, which consists of a single or double strand of DNA or, in some viruses, RNA, without histones.

**chromosome aberration** See: chromosomal aberration.

**chromosome banding** Differential staining of chromosomes in such a way that light and dark areas occur along the length of the chromosomes in repeatable patterns. Identical banding pattern implies chromosome homology.

**chromosome jumping** A technique that allows two segments of duplex DNA that are separated by thousands of base pairs (about 200 kb) to be cloned together. After sub-cloning, each segment can be used as a probe to identify cloned DNA sequences that, at the chromosome level, are roughly 200 kb apart. See positional cloning.

**chromosome landing** An alternative to chromosome walking for positional cloning. Clones of genomic DNA are fragmented so as to include both the target gene and a closely linked marker and are screened to select (‘land on’) those clones that contain the target gene.
chromosome mutation A change in the gross structure of a chromosome, usually causing severely deleterious effects in the organism, but can be maintained in a population (See: chromosomal polymorphism). They are often due to meiotic errors. The main types of chromosome mutation are translocation, duplication, and inversion.

chromosome theory of inheritance The theory that chromosomes carry the genetic information and that their behaviour during meiosis provides the physical basis for segregation and independent assortment.

chromosome walking A strategy for mapping or sequencing a chromosome segment and for positional cloning. Large restriction fragments (or BAC clones) are generated and, after probing, a single starting point is identified. New probes are synthesized complementary to sequences of the same fragment (BAC clone) that are adjacent to the starting point, and these are then used to identify different restriction fragments (BAC clones) overlapping the one selected as the starting point. The procedure is used repetitively, working away from the starting point.

chymosin An enzyme that clots milk, used in the manufacture of cheese.

ciliate (adj.) See cillum.

cillum (pl.: cilia) Hairlike locomotor structure on certain cells; a locomotor structure on a ciliate protozoan.

circadian Of physiological activity, etc.: recurring at approximately 24-hour intervals.

circularization The self-ligation of a linear DNA fragment having complementary ends, generally generated by digestion with a restriction endonuclease. Successful ligation produces a molecule in the form of a covalently-closed circle. Plastid DNA and plasmids are examples of naturally circularized DNA.

cis configuration See: coupling.

cis heterozygote A double heterozygote that contains two mutations arranged in a cis configuration (e.g. a+b+/a b).

cis-acting protein A protein with the particular property of acting only on the molecule of DNA from which it was expressed.

cis-acting sequence A nucleotide sequence that only affects the expression of genes located on the same chromosome.

cistron A DNA sequence that codes for a specific polypeptide; a gene.

class switching The process during which a plasma cell stops producing antibodies of one class and begins producing antibodies of another class.

cleave To break phosphodiester bonds of double-stranded DNA, usually with a type II restriction endonuclease. Synonyms: cut; digest.

cleaved amplified polymorphic sequence A segment of DNA that can be amplified by polymerase chain reaction (PCR) and which contains a DNA sequence polymorphism. Following PCR amplification of a locus, the amplicon is treated with a restriction endonuclease. If the recognition site for this enzyme is present in the amplicon, two or more restriction fragments are generated. Thus sequence variation between individuals at the recognition site(s) can be detected by electrophoresis. See also: restriction fragment length polymorphism.
cline Variation in one or more phenotypic characters or allele frequencies across a geographical gradient.

clonal propagation Asexual propagation of many new plants (ramets) from an individual (ortet); all have the same genotype.

clonal selection The production of a population of plasma cells all producing the same antibody in response to the interaction between a B lymphocyte producing that specific antibody and the antigen bound by that antibody. See: primary immune response, secondary immune response.

clude 1. A group of cells or individuals that are genetically identical as a result of asexual reproduction, breeding of completely inbred organisms, or forming genetically identical organisms by nuclear transplantation. 2. Group of plants genetically identical in which all are derived from one selected individual by vegetative propagation. 3. Verb: to clone. To insert a DNA segment into a vector or host chromosome.

cloned strain or line A strain or line descended directly from a clone.

cloning See: gene cloning.

cloning site See: insertion site.

cloning vector A small, self-replicating DNA molecule - usually a plasmid or viral DNA chromosome - into which foreign DNA is inserted in the process of cloning genes or other DNA sequences of interest. It can carry inserted DNA and be perpetuated in a host cell. 

Synonym: cloning vehicle.

cloning vehicle See: cloning vector.

closed continuous culture A culture system, in which the inflow of fresh medium is balanced by the outflow of corresponding volumes of spent medium. Cells are separated mechanically from outflowing medium and added back to the culture.

cluster of differentiation See: CD molecules.

cM Abbreviation for centiMorgan.

CMP Abbreviation for cytidine monophosphate. See: cytidylic acid.

coat protein See: capsid.

coccus A spherical bacterium.

co-cloning The unintentional cloning of DNA fragments, along with the desired one, that can occur when the source of DNA being cloned is not sufficiently purified.

coconut milk Liquid endosperm of the coconut, often used to supply organic nutrients to in vitro cultures of plant cells and tissues.

co-culture The joint culture of two or more types of cells, such as a plant cell and a microorganism, or two types of plant cells. Used in various dual-culture systems or in nurse culture.
**Codex Alimentarius Commission** An international regulatory body (part of FAO) responsible for the definition of a set of international food standards. The Commission periodically determines, then publishes a list of food ingredients and maximum allowable levels (the *Codex Alimentarius*) deemed to be safe for human consumption.

**coding** The specification of a peptide sequence, by the code contained in DNA molecules. See: genetic code.

**coding sequence** That portion of a gene which directly specifies the amino acid sequence of its product. Non-coding sequences of genes include introns and control regions, such as promoters, operators, and terminators.

**coding strand** The strand of a DNA double helix that contains the same base sequence (after substituting U for T) found in the mRNA molecule resulting from transcription of that segment of DNA. Sometimes called the sense strand. The mRNA molecule is transcribed from the other strand, known as the template or antisense strand. See: antisense DNA.

**co-dominance** Where both alleles are expressed in the heterozygous state, so that the phenotype reflects a contribution from both alleles. For example, roan coat colour in cattle results from a mixture of red hairs and white hairs, caused by heterozygosity for the red allele and the white allele.

**co-dominant alleles** See: co-dominance.

**codon** One of the groups of three consecutive nucleotides in mRNA, which represent the unit of genetic coding by specifying a particular amino acid during the synthesis of polypeptides in a cell. Each codon is recognized by a tRNA carrying a specific amino acid, which is incorporated into a polypeptide chain during protein synthesis. In DNA, any informative triplet of bases, including both coding and control sequences. See: genetic code, start codon, stop codon. Synonym: triplet. See: annex 3.

**codon optimization** An experimental strategy in which codons within a cloned gene - ones not generally used by the host cell translation system - are changed by in vitro mutagenesis to the preferred codons, without changing the amino acids of the synthesized protein.

**co-enzyme** Synonym for co-factor.

**co-evolution** The evolution of complementary adaptations in two species brought about by the selection pressure that each exerts on the other. Common in symbiotic associations, in insect-pollinated plants, etc.

**co-factor** An organic molecule or inorganic ion necessary for the normal catalytic activity of an enzyme. Synonym: co-enzyme.

**co-fermentation** The simultaneous growth of two micro-organisms in one bioreactor.

**cohesive end** See: extension.

**coincidence** The ratio of the observed to the expected frequency of double cross-overs, where the expected frequency is calculated by assuming that the two cross-over events occur independently of one another.

**co-integrate** A chimeric DNA molecule formed by the incorporation at a single site of two different DNA molecules.
co-integrate vector system A two plasmid system for plant transgenesis. One plasmid is engineered to carry a T-DNA segment incorporating the gene(s) to be introduced. After introduction into Agrobacterium tumefaciens, the plasmid undergoes homologous recombination with a resident disarmed Ti plasmid to form a single plasmid carrying the genetic information for transferring the genetically engineered T-DNA region to plant cells.

colchicine An alkaloid, obtained from the autumn crocus Colchicum autumnale, which inhibits spindle formation. When applied during mitosis, chromosomes are unable to separate during anaphase. This property is used to achieve a doubling of the chromosome number. A further use is to halt mitosis at metaphase, the stage at which karyotypes are best viewed.

coleoptile Protective sheath covering the shoot apex of the embryo in the grasses.

coleorhiza A protective sheath surrounding the radicle in the grasses.

colinearity 1. A general relationship in which the units in one molecule occur in the same sequence as the units in another molecule which they specify; e.g. the nucleotides in a gene are co-linear with the amino acids in its encoded polypeptide. 2. The phenomenon whereby gene order is preserved between distinct species.

collenchyma A tissue of living cells, found particularly in midribs and leaf petioles. Characterized by cell walls unevenly thickened with cellulose and hemicellulose, but never lignified; it functions as a mechanical support in young, short-lived or non-woody organs.

colony 1. An group of genetically identical cells or individuals derived from a single progenitor. 2. A group of interdependent cells or organisms.

colony hybridization A technique that uses a nucleic acid probe to identify a recombinant bacterial colony carrying a particular inserted DNA.

combinatorial library The many novel combinations (consisting of one heavy and one light immunoglobulin chain coding region) that are generated when a heavy-chain library is combined by random pairing with a light-chain library. These constructs are propagated in a vector, and their gene products screened for novel affinity properties.

combining site See: antibody binding site.

commensalism The interaction of two or more dissimilar organisms where the association is advantageous to one without affecting the other(s).

companion cell A living cell associated with the sieve cell of phloem tissue in vascular plants.

comparative mapping The comparison of map locations of genes and markers between species. In comparisons between closely related species, this will usually uncover a high degree of conservation of synten and co-linearity. In these cases, the likely location of many genes can be predicted from model system data. Comparisons across wider phylogenetic distances reveal increasing loss of synteny.

comparative positional candidate gene Relates to an indirect means of assigning function to a QTL. Where a QTL has been linked to a marker in one species, and that same marker is linked to a known gene in a model system, inferences may be drawn as to the nature of the QTL.
competent 1. Bacterial cells able to take up foreign DNA molecules and thereby become genetically transformed. Can be genetically determined, or induced by physical treatment. 2. A competent cell is capable of developing into a fully functional embryo.

complement proteins Proteins that bind to antibody-antigen complexes and help degrade the complexes by proteolysis.

complementarity 1. See: complementary. 2. The similar correspondence between DNA and the mRNA transcribed from it.

complementarity-determining regions (Abbreviation: CDR). Regions of the light and heavy subunits of the immunoglobulin molecules that interact with the antigen. The primary amino acid sequences of these regions are highly variable between antibodies of the same class. See: antibody binding site.

complementary Two DNA molecules are complementary to one another when each successive base position from the 5' end in the first molecule is matched by the corresponding residue in the second, starting at the 3' end, according to the normal base pair rules (i.e. A for T, C for G). In the appropriate conditions, two complementary single-stranded DNA molecules will renature to form a double-stranded molecule. Complementary nucleotides are members of the pairs adenine-thymine, adenine-uracil, and guanine-cytosine that have the ability to hydrogen bond to one another.

complementary DNA (Abbreviation: cDNA). A DNA strand synthesized in vitro from a mature RNA template using reverse transcriptase. DNA polymerase is then used to create a double-stranded molecule. Differs from genomic DNA by the absence of introns. Synonym: copy DNA.

complementary entity 1. Synonym of base pair. 2. One of a pair of segments or strands of nucleic acid that will hybridize with one another.

complementary genes Two or more interdependent genes, such that (in the case of dominant complementarity) the dominant allele from either gene can only produce an effect on the phenotype of an organism if the dominant allele from the other gene is also present; in the case of recessive complementarity, only double homozygous recessive individuals show the effect.

complementary homopolymeric tailing The process of adding complementary nucleotide extensions to DNA molecules, (e.g. deoxyguanosine) to the 3’ end of one DNA molecule and deoxycytidine to the 5’ end of another DNA molecule) to facilitate the ligation of the two DNA molecules. Synonyms: dA - dT tailing, dG - dC tailing.

complementation See: genetic complementation.

complementation test A genetic method to test whether or not independent mutations are allelic. In a cross between the two mutant individuals, the genotype will be $m_1m_2$ if the mutations are allelic and $m_1 +/+ m_2$ if non-allelic. The phenotype of the former will be mutant, but that of the latter will be wild type (normal). Synonym: trans test.

complete digest The treatment of a DNA preparation with a restriction endonuclease for sufficient time for all of the potential target sites within that DNA to have been cleaved. Opposite: partial digest.

composite transposon A transposon formed when two identical or nearly identical transposons insert on either side of a non-transposable segment of DNA.
compound chromosome A chromosome formed by the fusion of two separate chromosomes, as in attached-X chromosomes or attached-X-Y chromosomes.

concatemer A DNA segment made up of repeated sequences linked head to tail.

concordance Identity of matched pairs or groups for a given trait, such as sibs expressing the same trait.

conditional lethal mutation A mutation that is lethal under one set of environmental conditions (the restrictive conditions, commonly associated with high temperature) but is viable under another set of environmental conditions (the permissive conditions).

conditioning 1. The effects on phenotypic characters of external agents during critical developmental stages. 2. The undefined interaction between tissues and culture medium resulting in the growth of single cells or small aggregates. Conditioning may be accomplished by immersing cells or callus contained within a porous material (such as dialysis tubing) into fresh medium for a period dependent on cell density and a volume related to the amount of fresh medium.

conformation The various three dimensional shapes that can be adopted by a given molecule. In particular, the different ways in which the primary sequence of a biological polymer may be folded. This is determined by intra-molecular forces, including hydrogen bonding and, in proteins, disulphide bridges. In proteins, conformation is often critical for biological activity, and the functions of some molecules are carried out by switching between two alternative stable conformations. The native conformation found in vivo may be changed to typically less ordered, uncharacterized, and usually biologically-inactive forms by denaturing.

conidium (pl.: conidia) An asexual spore produced by a specialized hypha in certain fungi.

conjugation 1. Union of gametes or unicellular organisms during fertilization. 2. The unidirectional transfer of plasmid DNA from one bacterium cell to another, involving cell-to-cell contact. The plasmid usually encodes the majority of the functions necessary for its own transfer. 3. Attachment of sugar and other polar molecules to less polar compounds, thus making them more water soluble.

conjugative functions Plasmid-based genes and their products that facilitate the transfer of a plasmid from one bacterium to another via conjugation.

consanguinity Related by descent from a common ancestor.

consensus sequence The part of a gene or signal sequence that is shared over a wide range of members of a gene family, both within a given species, or in comparisons between species.

conservation See: gene (resources) conservation, conserved sequence

conserved sequence An identical or highly similar sequence of nucleotides or amino acids which occurs as part, or all of a number of different genes or proteins, in either the same or different species. This conservation can signify which part of the full sequence is responsible for the functionality.

constant domains Regions of antibody chains that have the same amino acid sequence in different members of a particular class of antibody molecules.

constitutive The expression of a gene without any requirement for induction.
**constitutive gene** A gene that is continually expressed in all cells of an organism.

**constitutive promoter** An unregulated promoter that allows for continual transcription of its associated gene.

**constitutive synthesis** Continual synthesis of a gene product by an organism.

**construct** An engineered chimeric DNA designed to be transferred into a cell or tissue. Typically, the construct comprises the gene or genes of interest, a marker gene and appropriate control sequences as a single package. A repeatedly-used construct may be called a cassette.

**contained use** See: containment.

**containment** Measures and protocols applied to limit contact of genetically modified organisms or pathogens with the external environment. *Synonym*: contained use.

**contaminant** 1. An undesired chemical present in a compound or mixture of compounds. 2. Any micro-organism accidentally introduced into a culture or culture medium. The contaminant may compete with the desired cells and consequently inhibit their growth, or totally replace them.

**contig** A set of overlapping cloned DNA fragments that can be assembled to represent a defined region of the chromosome or genome from which they were obtained. Contig definition is a necessary step for assembling whole genome sequences.

**continuous culture** A suspension culture continuously supplied with nutrients by the inflow of fresh medium. The culture volume is normally constant.

**continuous fermentation** A process in which cells or micro-organisms are maintained in culture in the exponential growth phase by the continuous addition of fresh medium that is exactly balanced by the removal of cell suspension from the bioreactor.

**continuous variation** Variation where individuals cannot be classified as belonging to one of a set of discrete classes. Characters showing continuous variation are referred to as quantitative. *See*: polygene, quantitative trait locus. *Opposite*: discontinuous variation.

**controlled environment** A closed environment in which parameters, such as light, temperature, relative humidity and sometimes the partial gas pressure (and possibly its composition), are fully controlled.

**controlling element** In eukaryotes, transposons which affect the activity of known genes. This can occur as a result of the integration within, or close to a gene, thereby disrupting its activity; or following its excision from such a site, thereby restoring activity.

**Convention on Biological Diversity** (Abbreviation: CBD). The inteRNAtional treaty governing the conservation and use of biological resources around the world, that has also called for the establishment of rules to govern the inteRNAtional movement of non-indigenous living organisms and genetically modified organisms.

**conversion** The development of a somatic embryo into a plant.

**coordinate repression** Correlated regulation of a structural gene within an operon by a molecule that interacts with the operator.

**copy DNA** See: complementary DNA.
**copy number** The number of a particular **plasmid** per bacterium cell, or **gene** per **genome**.

**co-repressor** An **effector molecule** that forms a complex with a **repressor** and turns off the expression of a gene or set of genes.

**corpus** A part of the **apical meristem** below the **tunica**. In the corpus, cells divide in all directions, and increase in volume.

**correlation** A statistical association between variables.

**cortex** Primary tissue of a stem or root, bounded externally by the **epidermis** and internally in the stem by the **phloem**, and in the root by the **pericycle**.

**cos ends** The 12-base, single-strand, complementary **extensions** of **bacteriophage** lambda **DNA**.

**cos sites** See **cos ends**.

**co-segregation** The joint **inheritance** of two characters, usually the result of genetic **linkage**.

**cosmid** A synthetic **plasmid** which incorporates the **cos ends**, and one or more **selectable** markers such as an **antibiotic resistance** gene. Cosmids were designed as **vectors** able to incorporate **DNA** fragments up to 40-50 kb in size.

**co-suppression** A natural **gene silencing** phenomenon, which probably evolved as part of plants’ defence against viral attack, but which has become important in the context of plant **transgenesis**. Operates by inhibiting the expression of **transgenes** with homology to native **DNA** through the interaction of native and transgenic **mRNA**.

**cot curve** A method to estimate the heterogeneity of sequence of a **DNA** preparation, based on the observation that the more homogenous the **DNA**, the more easily (and therefore faster) the annealing of **single-stranded DNA** will occur. The Cot curve plots the extent of annealing from a fully single-stranded preparation over time. The cot (product of initial concentration and time) at which half the DNA has re-natured is the half-cot, a parameter indicating both the degree of heterogeneity in a complex mixture, and of the extent of complementarity in a mixture of two single-stranded **DNA** molecules.

**co-transfection** The procedure by which a **baculovirus** and a transfer **vector** are simultaneously introduced into insect cells in culture.

**co-transformation** A protocol for producing **transgenesis**, in which **host** (plant or animal) cells are transformed simultaneously with two different **plasmids**, one of which carries a **selectable marker**, and the other the gene to be transferred. Relies on the observation that given a sufficiently high concentration of both plasmids, transformed cells will have incorporated both plasmids, possibly at different genomic **loci**. If the transgenes are separable through normal meiotic recombination, transgenic individuals without the selectable marker can be selected in subsequent generations.

**cotyledon** Leaf-like structures at the first **node** of the seedling stem. In some **dicotyledons**, they represent a food storage organ for the germinating seedling.

**coupling** The phase state in which either two **dominant** or two **recessive** alleles of two different genes occur on the same chromosome. **Synonym**: **cis configuration**. **Opposite**: **repulsion**; **trans configuration**.
covalently-closed circular DNA (Abbreviation: ccc DNA). A DNA molecule in which the free ends have ligated to form a circle. The strands remain linked together even after denaturation. Plasmids exist in this form in their in vivo state. In its native form, ccc DNA will adopt a supercoiled configuration. See: circularization.

CP4 EPSPS Abbreviation for CP4 5-enolpyruvyl-shikimate-3-phosphate synthase. See: enolpyruvyl-shikimate-3-phosphate synthase.

cpDNA Abbreviation for chloroplast DNA.

cross The mating of two individuals or populations. See: cross-breeding.

cross hybridization The annealing of a single-stranded DNA sequence to a single-stranded target DNA to which it is only partially complementary. Often, this refers to the use of a DNA probe to detect homologous sequences in species other than the origin of the probe.

cross pollination Application of pollen from one plant to another to effect the latter’s fertilization.

cross pollination efficiency The ease with which cross pollination can be achieved. Generally measured by the number of hybrid progeny generated per flower pollinated.

cross-breeding Mating between members of different populations (lines, breeds, races or species). See: cross.

crossing over The process by which homologous chromosomes exchange material at meiosis through the breakage and reunion of non-sister chromatids. See: recombination, chiasma.

crossing-over unit See: recombination fraction.

cross-over See: chiasma.

crown The base of the stem of cereals and forage species from which tillers or branches arise. In woody plants, the root-stem junction. In forestry, the top portion of the tree.

crown gall A tumorous growth at the base of certain plants characteristic of infection by Agrobacterium tumefaciens. The gall is induced by the transformation of the plant cell by portions of the Ti plasmid.

CRP Abbreviation for catabolite regulator protein. See: catabolite activator protein.

cry proteins A class of crystalline proteins produced by strains of Bacillus thuringiensis, and engineered into crop plants to give resistance against insect pests. These proteins are toxic to certain categories of insects (e.g. corn borers, corn rootworms, mosquitoes, black flies, armyworms, tobacco hornworms, some types of beetles, etc.), but are harmless to mammals and most beneficial insects. Synonym: delta endotoxins.

cryobiological preservation The preservation of germplasm resources in a dormant state by storage at ultra-low temperatures, often in liquid nitrogen. Currently applied to storage of plant seeds and pollen, micro-organisms, animal sperm, and tissue culture cell lines. Synonyms: cryopreservation, freeze preservation.

cryogenic At very low temperature.

cryopreservation See: cryobiological preservation.
cryoprotectant Compound preventing cell damage during successive freezing and thawing processes. Cryoprotectants are agents with high water solubility and low toxicity. Two types commonly used: permeating (glycerol and DMSO) and non-permeating (sugars, dextran, ethylene glycol, polyvinylpyrrolidone and hydroxyethyl starch).

cryptic Anything hidden. 1. Structurally heterozygous individuals that are not identifiable as they do not show abnormal meiotic chromosome pairing configurations (‘cryptic structural hybrids’). 2. A form of polymorphism controlled by recessive genes (‘cryptic polymorphism’). 3. Any mutation which is exposed by a sensitizing mutation and otherwise poorly detected (such mutations probably escape detection because of the plasticity of composition of the corresponding polypeptide). 4. Phenotypically very similar species (cryptic species) which do not hybridize under normal conditions. 5. Cryptic genetic variation refers to the existence of, for example, alleles conferring high performance for a trait, in a breed that has low performance for that trait.

CTP Abbreviation for 1. cytidine 5'-triphosphate, which is required for RNA synthesis since it is a direct precursor molecule; 2. Chloroplast transit peptide.

cultigen A cultivated plant species with no known wild progenitor.

cultivar (Abbreviation: cv). An interRNAtionally accepted term denoting a variety of a cultivated plant. Must be distinguishable from other varieties by stated characteristics and must retain their distinguishing characters when reproduced under specific conditions.

culture A population of plant or animal cells or micro-organisms grown under controlled conditions.

culture alteration A term used to indicate a persistent change in the properties of a culture’s behaviour (e.g. altered morphology, chromosome constitution, virus susceptibility, nutritional requirements, proliferative capacity, etc.). The term should always be qualified by a precise description of the change which has occurred in the culture.

culture medium Any nutrient system for the cultivation of cells, bacteria or other organisms; usually a complex mixture of organic and inorganic nutrients.

culture room A dedicated room for maintaining cultures, often in a controlled environment.

curing The elimination of a plasmid from its host cell. Many agents which interfere with DNA replication, e.g. ethidium bromide, can cure plasmids from either bacterial or eukaryotic cells.

cut See: cleave.

cuticle Layer of cutin or wax, formed on the outer surface of leaves and fruits, thought to have evolved to reduce evaporative water loss.

cutting A detached plant part that, with appropriate treatment, can regenerate into a complete plant.

cybrid A hybrid, originating from the fusion of a cytoplast (the cytoplasm without nucleus) with a whole cell derived from a different species.

cyclic adenosine monophosphate (Abbreviations: cyclic AMP, cAMP). A "messenger" molecule that regulates many intracellular reactions by transducing signals from extracellular growth factors to cellular metabolic pathways.
**cyclic AMP** Abbreviation for *cyclic adenosine monophosphate*.

**cycloextrin** Cyclic oligomer of glucose.

**cycloheximide** A molecule that inhibits protein synthesis in eukaryotes, but not in prokaryotes. It blocks peptide bond formation by binding to the large ribosomal subunits. *Synonym*: actidione.

**cytidine** The (ribo)nucleoside resulting from the combination of the base cytosine (C) and the sugar D-ribose. The corresponding deoxyribonucleoside is called deoxycytidine. *See*: CTP (1), dCTP, cytidylic acid.

**cytidine triphosphate (cytidine 5'-triphosphate)** *See*: CTP (1).

**cytidylic acid** Synonym for cytidine monophosphate (abbreviation: CMP), a (ribo)nucleotide containing the nucleoside cytidine. The corresponding deoxyribonucleotide is called deoxycytidine 5'-monophosphate or deoxycytidylic acid.

**cytochrome** A class of pigments in plant and animal cells, usually in the mitochondria. They function as electron carriers in respiration.

**cytochrome p450** A highly diversified set (more than 1500 known sequences) of heme-containing proteins. Frequently called hydroxylases, although P450 proteins can perform a wide spectrum of other reactions. In bacteria they are soluble and approximately 400 amino acids long; eukaryotic P450s are larger - about 500 amino acids. In mammals they are critical for drug metabolism, haemostasis, cholesterol biosynthesis and stereoidogenesis; in plants they are involved in plant hormone synthesis, phytoalexin synthesis, flower petal pigment biosynthesis and many unknown functions. In fungi they make ergosterol and they are involved in pathogenesis. Bacterial P450s are key elements in antibiotic synthesis.

**cytogenetics** The biology of chromosomes and their relation to the transmission and recombination of genes.

**cytokine** A generic name for a diverse group of soluble proteins and peptides which act as humoral regulators at extremely small concentrations and which, either under normal or pathological conditions, modulate the functional activities of individual cells and tissues. *See*: lymphokine, monokine.

**cytokinesis** Cytoplasmic division and other changes exclusive of nuclear division that are a part of mitosis or meiosis.

**cytokinin** Plant growth regulators characterized as substances that induce cell division and cell differentiation. In tissue culture, these substances are associated with enhanced callus and shoot development. The compounds are derivatives of adenine. *See*: kinin.

**cytology** The study of the structure and function of cells.

**cytolysis** Cell disintegration.

**cytoplasm** The living material of the cell, exclusive of the nucleus, consisting of a complex protein matrix or gel, and where essential membranes and cellular organelles (mitochondria, plastids, etc.) reside.

**cytoplasmic genes** Genes located on DNA outside the nucleus, i.e. on plastids.

**cytoplasmic inheritance** Hereditary transmission dependent on cytoplasmic genes.
cytoplasmic male sterility Genetic defect due to faulty functioning of mitochondria in pollen development, preventing the formation of viable pollen. Commonly found or inducible in many plant species and exploited for some F₁ hybrid seed programmes.

cytoplasmic organelles Discrete sub-cellular structures located in the cytoplasm of cells - mitochondria, plastids and lysosomes.

cytosine (Abbreviation: C). One of the bases found in DNA and RNA. See: cytidine.

cytosol The fluid portion of the cytoplasm, i.e. the cytoplasm minus its organelles.

cytotoxic T cell See: killer T cell.

cytotoxicity Poisoning of the cell.

cytotype A maternally inherited cellular condition in Drosophila that regulates the activity of transposable P elements.
Glossary of biotechnology for food and agriculture

D-H

D loop Abbreviation for displacement loop. Formed when a short stretch of RNA is paired with one strand of DNA. This displaces the original partner DNA; also the displacement of a region of one strand of duplex DNA by a single-stranded invader in the reaction catalyzed by recA.

dA - dT tailing See complementary homopolymeric tailing.

dAb (Full term: single domain antibody). Antibodies with only one (instead of two) protein chain derived from only one of the two domains of the normal antibody structure. Exploits the finding that for some antibodies, half of the molecule binds to its target antigen almost as well as the whole molecule. The major advantage of dAbs over other antibodies is that they can be cloned and expressed into bacteria, so that large numbers of antibodies can be generated and screened in parallel.

DAF See: DNA amplification fingerprinting.

Dalton (Abbreviation: Da). A unit of atomic mass roughly equivalent to the mass of a hydrogen atom. Used as to express molecular weight, which for biological macromolecules is usually in the range kilo- (kDa) to megaDaltons (MDa).

DAMD See: directed amplification of minisatellite DNA.

Darwinian cloning Selection of a clone from a large number of essentially random starting points, rather than isolating a natural gene or making a carefully designed artificial one. Molecules which are more similar to those needed are selected, mutated to generate new variants, and re-selected. The cycle proceeds until the required molecule is found. The advantage of the system is that the selection is from a vast number of possibilities.

dATP Abbreviation for deoxyadenosine 5’-triphosphate. dATP is required for DNA synthesis since it is a direct precursor molecule. See: adenosine, adenylic acid.

dCTP Abbreviation for deoxycytidine 5’-triphosphate. dCTP is required for DNA synthesis since it is a direct precursor molecule. See: cytidine, cytidylic acid.

ddNTP Abbreviation for di-deoxynucleotide.

death phase The final growth phase of cell culture, during which nutrients have been depleted and cell number decreases.

deceleration phase The phase of declining growth rate, following the linear phase and preceding the stationary phase in most batch-suspension cultures. See: growth phase.

de-differentiation The process, in response to wounding and in tissue cultures, by which plant cells can become unspecialized and start to proliferate by cell division to form a mass of undifferentiated cells (or callus) which, in response to appropriate stimuli, may later differentiate again to form either the same cell type or a different one.

defective virus A virus that, by itself, is unable to reproduce when infecting its host cell, but that can grow in the presence of another virus. This other virus provides the necessary molecular machinery that the first virus lacks.
**deficiency** Lack of adequate supply of nutritional, enzymatic, or environmental requirements, so that development, growth or physiological functions are affected.

**defined** 1. Fixed conditions of medium, environment and *protocol* for growth. 2. Precisely known and stated elements of a *tissue culture* medium.

**degeneracy** The specification of one *amino acid* by more than one *codon*. It arises from the inevitable redundancy resulting from the 64 possible codons encoding only 20 amino acids.

**degeneration** 1. Changes in cells, tissues or organs due to disease. 2. The reduction in size or complete loss of organs during evolution.

**dehalogenation** The removal of halogen atoms (fluorine, chlorine, bromine, iodine) from molecules, for example during biodegradation.

**dehiscence** The spontaneous and often violent opening of a fruit, *seed* pod or *anther* to release and disperse the seeds or pollen.

**dehydrogenase** An *enzyme* that catalyses the removal of hydrogen atoms in biological reactions.

**dehydrogenation** A chemical reaction in which hydrogen is removed from a compound.

**de-ionized water** Water from which most salts have been removed - with varying degrees of efficiency - by ion exchange.

**deletion** A *mutation* involving the removal of one or more *base* pairs in a *DNA* sequence. Large deletions are sometimes microscopically visible in *karyotype* analyses.

**deliberate release** In a biotechnology context, the intentional release of *genetically modified organisms*.

**delta endotoxins** See: *cry proteins*.

**deme** A group of organisms in the same taxon.

**demineralize** To remove the mineral content (salts, ions) from a substance, especially water. Removal methods include distillation, electrodialysis and ion exchange. *See: de-ionized water*.

**denature** To disrupt the normal *in vivo conformation* of a nucleic acid or (more usually) a *protein* by physical or chemical means, usually accompanied by the loss of activity. *See: denatured DNA, denatured protein*.

**denatured DNA** Double-stranded *DNA* that has been converted to single strands by breaking the hydrogen bonds linking *complementary nucleotide* pairs. Often reversible. Usually achieved by heating.

**denatured protein** Altering the *in vivo conformation* of a *protein* by heat or salt treatment, thereby destroying its biological activity. Unlike denatured *DNA*, denatured *proteins* are seldom able to be renatured.
**denaturing gradient gel electrophoresis** (Abbreviation: DGGE). An *electrophoresis* method for separating similar sized DNA fragments on the basis of their sequence, by applying across the gel a gradient of increasingly denaturing conditions (usually by increasing the concentration of a denaturing chemical, such as formamide or urea). As the double-stranded molecules denature into a partially and eventually a fully single-stranded state, their electrophoretic mobility changes.

**dendrimer** A polymer that repeatedly branches until stopped by the physical constraint of having formed a complete, hollow sphere. These structures possess sites on their exterior surface to which DNA fragments can be attached, and are thus useful as carriers of DNA for transgenesis.

**denitrification** A chemical process in which nitrates in the soil are reduced to molecular nitrogen, which is released to the atmosphere.

**density gradient centrifugation** High-speed *centrifugation* in which molecules are separated on the basis of their different densities using a concentration gradient of caesium chloride or sucrose. The density gradient may either be formed before centrifugation by mixing two solutions of different density (as in sucrose density gradients) or it can be formed by the process of centrifugation itself (as in CsCl and Cs₂SO₄ density gradients).

**deoxyadenosine** See: adenosine, dATP.

**deoxycytidine** See: cytidine, dCTP.

**deoxyguanosine** See: guanosine, dGTP.

**deoxyribonuclease** See: DNase.

**deoxyribonucleic acid** See: DNA.

**deoxyribonucleoside** See: nucleoside.

**deoxyribonucleotide** See: nucleotide.

**deoxyribose (2-deoxyribose)** See: ribose.

**deoxythymidine** Strictly correct but rarely used synonym for thymidine.

**derepression** The process of "turning on" the expression of a gene or set of genes whose expression has been repressed (turned off), usually by the displacement of a repressor from a promoter, since, when attached to the DNA, the repressor prevents transcription.

**derivative** 1. Resulting from or derived from. 2. Term used to identify a variant during meristematic cell division.

**desiccant** Any compound used to remove moisture or water.

**deoxyribonucleic acid** Obsolete spelling of deoxyribonucleic acid.

**desulphurization** See: biodesulphurization.

**detergent** Substance which lowers the surface tension of a solution, improving its cleaning properties.
**determinate growth** Growth determined and limited in time, with a **bud** or flower terminating the growth of the main axis. Once established, it is usually irreversible. **Opposite:**

**indeterminate growth.**

**determination** Process by which undifferentiated cells in an **embryo** become committed to develop into specific **cell** types, such as neurons, fibroblasts or muscle cells.

**determined** Describing embryonic tissue at a stage when it can develop only as a certain kind of tissue.

**development** The sum total of events that contribute to the progressive elaboration of an organism. The two major aspects of development are growth and differentiation.

**deviation** 1. An alteration from the typical form, function or behaviour. **Mutation** or **stress** are the common reasons behind deviation. 2. A statistical term describing the difference between an actual observation and the **mean** of all observations.

**dextrin** An intermediate **polysaccharide** compound resulting from the **hydrolysis** of starch to maltose by **amylase** enzymes.

**dG - dC tailing** See: **complementary homopolymeric tailing.**

**DGGE** See: **denaturing gradient gel electrophoresis.**

**dGTP** Abbreviation for deoxyguanosine 5’-triphosphate. dGTP is required for **DNA** synthesis since it is a direct precursor molecule. See: **guanosine, guanylic acid.**

**diagnostic procedure** A test or **assay** used to determine the presence of a specific substance, organism or **nucleic acid** sequence alteration, etc.

**diakinesis** A stage of **meiosis** at the end of **prophase I**, in which the contraction of the chromosomes is almost at a maximum, pairing configurations are well defined, the nucleolus normally disappears and the nuclear envelope is disrupted.

**dialysis** A biochemical technique by which large molecules such as **proteins** in solution are separated from smaller species such as salts. The technique is based on the properties of certain membrane structures, which selectively only allow the passage of the smaller molecules. A frequently used method for the purification of proteins.

**diazotroph** An organism that can fix atmospheric nitrogen.

**dicentric chromosome** A chromosome having two active **centromeres.**

**dichogamy** The condition in which the male and the female reproductive organs of a flower (or certain hermaphroditic animals) mature at different times, thereby making self-fertilization improbable or impossible.

**dicot** See: **dicotyledon.**

**dicotyledon** (Abbreviation: dicot). A plant with two **cotyledons.** One of the two major classes of flowering plants (along with the **monocotyledons**). Examples include many crop plants (potato, pea, beans), ornamentals (rose, ivy) and timber trees (oak, beech, lime).
**di-deoxynucleotide** (Abbreviations: ddNTP, didN). A synthetic deoxynucleotide that lacks a 3'-hydroxyl group, and is thus unable to form the 3'-5' phosphodiester bond necessary for chain elongation. Used as strand terminators in the Sanger DNA sequencing reaction and in the treatment of some viral diseases.

**didN** See: di-deoxynucleotide.

**differential centrifugation** A method for separating sub-cellular particles according to their sedimentation coefficients, which are roughly proportional to their size. Cell extracts are subjected to a succession of centrifuge runs at progressively faster rotation speeds. Large particles, such as nuclei or mitochondria, will be precipitated at relatively slow speeds; higher G forces will be required to sediment small particles, such as ribosomes.

**differential display** A method to identify mRNAs which are present at different levels in different tissues, or in response to specific treatments. The mRNAs are converted to cDNA, and a defined proportion of these are amplified by the polymerase chain reaction, and separated by electrophoresis.

**differentially permeable** Referring to a membrane, through which different substances diffuse at different rates. Some substances may be unable to diffuse through such a membrane, usually because they are too large to fit through the pores of the membrane.

**differentiation** A process as a result of which unspecialized cells develop structures and functions characteristic of a particular type of cell, typically during the process of development from one cell to many cells, accompanied by a modification of the new cells for the performance of particular functions. The process is generally irreversible in vivo in higher organisms. In tissue culture, the term is used to describe the formation of different cell types.

**diffusion** The spontaneous movement of molecules from a region of higher concentration to a region of lower concentration.

**digest** To treat DNA molecules with one or more restriction endonucleases in order to cleave them into smaller fragments.

**dihaploid** An individual which arises from a doubled haploid.

**dihybrid** An individual that is heterozygous for two pairs of alleles; the progeny of a cross between homozygous parents differing at two loci.

**dimer** 1. A molecule formed by the covalent combination of two monomers, generally accompanied by elimination of water. 2. The reversible association of two similar (or nearly similar) molecules. The active form of many enzymes is as a dimer between two non-active monomeric subunits.

**dimethyl sulphoxide** (Abbreviation: DMSO). A highly hygroscopic liquid and powerful solvent with little odour, colour or toxicity when pure. It is employed in small quantities to dissolve organic substances in tissue culture media preparation and has uses as a cryoprotectant and in promoting the passage of chemicals through skin.

**dimorphism** The existence of two distinctly different types of individuals within a species. An obvious example is sexual dimorphism in mammals.

**dinucleotide** A nucleotide dimer.

**dioecious** A plant species in which male and female flowers form on different plants.
**diplochromosome** See: endoreduplication.

**diploid** The status of having two complete sets of chromosomes, most commonly one set of paternal origin and the other of maternal origin. **Somatic** tissues of higher plants and animals are ordinarily diploid in chromosome constitution, in contrast with the **haploid** gametes.

**diplonema** Stage in **prophase I** of **meiosis** following the **pachytene** stage, but preceding **diakinesis**, in which one pair of sister chromatids begin to separate from the other pair.

**diplotene** (adj.) See diplonema.

**direct embryogenesis** The formation in culture, on the surface of zygotic or **somatic** embryos or on **explant** tissues (leaf section, root tip, etc.), of embryoids without an intervening callus phase. **Opposite:** **indirect embryogenesis**.

**direct organogenesis** Formation of organs directly on the surface of cultured intact explants. The process does not involve callus formation. **Opposite:** **indirect organogenesis**.

**direct repeat** Two or more stretches of DNA within a single molecule which have the same **nucleotide sequence** in the same orientation. Direct repeats may be either adjacent to one another or far apart on the same molecule.

**directed amplification of minisatellite DNA** (Abbreviation: DAMD). A polymerase chain reaction technique used for obtaining molecular markers in the region of **minisatellites**. To target these regions, one of the **primers** is directed to a **VNTR** core sequence.

**directed mutagenesis** The generation of changes in the **nucleotide sequence** of a cloned gene by one of several procedures. Undertaken to explore the relationship between nucleotide sequence and gene function, and to modify gene products. **Synonym:** **in vitro mutagenesis**.

**directional cloning** The technique by which a vector and a DNA insert are both digested with two different **restriction endonucleases** to create non-complementary sticky ends at either end of both molecules, so favouring the insert to be ligated into the vector in a specific orientation, while also preventing the vector from re-circularizing.

**disaccharide** A dimer consisting of two covalently linked **monosaccharides**.

**disarm** The deletion from a **plasmid** or **virus** of genes that are pathogenic.

**discontinuous variation** Variation where individuals can be classified as belonging to one of a set of discrete, non-overlapping classes. Generated by simple genetic control of a trait (one or a small number of genes, each of large effect) and involving minimal non-genetic effect. Characters showing discontinuous variation are referred to as qualitative. **Opposite:** **continuous variation**.

**discordant** Members of a pair showing different, rather than similar, characteristics.

**disease resistance** The genetically determined ability to prevent the reproduction of a **pathogen**, thereby remaining healthy. Some resistances operate by pathogen exclusion, some by preventing pathogen spread, and some by tolerating pathogen **toxin**.

**disease-free** A plant or animal certified through specific tests as being free of specified pathogens. Should be interpreted to mean “free from any known disease” as “new” diseases may yet be discovered to be present.
disease-indexing Disease-indexed organisms have been assayed for the presence of known diseases according to standard testing procedures.

disinfection Attempted elimination by chemical means of internal micro-organisms (particularly pathogens) from a culture or sample; rarely attained. See: sterilize (1).

disinfestation The elimination or inhibition of the activity of surface-adhering microorganisms and removal of insects.

disjunction Separation of homologous chromosomes during anaphase I of meiosis, or of sister chromatids during anaphase of mitosis and anaphase II of meiosis.

disomic (adj.) See disomy.

disomy The presence of a pair of a specific homologous chromosomes. This is the norm for diploids.

dispense The transfer of a measured volume of a solution.

disrupter gene Used to enforce the sterility of seed saved from a genetically engineered crop. See: genetic use restriction technology.

dissecting microscope A microscope with a magnifying power of about 50x, used as an aid in the manipulation of small objects, e.g. excision of embryos from young zygotes.

dissection Separation of a tissue by cutting into components, for analysis or observation.

distillation The process of heating a mixture to separate the more volatile from the less volatile parts, and then condensing fractions of the resulting vapour so as to produce a more nearly pure or refined substance.

disulphide bond See: disulphide bridge.

disulphide bridge A chemical bond between pairs of sulphur atoms that stabilizes the three-dimensional structure of proteins, and hence the protein's normal function. These form particularly readily between cysteine residues in the same or different peptide molecules. Synonym: disulphide bond.

ditype In fungi, a tetrad that contains two kinds of meiotic products (spores), e.g. 2AB and 2ab.

diurnal An event that occurs repetitively on a daily basis, generally during daylight hours.

dizygotic twins Two-egg twins, i.e. a pair of individuals that shared the same uterus at the same time, but which arose from separate and independent fertilization of two ova.

DMSO See: dimethyl sulfoxide.

DNA Abbreviation for deoxyribonucleic acid, former spelling desoxyribonucleic acid. A long chain polymer of deoxyribonucleotides. DNA constitutes the genetic material of most known organisms and organelles, and usually is in the form of a double helix, although some viral genomes consist of a single strand of DNA, and others of a single- or a double-stranded RNA. See: base pair, genetic code.
DNA amplification  Many-fold multiplication of a particular DNA sequence either in vivo in a plasmid, phage or other vector; or in vitro using, most commonly, the polymerase chain reaction.

DNA amplification fingerprinting (Abbreviation: DAF). A arbitrarily primed polymerase chain reaction technique for obtaining molecular markers using very short (5-8 bp) primers.

DNA chip  See: micro-array.

DNA cloning  See: gene cloning.

DNA construct  A chimeric DNA molecule, carrying all the genetic information necessary for its transgenic expression in a host cell.

DNA delivery system  A generic term for any procedure that transports DNA into a recipient cell.

DNA diagnostics  The use of DNA polymorphisms to detect the presence of a specific sequence, which could indicate the presence of a contaminant, of a pathogen, or of a particular allele at a target gene. Most commonly utilises the polymerase chain reaction.

DNA fingerprint  A description of the genotype of an individual from the pattern of DNA fragments obtained from DNA fingerprinting. Synonym: DNA profile.

DNA fingerprinting  The derivation of unique patterns of DNA fragments obtained using a number of marker techniques; historically these were RFLPs, but latterly they are generally polymerase chain reaction based. Synonym: genetic fingerprinting.

DNA helicase  An enzyme that catalyses the unwinding of the complementary strands of a DNA double helix. Synonym: gyrase.

DNA hybridization  The annealing of two single-stranded DNA molecules, possibly of different origin, to form a partial or complete double helix. The degree of hybridization varies with the extent of complementarity between the two molecules, and this is exploited to test for the presence of a specific nucleotide sequence in a DNA sample.

DNA ligase  An enzyme that catalyses a reaction to link two separate DNA molecules via the formation of a phosphodiester bond between the 3'-hydroxyl end of one and the 5'-phosphate of the other. Its natural role lies in DNA repair and replication. An essential tool in recombinant DNA technology, as it enables the incorporation of foreign DNA into vectors.

DNA micro-array  See: micro-array, somatic cell hybrid panel, radiation hybrid cell panel

DNA polymerase  See: polymerase.

DNA polymorphism  The existence of two or more alternative alleles at a DNA-based marker locus.

DNA primase  An enzyme that catalyses the synthesis of the short strands of RNA that initiate the synthesis of DNA strands.

DNA probe  See: probe.

DNA profile  See: DNA fingerprint.
DNA repair A variety of mechanisms that repair errors (e.g. the incorporation of a non-complementary nucleotide) that occur naturally during DNA replication.

DNA replication The process whereby DNA copies itself, under the action of and control of DNA polymerase.

DNA sequencing Procedures for determining the nucleotide sequence of a DNA fragment. Two common methods available: 1. The Maxam Gilbert technique, which uses chemicals to cleave DNA into fragments at specific bases; or, most commonly, 2. the Sanger technique (also called the di-deoxy or chain-terminating method) which uses DNA polymerase to make new DNA chains, in the presence of di-deoxynucleotides (chain terminators) to stop the chain randomly as it grows. In both cases, the DNA fragments are separated according to length by polyacrylamide gel electrophoresis, enabling the sequence to be read directly from the gel. The procedure has become increasingly automated and large-scale in recent years.

DNA topo-isomerase An enzyme that catalyses the introduction or removal of supercoils in DNA. Synonym: topo-isomerase.

DNA transformation See: transformation.

DNA vaccine A vaccine generated by the injection of specific DNA fragments to stimulate an immune response.

DNAase See DNase.

DNase Abbreviation for deoxyribonuclease. Any enzyme that catalyses the cleavage of DNA phosphodiester bonds. DNase I is a digestive endonuclease secreted by the pancreas, that degrades DNA into shorter fragments. Many other endonucleases and exonucleases are involved in DNA repair and replication. Synonym: DNase. See: restriction endonuclease.

Dolly The first mammal (a sheep) to be created (via nuclear transfer) by the cloning of an adult cell (from the mammary tissue of a ewe). This showed that the process of differentiation into adult tissue is not, as previously thought, irreversible.

domain A portion of a protein or DNA molecule that has a discrete function or conformation. At the protein level, can be as small as a few amino acid residues or as large as half of the entire protein.

dominance The gene action exhibited by a dominant allele.

dominant 1. Of alleles, one whose effect with respect to a particular trait is the same in heterozygotes as in homozygotes. The opposite is recessive. 2. Of an individual animal, one that is allowed priority in access to food, mates, etc., by others of its species because of its success in previous aggressive encounters. 3. Of an animal or plant species, the most conspicuously abundant and characteristic in a particular location or environment.

dominant (-acting) oncogene A gene that stimulates cell proliferation and contributes to oncogenesis when present in a single copy.

dominant marker selection Selection of cells via a gene encoding a product that enables only the cells that carry the gene to grow under particular conditions. For example, plant and animal cells that express the introduced neo gene are resistant to neomycin and analogous antibiotics, while cells that do not carry neo are killed. See: positive selection.
**dominant selectable marker** A gene that allows the host cell to survive under conditions where it would otherwise die. *Synonym:* positive selectable marker.

**donor junction site** The junction between the 5’ end of an *exon* and the 3’ end of an *intron*. *See:* acceptor junction site.

**donor plant** *See:* ortet.

**dormancy** A period in the life of an animal (hibernation and aestivation) or plant during which growth slows or completely ceases. Evolved to allow survival of adverse environmental conditions. Annual plants survive the winter as dormant seeds, while many perennial plants survive as dormant tubers, rhizomes, or bulbs. Premature breaking of seed dormancy post harvest can be a major problem for maintaining nutritional and/or functional quality, while difficulties in breaking dormancy will lead to poor *germination* of the crop. *See:* quiescent.

**dosage compensation** A regulatory mechanism for sex-linked genes, to allow equivalent levels of gene expression from (in mammals) XY or XX genotypes, even though the gene *copy number* in XX is double that in XY. *See:* sex linkage, Barr body.

**double crossing-over** The formation of two chiasmata within a *chromosome* arm, leading to the generation of a double *recombinant* gamete with respect to genes located within the segment defined by the two genes concerned.

**double fertilization** A process, unique to flowering plants, in which two male nuclei, which have travelled down the *pollen* tube, separately fuse with different female nuclei in the *embryo* sac. The first male *nucleus* fuses with the *egg cell* to form the *zygote*; the second male nucleus fuses with the two *polar nuclei* to form a *triploid* nucleus that develops into the endosperm.

**double helix** Describes the coiling of the two strands of the *double-stranded DNA* molecule, resembling a spiral staircase in which the *base pairs* form the steps and the sugar-phosphate backbones form the rails on each side. One strand runs 3’?5’, while the complementary one runs 5’?3’

**double recessive** An organism homozygous for a *recessive allele* at each of two loci.

**double-stranded complementary DNA** (Abbreviation: dscDNA). A double-stranded DNA molecule created from a *cDNA* template.

**double-stranded DNA** (Abbreviation: dsDNA). Two *complementary* strands of *DNA* annealed in the form of a *double helix*. *Synonym:* duplex DNA.

**doubling time** *See:* cell generation time.

**down promoter mutation** A mutation that decreases the frequency of initiation of transcription. This leads to a fall in the level of *mRNA* compared to the *wild type* state.

**down-regulate** To induce genetically a reduction in the level of a gene’s expression.

**downstream** 1. With respect to DNA, the *nucleotides* that lie in the 3’ direction from the point of reference, which is frequently the site at which transcription is initiated. This is generally designated +1, with downstream nucleotides numbered +2, +10 etc. 2. In chemical engineering, those phases of a manufacturing process that follow the *biotransformation* stage. Usually refers to the recovery and purification of the product of a *fermentation* process. *See:* downstream processing.
**downstream processing** A general term for biotechnological processes which follow the biology, i.e. fermentation of a **micro-organism** or growth of a plant. Particularly relevant to **fermentation** processes, which produce a large quantity of a dilute mixture of substances, products and micro-organisms. These must be separated, and the product concentrated, purified and converted into a useful form.

**drift** See: **genetic drift**.

**Drosophila melanogaster** The fruit fly, used for many years as a **model** for eukaryotic genetics. Of the nearly 300 disease-causing genes in the human genome, more than half have an analogous gene in the *Drosophila* genome.

**drug** See: **therapeutic agent**.

**drug delivery** Method by which a drug is delivered to its site of action. For traditional drugs this is another name for **formulation**. However, biotechnology has allowed the development of a range of new therapeutic-agent delivery systems, such as **liposomes** and other **encapsulation** techniques, and a range of mechanisms that target a **therapeutic** agent to a particular cell or tissue.

**dry weight** The weight of **tissue** obtained following sufficiently prolonged oven-drying at high temperature to remove all water. **Freeze-drying** may also be employed but generates a slightly different result because **bound water** is not removed. See: **free water**.

**dscDNA** See: **double-stranded complementary DNA**.

**dsDNA** See: **double-stranded DNA**.

**dTTP** Rarely used but strictly correct abbreviation for **deoxythymidine** 5'-triphosphate. Required for **DNA** synthesis since it is a direct precursor molecule. See: **TTP**.

**dual culture** A culture made of a plant tissue and one organism (such as a nematode) or an obligate parasite/micro-organism (such as a fungus). Dual culture techniques are used for a variety of purposes, including assessing host-parasite interactions and the production of **axenic cultures**.

**duplex DNA** See: **double-stranded DNA**.

**duplication** Multiple occurrence of: 1. A **DNA sequence** within a defined length of **DNA**; or 2. A specific segment in the same **chromosome** or **genome**.

**E site** See: **exit site**.

**E. coli** See: **Escherichia coli**.

**EBV** See: **estimated breeding value**.

**EC** See: **Enzyme Commission number**.

**ecdysone** A steroid **hormone** in insects stimulating the synthesis of **proteins** involved in moulting and metamorphosis.

**eclosion** 1. Emergence of an adult insect from the pupal stage. 2. Initial phase of germination of fungal spores.

**ecological diversity** See: **biodiversity**.
**economic trait locus** (Abbreviation: ETL). A locus influencing a trait that contributes to producer's income.

**ecosystem** The complex of a living community and its environment, functioning as an ecological unit in nature. See: abiotic; biotic factors.

**ecotype** A population or a strain of an organism that is adapted to a particular habitat.

**ectopic** Anomalous situation or relation, particularly with respect to pregnancy, where the foetus is implanted outside the uterus.

**edible vaccine** Edible antigen-containing material, that activates the immune system via gut-associated lymphoid tissues. A preferred route for vaccine administration, particularly in areas where the technological infrastructure needed for maintenance of vaccines is absent. The vaccine is synthesized in vivo in the edible parts of transgenic plants (e.g. grains, tubers, fruits, etc.) or eggs.

**editing** See: splicing (1).

**EDTA** See: ethylenediamine tetraacetic acid.

**EDV** Abbreviation for essential derivation of varieties.

**effector cells** Cells of the immune system that are responsible for the production of cell-mediated cytotoxicity.

**effector molecule** A molecule that influences the behaviour of a regulatory molecule, such as a repressor protein, thereby influencing gene expression.

**egg** 1. The fertilized zygote in egg-laying animals. 2. The mature female reproductive cell in animals and plants.

**EGS** See: external guide sequence.

**EIA** See: enzyme immunoassay, ELISA.

**elastin** A fibrous protein that is the major constituent of the yellow elastic fibres of animal connective tissue.

**electro-blotting** The electrophoretic transfer of DNA, RNA or protein from a gel, in which they have been separated, to a support matrix, such as nitrocellulose. A transfer technique employed in Southern and northern blotting.

**electrochemical sensor** Biosensors, such as an enzyme electrode, in which a biological process is harnessed to an electrical sensor system. Other types couple a biological event to an electrical one via a range of mechanisms, including the reduction of oxygen or pH change.

**electron microscope** (Abbreviation: EM). A microscope that uses an electron beam focussed by magnetic 'lenses'. See: scanning electron microscope.
electrophoresis A ubiquitous molecular biology technique, with many variants, used to resolve complex mixtures of macromolecules into their components. Its principle is to subject samples to an electric field applied across a porous matrix. Molecules will migrate under these conditions at a rate dependent on their net electric charge and/or their molecular weight. See: agarose gel electrophoresis, polyacrylamide gel electrophoresis, denaturing gradient gel electrophoresis, capillary electrophoresis, sodium dodecyl sulphate polyacrylamide gel electrophoresis, thermal gel gradient electrophoresis, pulsed-field gel electrophoresis, and iso-electric focusing gel.

electroporation The induction of transient pores in bacterial cells or protoplasts by the application of a pulse of electricity. These pores allow the entry of exogenous DNA into the cell. Widely used for the transformation of bacteria.

ELISA Abbreviation for enzyme-linked immunosorbent assay. An immunoassay, i.e. an antibody-based technique for the diagnosis of the presence and quantity of specific molecules in a mixed sample. It combines the specificity of an immunoglobulin with the detectability of an enzyme-generated coloured product. In one form, the primary antibody (specific to the test protein) is adsorbed onto a solid substrate, and a known amount of the sample is added; all the antigen in the sample is bound by the antibody. A second antibody (conjugated with an enzyme) specific for a second site on the test protein is added; and the enzyme generates a colour change in the presence of a substrate reagent.

elite tree A phenotypically superior tree in a tree breeding programme.

elongation factors Soluble proteins required for the elongation of polypeptide chains on ribosomes.

embryo An immature organism in the early stages of development. In mammals, develops in the first months in the uterus. In plants, it is the structure that develops in the megagametophyte, as result of the fertilization of an egg cell, or occasionally without fertilization. Somatic embryos can often be induced in in vitro plant cell cultures.

embryo cloning The creation of identical copies of an embryo by embryo splitting or by nuclear transfer from undifferentiated embryonic cells.

embryo culture The culture of embryos on nutrient media.

embryo multiplication and transfer (Abbreviation: EMT). The cloning of animal embryos and their subsequent transfer to recipients via artificial inembryonation. The cloned embryos can be derived from embryonic or adult tissue.

embryo rescue A sequence of tissue culture techniques utilized to enable a fertilized immature embryo resulting from an interspecific cross to continue growth and development, until it can be regenerated into an adult plant.

embryo sac The mature female gametophyte in angiosperms. Generally a seven-celled structure - two synergids, one egg cell, three antipodal cells (each with a single haploid nucleus) and one endosperm mother cell with two haploid nuclei.

embryo sexing The determination of the sex of an embryo prior to birth. Typically achieved by the polymerase chain reaction-mediated amplification of DNA extracted from a sample of embryonic tissue. Dependent on the availability of reliable markers for the differential sex chromosome.
**embryo splitting** The splitting of young embryos into several sections, each of which develops into an animal. A form of animal cloning, i.e. of producing animals that are genetically identical. In practice, the number of animals that can be produced from a single embryo is less than 10.

**embryo storage** Cryogenic preservation of animal embryos, allowing inembryonation or other manipulations long after embryo formation.

**embryo technology** Generic name for any modification of mammalian embryos. It encompasses embryo cloning, embryo splitting, embryo storage, and *in vitro* fertilization.

**embryo transfer** (Abbreviation: ET). See: embryo multiplication and transfer, multiple ovulation and embryo transfer.

**embryogenesis** 1. (General) Development of an embryo. 2. (In plants) *in vitro* formation of plants from plant tissues, through a pathway closely resembling normal embryogenesis from the zygote. Somatic cell embryogenesis is an alternative technique. The generation of embryos has two stages: initiation and maturation. Initiation needs a high level of the group of plant hormones called auxins; maturation needs a lower level.

**embryoid** Plant biotechnology term no longer commonly used. An embryo-like body developing *in vitro*, forming a complete, self-contained plantlet with no vascular connection with the callus.

**embryonic stem cells** (Abbreviation: ES cells). Cells of the early embryo that can give rise to all differentiated cells, including germ line cells.

**emission wavelength** The specific wavelength of light emitted by a fluorescent molecule, such as a labelled probe, upon absorption of light at the (higher) excitation wavelength.

**EMT** See: embryo multiplication and transfer.

**encapsidation** The process by which the nucleic acid of a virus is enclosed in a capsid.

**encapsulating agents** Anything which forms a shell around an enzyme or bacterium, common agents being polysaccharides such as alginate or agar. The agents are inert and allow nutrients and oxygen to diffuse readily into and out of the sphere, and are easy to convert from gel (solid) to sol (liquid) or solution form by altering the temperature or the concentration of ions.

**encapsulation** Any method packaging an enzyme or bacterium and maintaining its normal functions. Used to immobilize cells in a bioreactor.

**encode** The gene product specified by a particular nucleic acid sequence. See: genetic code.

**endangered species** A plant or animal species in immediate danger of extinction because its population number has reached a critical level, or its habitat has been drastically reduced.

**endemic** Describing an organism, often a disease or pest, that is always present in a stated area.

**end-labelling** The introduction of a readily-visualized tag at the end of a DNA or RNA molecule. A commonly used method is to introduce a $^{32}$P atom onto the end of a DNA molecule by means of the enzyme T4 polynucleotide kinase.
**endocrine gland** Any gland in an animal that manufactures hormones and secretes them directly into the bloodstream to act at distant sites in the body, known as target organs or cells.

**endocrine interference** Interference with the normal balance of hormones.

**endocytosis** The process by which materials enter a cell without passing through the cell membrane. The membrane folds around material outside the cell, resulting in the formation of a sac-like vesicle inside which the material is entrapped. This vesicle is then pinched off from the cell surface so that it lies within the cell. See: phagocytosis, pinocytosis.

**endoderm** The internal layer of cells of the gastrula, which develops into the alimentary canal (gut) and digestive glands of the adult.

**endodermis** The layer of living cells, with various characteristically thickened walls and no intercellular spaces, which surrounds the vascular tissue of certain plants and occurs in nearly all roots and certain stems and leaves. It separates the cortical cells from cells of the pericycle.

**endogamy** See: inbreeding.

**endogenous** Derived from within; from the same cell type or organism. Opposite: exogenous.

**endomitosis** Duplication of chromosomes without division of the nucleus, resulting in a doubling (or more) in the chromosome number within a cell.

**endonuclease** An enzyme that cleaves a phosphodiester bond within a DNA strand, forming two smaller strands. See: exonuclease, restriction endonuclease.

**endophyte** An organism that lives inside a plant.

**endoplasmic reticulum** (Abbreviation: ER). A cytoplasmic net of membranes, adjacent to the nucleus, visible under the electron microscope. The sites of protein synthesis.

**endopolyploidy** The net result of endomitoses. The somatic chromosome number has doubled (or more), forming a polyploid cell line. If these differentiate into a germ line, then the gametic number will have also increased proportionately, giving rise to homogeneously polyploid individuals, termed endopolyploids.

**endoprotease** An enzyme that cleaves internal peptide bonds within a polypeptide molecule. Site of cleavage is usually specific to certain amino acid residues.

**endoreduplication** Chromosome reproduction during interphase. Four-chromatid chromosomes (diplochromosomes) are seen during this phase.

**endosperm** The nutritive tissue that develops in the seed of most angiosperms, containing varying proportions of carbohydrate (usually starch), protein and lipid. In most diploid plants, the endosperm is triploid.

**endosperm mother cell** One of the seven cells of the mature plant embryo sac, containing the two polar nuclei and, which, following fertilization, gives rise to the primary endosperm cell from which the endosperm develops.

**endotoxin** A component of the cell wall of gram-negative bacteria that elicits, in mammals, an inflammatory response and fever.
end-product inhibition The inhibition of an enzyme by a metabolite. Typically, the enzyme is the first enzyme in a biosynthetic pathway, and the metabolite the product of the last step in the pathway. See: feedback inhibition.

enhancer 1. A substance or object that increases a chemical activity or a physiological process. 2. A eukaryotic DNA sequence (also found in some eukaryotic viruses) which increases the transcription of a gene. Located up to several kbp, usually (but not exclusively) upstream of the gene in question. In some cases can activate transcription of a gene with no (known) promoter. Synonyms: enhancer element; enhancer sequence. 3. A major or modifier gene that increases the rate of a physiological process.

enhancer element See: enhancer.

enhancer sequence See: enhancer.

enolpyruvyl-shikimate-3-phosphate synthase (Abbreviation EPSP synthase or EPSPS). An enzyme produced by virtually all plants, which is essential for normal metabolism, and for the biosynthesis of aromatic amino acids. Glyphosate- and sulfosate-containing herbicides act by inhibiting EPSP synthase activity, but because strain CP4 of Agrobacterium sp. is unaffected by glyphosate, the introduction of the CP4 EPSPS gene into crop plants generates a tolerance of glyphosate-containing herbicides.

enterotoxin A bacterial protein that, following release into the intestine, causes cramps, diarrhoea and nausea.

enucleated ovum Egg cell from which the nucleus has been removed, usually as a preparatory step for nuclear transfer.

enzyme A protein which, even in very low concentration, catalyses specific chemical reactions but is not used up in the reaction. Enzymes are classified into six major groups (1-6), according to the type of reaction they catalyse: 1. oxidoreductases; 2. transferases; 3. hydrolases; 4. lyases; 5. isomerases; 6. ligases. Generally enzymes are named by the addition of the suffix -ase to the name of their substrate, and are classified by a standard numerical system: the Enzyme Commission (EC) number.

enzyme bioreactor A reactor in which a chemical conversion reaction is catalysed by an enzyme.

Enzyme Commission number (Abbreviation: EC number). Systematic label which identifies an enzyme in the technical literature. Consists of four numbers separated by dots: the first classifies the enzyme into one of the six broad enzyme groups (see: enzymes); each group is subdivided into sub-groups, each sub-group into sub-sub-groups, and the last number is specific for the enzyme, e.g. EC 3.1.21.1 is deoxyribonuclease I.

enzyme electrode A type of biosensor, in which an enzyme is immobilized onto the surface of an electrode. When the enzyme catalyses its reaction, electrons are transferred from the reactant to the electrode, and so a current is generated. There are two types of enzyme electrodes: 1. Ampometric (measuring current flow) where the electrode is kept as near zero voltage as possible. When the enzyme catalyses its reaction, electrons move into the electrode, and so a current flows; 2. Potentiometric (measuring changes in electrical potential) when the electrode is held at a voltage which counteracts the voltage determined by the enzyme's tendency to push electrons into it. Usually enzymes transfer their electrons inefficiently to the electrode, so a mediator compound is coated onto the electrode to help the transfer.

enzyme immunoassay A range of immunoassay techniques employing enzymes, which includes ELISA.
enzyme kinetics  The quantitative characteristics of enzyme reactions.

enzyme stabilization  Maintaining the active conformation of an enzyme. This can be achieved in vitro by providing the appropriate chemical environment and cofactors. In some cases the criticality of these factors can be reduced by binding an antibody to the enzyme, in such a way that the active site of the enzyme is left unblocked.

enzyme-linked immunosorbent assay  See: ELISA.

EPD  See: expected progeny difference.

epicotyl  The upper portion of the axis of a plant embryo or seedling, above the cotyledons.

epidermis  1. The outmost layer of cells of the body of an animal. In invertebrates the epidermis is normally only one cell thick and is covered by an impermeable cuticle. In vertebrates the epidermis is the thinner of the two layers of skin. 2. The outermost layer of cells covering a plant. It is overlaid by a cuticle and its functions are principally to protect the plant from injury and to reduce water loss. Some epidermal cells are modified to form guard cells or hairs of various types. In woody plants the functions of the shoot epidermis are taken over by the periderm tissues and in mature roots the epidermis is sloughed off and replaced by the hypodermis.

epigenesis  Describes the developmental process whereby each successive stage of normal development is built upon the foundations created by the preceding stages of development; an embryo is built up from a zygote, a seedling from an embryo, and so on.

epigenetic variation  Non-hereditary and reversible variation; often the result of a change in gene expression due to methylation of DNA.

epinasty  A process by which the growth of branches or petioles is abnormally pointing downward. This phenomenon is caused by the more rapid growth of the upper side. Epinasty may result from either nutritional deficiencies or irregularities at the plant growth regulator level. Not to be confused with wilting, as epinastic tissues are turgid.

epiphyte  A plant that grows upon another plant, but is neither parasitic on it nor rooted in the ground.

episome  A genetic extrachromosomal element (e.g. the F factor in Escherichia coli) which replicates within a cell independently of the chromosome and is able to integrate into the host chromosome. The step of integration may be governed by a variety of factors and so the term episome has lost favour and been superseded by the wider term plasmid.

epistasis  Interaction between genes at different loci, e.g. one gene suppresses the effect of another gene that is situated at a different locus. Dominance is associated with members of allelic pairs, whereas epistasis describes an interaction among products of non-alleles.

epitope  Synonym for antigenic determinant.

epizootic  A disease simultaneously affecting a large number of animals.

EPSP synthase  Abbreviation for enolpyruvyl-shikimate 3-phosphate synthase.

EPSPS  Abbreviation for enolpyruvyl-shikimate 3-phosphate synthase.
equational division A chromosome division in which the two chromatids of each duplicated chromosome separate longitudinally, prior to being incorporated into two daughter nuclei. Seen at the mitotic-type second division of meiosis; also in somatic mitosis and the non-reductional division of meiosis. The number of chromosomes is the same at the end of the division as at the beginning.

equilibrium density gradient centrifugation A procedure used to separate macromolecules based on their density (mass per unit volume).

ER See: endoplasmic reticulum.

Erlenmeyer flask A conical flat-bottomed laboratory flask with a narrow neck, widely used for culturing micro-organisms.

ES cells See: embryonic stem cells.

Escherichia coli A commensal bacterium inhabiting the colon of many animal species, including human. *E. coli* is widely used as a model of cell biochemical function, and as a host for cloning DNA. In environmental studies, its presence is a key indicator of water pollution due to human sewage effluent. Some strains, notably *E. coli* 0157:H7, are significant pathogens.

essential amino acid An amino acid required for normal metabolism, but which cannot be synthesized by an organism. It therefore has to be supplied via feed or food.

essential derivation of varieties (Abbreviation: EDV). Genotypes very similar to an originating cultivar, obtained, for example, by the selection of a mutant or a variant individual from plants of the initial variety, or by backcrossing or transformation.

essential element Any of a number of elements required by living organisms to ensure normal growth, development and maintenance.

essential nutrient Any substance required by living organisms to ensure normal growth, development and maintenance.

essential requirement In plant cell tissue culture, comprises inorganic salts, including all of the elements necessary for plant metabolism; organic factors (amino acids, vitamins); usually also endogenous plant growth regulators (auxins, cytokinins and often gibberellins); as well as a carbon source (sucrose or glucose).

EST See: expressed sequence tag.

established culture 1. An aseptic viable explant (See: micropropagation). 2. A suspension culture subjected to several passages with a constant cell number per unit time.

estimated breeding value (Abbreviation: EBV). Twice the expected progeny difference. The difference is doubled because breeding value is a reflection of all the genes of an individual, in contrast to progeny difference, which is a reflection of a sample half of an individual’s genes. The predicted performance of the offspring of the mating between any two parents is the average of their EBVs (averaged because each parent makes an equal contribution to each offspring).

estrogen See: oestrogen.

ET Abbreviation for embryo transfer. See: multiple ovulation and embryo transfer.
ethanol Commonly used to disinfect plant tissues, glassware utensils and working surfaces in tissue culture manipulations; to precipitate aqueous solutions of nucleic acids; and to dissolve water-insoluble components of culture media. Synonym: ethyl alcohol.

ethephon A synthetic compound commonly used as a source of ethylene, a gaseous plant growth regulator.

ethidium bromide A fluorescent dye which can intercalate between base pairs of double-stranded DNA, and hence is much used to stain DNA in gels. The dye fluoresces when exposed to UV light. It is a known to be a strong mutagen and is also possibly both a carcinogen and a teratogen.

ethyl alcohol See: ethanol.

ethylene A gaseous plant growth regulator acting on various aspects of vegetative growth, fruit ripening and abscission of plant parts. Synonym: ethene.

ethylenediamine tetraacetic acid (Abbreviation: EDTA). A chelating compound. Used to keep nutrients, such as iron, bound in a soluble form that leaves them still available to the plant cells in vitro. Also a potent inhibitor of DNase activity and therefore used as an additive for long-term storage of dissolved DNA.

etiolation An abnormal increase in stem elongation, accompanied by poor (if any) leaf development. Physiological etiolation is caused by a lack of chlorophyll, and is typical of plants growing under low light intensity or in complete darkness. It can also be induced by some fungal pathogens.

ETL See: economic trait locus.

eucaryote See: eukaryote.

eucaryotic (adj.) See: eukaryote.

euchromatin Chromosomal material that is stained less intensely by certain dyes. Thought to be the chromosomal domains which are gene-rich, since the DNA in these regions remains less contracted than those rich in repetitive DNA - the heterochromatin.

eugenics The application of the principles of genetics to the 'improvement' of humankind. Wholly discredited as a scientific approach since the Nazi period.

eukaryote One of the two major evolutionary clades, characterized by having the nucleus enclosed by a membrane, and possessing chromosomes that undergo mitosis and meiosis. Eukaryotic organisms include animals, plants, fungi and some algae. See: prokaryote.

 euploid An organism or cell having a chromosome number that is an exact multiple of the haploid number. Terms used to identify different levels in an euploid series are diploid (2x), triploid (3x), tetraploid (4x) etc. Opposite: aneuploid.

evapotranspiration The net water loss (in vapour form) per unit area of land, both directly from the land surface, and indirectly through transpiring leaves.

 evolution The process by which the present diversity of plant and animal life has arisen, and which continues to drive changes in form and mode of existence of all living organisms.

ex-situ conservation The conservation of components of biological diversity outside their natural habitats.
**ex vitro** Organisms removed from *tissue culture* and transplanted; generally plants to soil or potting mixture.

**ex vivo gene therapy** The delivery of a gene or genes to the isolated cells of an individual, with the intention of alleviating a genetic disorder. After culturing, the transformed cells are re-introduced into the individual by transfusion, infusion or injection.

**excinuclease** The *endonuclease*-containing *protein* complex that excises a segment of damaged DNA during *excision* repair.

**excision** 1. The natural or *in vitro* enzymatic removal of a DNA segment from a *chromosome* or *cloning* vector. 2. The cutting out and preparation of a tissue, organ, etc., for culture. 3. The removal of adventitious shoots from callus tissue.

**excision repair** DNA repair processes that involve the removal of a damaged or incorrect segment of one strand of *double-stranded DNA* and its replacement by the synthesis of a new segment using the *complementary* strand of DNA as template.

**excitation wavelength** The specific wavelength of light required to stimulate a fluorescent molecule, such as a labelled *probe*, to emit light at the (lower) *emission wavelength*.

**excrete** To transport material out of a *cell* or *organism*.

**exit site** (Abbreviation: E site). The ribosome binding site that contains the free tRNA prior to its release.

**exo III** See: *exonuclease III*.

**exocrine gland** An animal *gland* that secretes through a duct.

**exodeoxyribonuclease III** See: *exonuclease III*.

**exogamy** See: *outbreeding*.

**exogenous** Produced outside of; originating from, or due to, external causes. *Opposite*: *endogenous*.

**exogenous DNA** DNA that has been derived from one organism, and is to be introduced into a cell a different species. Also referred to as *foreign DNA* or *heterologous DNA*.

**exon** A segment of a eukaryotic gene that is transcribed as part of the primary *transcript* and is retained, after processing, with other exons to form a functional mRNA molecule. Many eukaryotic genes are composed of a *mosaic* of exons and *introns*.

**exon amplification** A procedure that is used to *amplify* exons.

**exonuclease** An enzyme that digests *DNA* or *RNA*, beginning at the end of a strand. It therefore requires a free end in order to begin the degradation. 5’-exonucleases require a free 5’ end and degrade the molecule in the 5’-3’ direction. 3’-exonucleases require a free 3’ end and degrade in the opposite direction.

**exonuclease III** (Abbreviation: exo III). An *Escherichia coli* enzyme that removes nucleotides from the 3’ hydroxyl ends of double-stranded DNA. *Synonym*: exodeoxyribonuclease III.
**exopolysaccharide** A polysaccharide that is secreted by a micro-organism into the surrounding environment.

**exotoxin** A toxin released by a bacterium into the medium in which it grows.

**expected progeny difference** (Abbreviation: EPD). The predicted performance of the future offspring of an individual for a particular trait, calculated from measurement(s) of the individual's own performance and/or the performance of one or more of its relatives, for the trait in question and/or for one or more correlated traits. Typically, the prediction is expressed as a deviation from a well-defined base population, assuming the individual in question is mated to a sample of individuals whose average genetic merit equals that of the base population. The predicted performance of the offspring of the mating between any two individuals is the sum of their EPDs.

**explant** A portion of a plant aseptically excised and prepared for culture in a nutrient medium.

**explant donor** The plant from which an explant has been taken.

**explantation** The removal of cells, tissues or organs of animals and plants for observation of their growth and development in appropriate culture media.

**explosion method** A technique for the genetic transformation of cells, in which the transgene is driven into the target (plant) cells by the sudden vaporization (effected by the application of a pulse of high voltage) of a water droplet containing the DNA and gold particles.

**exponential phase** See: logarithmic phase.

**export** The removal of a compound from a cell by active transport.

**express** To transcribe and translate a gene.

**expressed sequence tag** (Abbreviation: EST). Partially sequenced cDNA clone. Because the read length of a standard DNA sequencing reaction is shorter than the majority of cDNA clones, full length sequence can only be obtained by further manipulations. For the purposes of (1) assigning putative function to a cDNA and (2) designing PCR primers to extract the genomic DNA equivalent to the cDNA, full length sequence is usually unnecessary. By restricting sequencing to a single run, large numbers of cDNAs can be characterized at the EST level.

**expression library** A cDNA library that has been inserted into a bacterial host cell engineered to express transgenes. See: library.

**expression system** Combination of host and vector which provides a genetic context for making a cloned gene functional, i.e. produce peptide, in the host cell.

**expression vector** A cloning vector that has been constructed in such a way that, after insertion of a DNA molecule, its coding sequence is properly transcribed and the mRNA is translated. The cloned gene is put under the control of a promoter sequence for the initiation of transcription, and often also has a transcription termination sequence at its end.

**expressivity** Degree of expression of a trait controlled by a particular gene. The gene may show different degrees of expression in different individuals. See: variable expressivity.

**extension** The short single-stranded stretch of nucleotides remaining on a double-stranded DNA molecule, following treatment with a restriction endonuclease which makes a
staggered cut. The presence of these unpaired regions make the molecule more easily ligatable, and are thus important in gene cloning. Synonyms: protruding end; sticky end; overhang; cohesive end.


extrachromosomal In eukaryotes, non-nuclear DNA, present in cytoplasm organelles such as mitochondria and chloroplasts. In prokaryotes, non-chromosomal DNA, i.e. plasmids.

extrachromosomal inheritance See: cytoplasmic inheritance.

extranuclear genes Genes residing elsewhere than in the nucleus (e.g. in mitochondria, chloroplasts or plastids).

exude Slowly discharge liquid material (such as tannins or oxidized polyphenols from plant material) through pores or cuts, or by diffusion into the medium.

F factor Abbreviation for fertility factor. A bacterial plasmid that confers the ability to function as a genetic donor in conjugation. See: Hfr.

F₁ Abbreviation for filial generation. The initial hybrid generation resulting from a cross between two parents. See Fₙ.

F₂ The second hybrid generation, produced either by intercrossing two F₁ individuals, or by self-fertilizing an F₁ individual. See Fₙ.

Fab A product of hydrolysis of an IgG antibody, consisting of the variable region with some of the constant region of a heavy chain, and an entire light chain. Contains a single antigen-binding site.

FACS See: fluorescence-activated cell sorting.

factorial mating A mating scheme in which each male parent is mated with each female parent. Made possible in animals by means of in vitro embryo production. Such a mating scheme substantially reduces the rate of inbreeding in a selection programme.

facultative anaerobe An organism that will grow under either aerobic or anaerobic conditions.

FAD See: flavin adenine dinucleotide.

false fruit See: pseudocarp.

false negative A negative assay result that should have been positive.

false positive A positive assay result that should have been negative.

farm animal genetic resources Those animal species that are used, or may be used, for the production of food and agriculture, and the populations within each of them. Within each species, these populations can be classified as wild and feral populations, landraces and primary populations, standardized breeds, selected lines, and any conserved genetic material.

farmers’ privilege Rights to hold germplasm, covered by plant variety protection, as a seed source for subsequent seasons. Considered as optional for governments to include in their legislation. Synonym: farmer-saved seed.
farmers’ rights Rights first recognized by Resolution 5 of the 1989 FAO Conference as "rights arising from the past, present and future contributions of farmers in the conservation, improvement and the making available of plant genetic resources"; this item became an attachment to the *International Undertaking on Plant Genetic Resources*. The binding 'International Treaty of Plant Genetic Resources for Food and Agriculture' that resulted from the renegotiations of the Undertaking makes provision for the Farmers’ Rights in Article 9.

fascicle See: vascular bundle.

F₂ A product of hydrolysis of an IgG antibody, consisting of parts of the constant regions of two heavy chains held together by a disulphide bridge, but excluding the antigen-binding regions, and also excluding the light chains.

fed-batch fermentation Culture of cells or micro-organisms where nutrients are added periodically to the bioreactor.

feedback inhibition The process by which the accumulated end product of a biochemical pathway stops synthesis of that product. The effect is that a late metabolite of a synthetic pathway regulates the synthesis of an earlier step of the pathway. See: end-product inhibition.

fermentation The anaerobic breakdown of complex organic substances, especially carbohydrates, by micro-organisms, yielding energy. Often misused to describe large-scale aerobic cell culture in specialized vessels (fermenters, bioreactors) for secondary product synthesis.

fermentation substrates Materials used as food for growing micro-organisms. The fermentation substrates and the trace materials needed, together with chemicals added to make the fermentation easier, form the culture medium.

fermenter See: bioreactor.

fertile Capable of breeding and reproduction.

fertility factor See: F factor.

fertilization The union of two gametes from opposite sexes to form a zygote. Typically, each gamete contains a haploid set of chromosomes. Hence the zygotic nucleus contains a diploid set of chromosomes. Several categories can be distinguished: 1. Self-fertilization (selfing): fusion of male and female gametes from the same individual. 2. Cross-fertilization (crossing): fusion of male and female gametes from different individuals. 3. Double fertilization; restricted to flowering plants, in which the fusion of one male gamete with the ovum occurs at about the same time as the second male gamete nucleus fuses with the female polar nuclei (or secondary nucleus) to form the endosperm.

fertilizer Any substance that is added to soil in order to increase its productivity. Fertilizers can be of biological origin (e.g. composts), or they can be synthetic (artificial fertilizer).

fetus See: foetus.

Feulgen staining A histochemical stain by which the distribution of DNA in the chromosomes of dividing cell nuclei can be observed.

FIA Abbreviation for fluorescence immunoassay.
fibril A microscopic to sub-microscopic cellulose thread that is part of the cellulose matrix of plant cell walls.

fibroblasts Irregularly shaped, branching cells distributed throughout vertebrate connective tissue. A cell type which is readily cultured in vitro.

fibrous root Root system in which both primary and lateral roots have approximately equal diameters. Opposite: tap root.

field gene bank See: gene bank (2).

filial generation See: F₁, F₂, Fₙ.

filter bioreactor A cell culture system, in which cells are grown on a fine mesh of an inert material, which allows the culture medium to flow past it but retains the cells. This is similar in idea to membrane and hollow fibre reactors, but can be much easier to set up, being similar to conventional tower bioreactors, but with the mesh replacing the central reactor space. Synonym: mesh bioreactor.

filter sterilization Process of removing microbial contaminants from a liquid by passing through a filter with pores too small to allow the passage of micro-organisms and spores.

filtration 1. Separation of solids from liquids by using a porous material that only allows passage of the liquid or of solids smaller than the pore size of the filter. The material passing the filter forms the filtrate. 2. Removal of cell aggregates to obtain a filtrate of single cells that can be utilized as plating inocula.

fingerprinting See: DNA fingerprinting.

FISH See: fluorescence in situ hybridization.

fission Asexual reproduction involving the division of a single-celled individual into two daughter single-celled individuals of approximately equal size.

fitness The survival value and the reproductive capability of an individual, compared to that of competitor individuals of the same or other species within a population or an environment.

fixation The situation in which only one allele for a given gene/locus is present in a population. This can occur as a result of direct selection where the allele delivers a greater level of fitness; because of indirect selection, where the locus is linked to a gene that is subject to direct selection; or because of genetic drift.

FLAG See affinity tag.

flaming A technique for sterilizing instruments, to remove live micro-organism contaminants. The instrument is dipped in alcohol, and the alcohol remaining on the instrument is ignited, thereby heat-sterilizing the surface.

flanking region The DNA sequences extending either side of a specific sequence.

flavin adenine dinucleotide (Abbreviation: FAD). A coenzyme important in various biochemical reactions. It comprises a phosphorylated vitamin B₂ (riboflavin) molecule linked to AMP, and functions as a hydrogen acceptor in dehydrogenation reactions. The reduced form is oxidized back to FAD by the electron transport chain, generating two molecules of ATP per molecule of reduced FADH.
flocculant A chemical agent that causes small particles to aggregate (flocculate).

floccule A micro-organism aggregate or colloidal particle floating in or on a liquid. The cloudy appearance of micro-organism contaminated liquid media illustrates the flocculation phenomenon.

flow cytometry Automated measurements on large numbers of individual cells or other small biological materials, made as the cells flow one by one in a fluid stream past optical and/or electronic sensors. A similar approach may be used for sorting cells - see fluorescence-activated cell sorting.

fluorescence immunoassay (Abbreviation: FIA). An immunoassay based on the use of fluorescence-labelled antibody.

fluorescence in situ hybridization (Abbreviation: FISH). Hybridization of cloned, fluorescently labelled DNA or RNA, to intact biological materials, notably chromosome spreads and thin tissue sections. The technique allows the visualization of the physical location of nucleic acid sequences homologous to the probe, and is used for the placement of genes on chromosomes and for the spatial and temporal pattern of gene expression of specific mRNA molecules.

fluorescence-activated cell sorting (Abbreviation: FACS). A flow cytometry method in which targets (cells, individual chromosomes etc.) are labelled with a fluorescent dye, which is excited by a laser beam. Differences in the fluorescence signal emitted are used as a criterion for sorting the material. A specific application is in sperm sexing.

fluorescent probe A probe which is labelled with a fluorescent dye, so that the signal emitted can be captured by photometric methods.

flush end See: blunt end.

flush-end cut See: blunt-end cut.

F₁, F₂, Fₙ Subsequent hybrid generations, counting from the F₁. Thus, for example, F₄ describes the progeny of the F₃, which is the progeny of the F₂ generation, where all progeny are derived from intercrossing or self-fertilization.

foetus Pre-natal stage of a viviparous animal, between the embryonic stage and birth. AlterRNAtive spelling: fetus. See: embryo.

fog Fine particles of liquid suspended in the air, such as of water in a fog chamber used for acclimatizing recent ex vitro transplants. See: mist propagation.

fold-back The structure of a double-stranded DNA molecule formed when a molecule containing an inverted repeat sequence is denatured and then allowed to re-anneal at low DNA concentrations. Under these conditions, the repeated sequence self-anneals to form a double-stranded region within each of the separated strands of the original molecule.

folded genome The condensed state of the chromosomal DNA of a bacterium. The DNA is segregated into domains, and each domain is independently negatively supercoiled.

follicle An enclosing cluster of cells that protects and nourishes a cell or structure within. Thus a follicle in the ovary contains a developing egg cell, while a hair follicle envelops the root of hair.
**follicle stimulating hormone** (Abbreviation: FSH). A hormone, secreted by the anterior pituitary gland in mammals, that stimulates the ripening of the specialized structures in the **ovary** (Graafian follicles) that produce ova in female mammals; and in males, the formation of **sperm** in the testis. FSH is a major constituent of fertility drugs.

**food processing enzyme** Enzyme used to control food texture, flavour, appearance, or nutritional value. Amylases break down complex polysaccharides to simpler sugars; proteases tenderize meat proteins. A prominent target of food biotechnology is to develop novel food enzymes which can improve the quality of processed foods.

**forced cloning** The insertion of **foreign DNA** into a cloning **vector** in a predetermined orientation.

**foreign DNA** Exogenous DNA that is incorporated into a host genome.

**formulation** See: medium formulation.

**forskolin** A medicinal, diterpenoid, compound exclusive to plant roots and used in the preparation of drugs for the treatment of cardiomyopathy, glaucoma and certain cancers.

**fortify** To add strengthening components or beneficial ingredients to a nutrient medium.

**forward mutation** A mutation from the **wild type** to the mutant type. **Opposite**: reverse mutation.

**fouling** The coating or plugging (by materials or micro-organisms) of equipment, thus preventing it from functioning properly.

**founder animal** An organism that carries a **transgene** in its **germ line** and can be used in matings to establish a pure-breeding transgenic line, or one that acts as a breeding stock for transgenic animals.

**founder principle** The possibility that a new, isolated population, initiated by a small number of individuals taken from a parent population, may be genetically different from the parent population, because the founding individuals might not be typical of the parent population. See: genetic drift.

**four-base cutter** A type II restriction endonuclease with a four-nucleotide recognition site. Because any particular sequence of four bases occurs more frequently by chance than one of six bases, four-base cutters **cleave** more frequently than six-base cutters, and therefore generate, on average, smaller restriction fragments. **Synonyms**: four-base-pair-cutter, four-cutter.

**fractionation** The separation in components of a complex mixture of molecules.

**fragment** Partial structure. See: restriction fragment.

**frameshift mutation** A mutation that changes the reading frame of a DNA, either by the insertion or the deletion of nucleotides. Because of the triplet nature of codons, this occurs if the number of nucleotides involved is not a multiple of three.

**free water** The cellular water released into the intercellular spaces when tissue is frozen and thawed. **Opposite**: bound water.
free-living conditions  Natural or greenhouse conditions experienced by plantlets upon transfer from in vitro conditions to soil. Prior to transfer, nutrients were supplied by the culture medium, but following transfer, plantlets must take up nutrients from soil and synthesize their own food supply.

freeze preservation  See: cryobiological preservation.

freeze-dry  The removal of water as vapour from frozen material under vacuum. Used to measure water content and to preserve samples, particularly spores. Unlike oven-drying, bound water remains associated with the specimen. Synonym: lyophilize.

fresh weight  The weight, including the water content, of a specimen. Synonym: wet weight.

friable  A term commonly used to describe a crumb-like callus. In this state, the callus is easily dissected and readily dispersed into single cells or clumps of cells in solution.

FSH  See: follicle stimulating hormone.

functional food  A foodstuff that provides a health benefit beyond basic nutrition, demonstrating specific health or medical benefits, including the prevention and treatment of disease.


functional genomics  The field of research, that aims to determine patterns of gene expression and interaction in the genome, based on the knowledge of extensive or complete genomic sequence of an organism.

fungicide  A chemical agent toxic to fungi.

fungus (pl.: fungi)  Multinucleate single-celled or multicellular heterotrophic micro-organisms, including yeasts, moulds, and mushrooms. They live as parasites, symbionts, or saprophytes. Lacking any vascular tissues (unlike plants), their cell walls are made of chitin or other non-cellulose compounds.

Fusarium spp.  A group of fungal pathogens of many economic crop species, particularly cereals, where severe infestation leads to losses in both grain yield and quality. The latter can be a particularly serious problem as many of these fungi produce mycotoxins, some of which are dangerous to both livestock and human health (See: aflatoxin). Specific strains are also employed on an industrial scale to produce protein for human consumption.

fusion biopharmaceuticals  Fusion proteins with pharmaceutical properties. Their advantages are: 1. Synergistic activities in one molecule, i.e. when the molecule binds to its target, it can perform more than one function simultaneously; 2. An adverse effect or poor stability of one part of the molecule may be offset by the properties of the other; and 3. One part of the molecule can act as a targeting mechanism for the active protein. See: immunotoxin, fusion toxin.

cellulose

fusion gene  See: chimeric gene.

fusion protein  A polypeptide translated from a chimeric gene. The different genes are joined so that their coding sequences are in the same reading frame, and the resulting construct is transcribed and translated as a single gene, producing a single protein. These are used for a number of purposes, including: 1. To add an affinity tag to a protein; 2. To produce a protein with the combined characteristics of two natural proteins; 3. To produce a protein where two different activities are physically linked. See: fusion biopharmaceuticals.
fusion toxin A fusion protein that consists of a toxic protein domain plus a cell receptor binding domain. The latter delivers the toxin directly to the target cell, thus sparing other healthy tissues from the effect of the toxin.

fusogenic agent Any chemical or virus, etc., that causes cells to fuse together.

G Abbreviation for guanine.

G cap The 5'-terminal methylated guanine nucleoside that is present on many eukaryotic mRNAs. It is joined to the mRNA, via a 5'?5' phosphodiester bond, after transcription. See: cap site.

G protein Proteins found on the inner surface of the plasma membrane, which bind to the guanine nucleotides, GTP and GDP. They transmit signals from outside the membrane, via trans-membrane (G-protein-coupled) receptors, to adenylate cyclase, which catalyses the formation of the second messenger, cyclic AMP, inside the cell.

galactomannan A gum in which the structural chain is made up of D-mannose units with 1?4 linkages. The ratio of galactose to mannose is 1:2.

gall A tumorous growth in plants. See: crown gall.

gamete A mature reproductive cell which is capable of fusing with a cell of similar origin but of opposite sex to form a zygote from which a new organism can develop. Gametes normally have a haploid chromosome content. In animals, a gamete is a sperm or egg; in plants, it is pollen, spermatid nucleus, or ovum.

gamete and embryo storage Storage of ova, sperm or fertilized embryos outside their original source. Almost invariably this means cryopreservation.

gametic (phase) disequilibrium In relation to any two loci, the occurrence of haplotypes (gametes) at a frequency other than that predicted from the product of the respective allele frequencies. Opposite: gametic (phase) equilibrium.

gametic (phase) equilibrium In relation to any two loci, the occurrence of haplotypes (gametes) at a frequency equal to the product of the frequency of the two relevant alleles. For example, A and B are in gametic equilibrium if the frequency of AB gametes equals the product of the frequencies of alleles A and B. Opposite: gametic (phase) disequilibrium.

gametocline A plant regenerated from a tissue culture originating from gametic tissue.

gametogenesis The process of the formation of gametes.

gametophyte The phase of the plant life cycle that carries the gamete producing organs. In flowering plants, the pollen grain is the male gametophyte and the embryo sac is the female gametophyte.

gametophytic incompatibility A phenomenon in plants, in which a pollen grain is genetically incapable of fertilizing a particular egg, because both gametes carry the identical allele at an incompatibility locus (usually denoted S). This is a mechanism for forcing crossfertilization.

gap A missing section on one of the strands of double-stranded DNA. The DNA will therefore have a single-stranded region.

gapped DNA A double-stranded DNA molecule with one or more internal single-stranded regions.
gas transfer The rate at which gases are transferred from gas into solution, an important parameter in fermentation systems because it controls the rate at which the organism can metabolize. Efficient gas transfer can be achieved in several ways, including the use of small bubbles, from which gas dissolves faster than from larger ones, due to their larger surface area per unit of volume; or spreading the liquid out, for example in a thin sheet, or in a thin permeable tube, as in hollow fibre bioreactor.

gastrula An early animal embryo consisting of two layers of cells; an embryological stage following the blastula.

GC island A segment of double-stranded DNA that is rich in GC base pairs. This type of sequence is characteristic of eukaryotic genomic regions with a high gene content.

GDP Abbreviation for guanosine 5’-diphosphate.

gel A jelly-like solid, used widely as a matrix for the electrophoresis of macromolecules, for encapsulation, and to solidify media for cell cultures.

gel electrophoresis See: electrophoresis.

gel filtration A method of protein or DNA purification, where differences in size are used to separate the components of a complex mixture.

gelatin A gluttonous, proteinaceous gelling and solidifying agent. Gelatin is produced by the partial hydrolysis (via boiling) of collagen, found in the connective tissues of many farm animals. Used to gel or solidify nutrient solutions for tissue culture, and as a food additive.

gelatinization The swelling of starch when added to hot water. Hydrolysis causes the molecule to lose structure, and technically gelatinization is not complete until there is no structure left at all.

Gelrite™ The brand name of a Pseudomonas-derived refined polysaccharide used as a gelling agent and agar substitute.

GEM Abbreviation for genetically engineered micro-organism. See: genetically modified organism.

gene The unit of heredity transmitted from generation to generation during sexual or asexual reproduction. More generally, the term is used in relation to the transmission and inheritance of particular identifiable traits. The simplest gene consists a segment of nucleic acid that encodes an individual protein or RNA.

gene (resources) conservation The conservation of species, populations, individuals or parts of individuals, by in situ or ex situ methods, to provide a diversity of genetic materials for present and future generations.

gene addition The addition of a functional copy of a gene to the genome of an organism.

gene amplification The selective production of multiple copies of one gene without a proportional increase in others.
gene bank 1. The physical location where collections of genetic material in the form of seeds, tissues or reproductive cells of plants or animals are stored. 2. Field gene bank: A facility established for the ex situ storage and maintenance, using horticultural techniques, of individual plants. Used for species whose seeds are recalcitrant, or for clonally propagated species of agricultural importance, e.g. apple varieties. 3. A collection of cloned DNA fragments from a single genome. Ideally the bank should contain cloned representatives of all the DNA sequences in the genome. 4. See: library.

gene cloning The synthesis of multiple copies of a chosen DNA sequence using a bacterial cell or another organism as a host. The gene of interest is inserted into a vector, and the resulting recombinant DNA molecule is amplified in an appropriate host cell. Synonym: DNA cloning.

gene construct See: construct.

gene conversion A process, often associated with recombination, during which one allele is replicated at the expense of another, leading to non-Mendelian segregation ratios.

gene expression The process by which a gene produces mRNA and protein, and hence exerts its effect on the phenotype of an organism.

gene flow The spread of genes from one breeding population to another (usually) related population by migration, thereby generating changes in allele frequency.

gene frequency See: allele frequency.

gene gun See: biolistics.

gene imprinting The differential expression of a single gene according to its parental origin.

gene insertion The incorporation of one or more copies of a gene into a chromosome.

gene interaction The modification of the action of one gene by another, non-allelic gene.

gene knockout See: knockout.

gene library See: library.

gene linkage See: linkage.

gene machine See: transposon tagging.

gene mapping See: mapping.

gene modification Chemical change to a gene's DNA sequence.

gene pool 1. The sum of all genetic information in a breeding population at a given time. 2. In plant genetic resources, use is made of the terms 'primary', 'secondary' and 'tertiary' gene pools. In general, members of the primary gene pool are inter-fertile; those of the secondary can be crossed with those in the primary gene pool under special circumstances; but to introgress variation from the tertiary gene pool, special techniques are required to achieve crossing.

gene probe See: probe.

gene recombination See: recombination.
gene regulation The process of controlling the synthesis or suppression of gene products in specific cells or tissues.

gene replacement The incorporation of a transgene into a chromosome at its normal location by homologous recombination, thus replacing the copy of the gene originally present at the locus.

gene sequencing See: DNA sequencing.

gene shears See: ribozyme.

gene silencing See: silencing.

gene splicing See: splicing (1).

gene stacking See: stacked genes.

gene therapy The proposed treatment of an inherited disease by the transformation of an affected individual with a wild-type copy of the defective gene causing the disorder. In germ-line (or heritable) gene therapy, reproductive cells are transformed; in somatic-cell (or non-heritable) gene therapy, cells other than reproductive ones are modified.

gene tracking Following the inheritance of a particular gene from generation to generation.

gene transfer See: transformation.

gene translocation The movement of a gene from one chromosomal location to another.

genera Plural form of genus.

generally regarded as safe (Abbreviation: GRAS). Designation given to foods, drugs, and other materials with a long-term history of not causing illness to humans, even though formal toxicity testing may not been conducted. Certain host organisms for recombinant DNA experimentation have recently been given this status.

generation time See: cell generation time.

generative See: germ line.

generative nucleus In many flowering plants, shed pollen is two-celled (in others it is three-celled or has a variable number). Before pollen is shed, the male gametophyte divides mitotically to give a generative and a vegetative nucleus. The former is the progenitor of the sperm cells.

genet The individual(s) descended vegetatively from a single sexually produced zygote, including all entities derived from it. All these individuals are genetically identical to one another (barring mutation).

genetic assimilation Eventual extinction of a natural species as massive gene flow occurs from a related species.

genetic code The correspondence between the set of 64 possible nucleotide triplets and the amino acids and stop codons that they specify. See annex 3.

genetic complementation When two DNA molecules that are in the same cell together produce a function that neither DNA molecule can supply on its own.
**genetic disease** A disease caused by an abnormality in the genetic material, which could be at the level of DNA sequence at a locus, or at the level of karyotype. Usually refers to inherited diseases, although somatic mutations can also cause disease without being inherited.

**genetic distance** A measure of the genetic similarity between any pair of populations. This is measured on the basis of variation in a combination of phenotypic traits, allele frequencies or DNA sequences. For example, the genetic distance between two populations having the same allele frequencies at a particular locus, and based solely on that locus, is zero.

**genetic distancing** The collection of the data on phenotypic traits, marker allele frequencies or DNA sequences for two or more populations, and estimation of the genetic distances between each pair of populations.

**genetic diversity** The heritable variation within and among populations which is created, enhanced or maintained by evolutionary or selective forces.

**genetic drift** Change in allele frequency from one generation to another within a population, due to the sampling of finite numbers of genes that is inevitable in all finite-sized populations. The smaller the population, the greater is the genetic drift, with the result that some alleles are lost, and genetic diversity is reduced. Thus minimization of genetic drift is an important consideration for conservation of genetic resources.

**genetic engineering** Modifying genotype, and hence phenotype, by transgenesis.

**genetic equilibrium** The maintenance of a steady state with respect to allele frequencies in a group of interbreeding organisms.

**genetic erosion** The loss over time of allelic diversity, particularly in farmed organisms, caused by either natural or man-made processes. See: genetic drift.

**genetic fingerprinting** See: DNA fingerprinting.

**genetic gain** The increase in productivity achieved following a change in gene frequency effected by selection.

**genetic heterogeneity** Occurs where the genetic determination of a given phenotype differs between individuals.

**genetic immunization** Delivery to a host organism of a cloned gene that encodes an antigen. After the cloned gene is expressed, it elicits an antibody response that protects the organism from infection by the relevant pathogen.

**genetic information** Information contained in a nucleotide base sequence in chromosomal DNA or RNA.

**genetic linkage** See: linkage.

**genetic map** The linear array of genes on a chromosome, based on recombination frequencies (linkage map) or physical location (physical or chromosomal map). See: linkage map.

**genetic mapping** See: mapping.

**genetic marker** A DNA sequence used to identify a particular location (locus) on a particular chromosome. See: marker gene.
**genetic pollution** Uncontrolled spread of **genetic information** (frequently referring to **transgenes**) into the genomes of organisms in which such genes are not present in nature.

**genetic polymorphism** See: **polymorphism**.

**genetic relatedness** A quantitative estimate of the proportion of genes, $r$, shared between the genomes of any two individuals, groups or populations, e.g. $r = 0.5$ for full siblings and parent offspring pairs.

**genetic resources** genetic material of actual or potential value.

**genetic selection** The process of selecting genes, cells, clones, etc., within populations or between populations or species. Genetic selection usually results in differential survival rates of the various genotypes, reflecting many variables, including the selection pressure and genetic variability present in populations.

**genetic transformation** See: **transformation**.

**genetic use restriction technology** (Abbreviation: GURT). A proposed technology applying **transgenesis** to genetically compromise the fertility or the performance of saved seed of a **cultivar** or of second generation animals. The intention is to protect the market for the seed producer or to prevent undesired escape of genes. Two types of GURTs have been patented: variety-level GURT (V-GURT), which produces **sterile** progeny, and **trait**-specific GURT (T-GURT), in which only the added value transgenic trait is genetically protected. See: **terminator gene**, **disrupter gene**.

**genetic variation** Differences between individuals attributable to differences in genotype.

**genetically engineered organism** (Abbreviation: GEO). Occasional alternative term for **genetically modified organism**.

**genetically modified organism** (Abbreviation: GMO). An organism that has been transformed by the insertion of one or more transgenes.

**genetics** The science of heredity.

**genome** 1. The entire complement of genetic material (genes plus non-coding sequences) present in each cell of an organism, **virus** or organelle. 2. The complete set of chromosomes (hence of genes) inherited as a unit from one parent.

**genomic library** A clone **library** specifically constructed from restriction fragments of the genomic **DNA** of an organism.

**genomics** The research strategy that uses molecular characterization and cloning of whole genomes to understand the structure, function and **evolution** of genes and to answer fundamental biological questions. See: **bio-informatics**, **functional genomics** and **proteomics**.

**genotype** 1. The genetic constitution of an organism. 2. The **allelic** constitution at a particular locus, e.g. $Aa$ or $aa$. 3. The sum effect of all loci that contribute to the expression of a trait.

**genus** (pl.: genera) A group of closely related **species**, whose perceived relationship is typically based on physical resemblance, now often supplemented with **DNA sequence** data.
GEO Abbreviation for genetically engineered organism. See: genetically modified organism.

geotropism A growth curvature induced by gravity. Synonym: gravitropism.

germs 1. The botanical term for a plant embryo. 2. Colloquial: a disease-causing microorganism.

germin A member of a cell lineage (the germ line) leading to the production of gametes. In mammals, germ cells are found in the germinal epithelium of the ovaries and testes. Synonym: germ line cell. Opposite: somatic cell.

germ cell gene therapy The repair or replacement of a defective gene within the gamete-forming tissues, resulting in a heritable change in an organism's genetic constitution.

germlayer The layers of cells in an animal embryo at the gastrula stage, from which the various organs of the animal's body will be derived.

germline A lineage of cells which, during the development of an organism, are set aside as potential gamete-forming tissues. The location, nature and time of formation of potential gamete-forming tissues are species specific, and may vary greatly from one species to another. See: somatic

germline cell See: germ cell.

germline gene therapy The delivery of a gene or genes to a fertilized egg or an early embryonic cell. The transferred gene(s) is present in all or some of the nuclei of the cells of the mature individual, including possibly the reproductive cells, and alters the phenotype of the individual that develops.

germicide Any chemical agent used to control or kill any pathogenic and non-pathogenic micro-organisms.

germinal epithelium 1. A layer of epithelial cells on the surface of the ovary that are continuous with the mesothelium. 2. The layer of epithelial cells lining the seminiferous tubules of the testis, which gives rise to spermatogonia. See: spermatogenesis.

germination 1. The initial stages in the growth of a seed to form a seedling. 2. The growth of spores (fungal or algal) and pollen grains.

germinplasm 1. An individual, group of individuals or a clone representing a genotype, variety, species or culture, held in an in situ or ex situ collection. 2. Original meaning, now no longer in use: the genetic material that forms the physical basis of inheritance and which is transmitted from one generation to the next by means of the germ cells.

germination The period between conception (fertilization of the egg) to parturition (birth) spent in utero by the foetus of viviparous animals.

GFP Abbreviation for green fluorescent protein.

GH Abbreviation for growth hormone.

gibberellins A class of plant growth regulators which are active in the elongation, enhancement of flower, fruit and leaf size, germination, vernalization and other physiological processes.
gland A specialized group of cells or a single cell in animals or plants that secretes a specific substance. The two types of animal glands are: endocrine, which secrete directly into the blood vessels; and exocrine, which secrete through a duct or network of ducts into a body cavity or onto the body surface.

glaucous A surface with a waxy, white coating. In most cases, this waxy covering can be rubbed off.

globulins Common class of proteins in blood, eggs and milk, and seeds. Characterized by their slight solubility in water but are freely soluble in dilute salt solutions. Gamma- globulins are defined further by their electrophoretic behaviour, and include the immunoglobulins.

GLP Abbreviation for good laboratory practice.

glucocorticoid A steroid hormone that regulates gene expression in higher animals.

glucose invertase An enzyme that catalyses the hydrolysis of sucrose into its component monosaccharides, glucose and fructose.

glucose isomerase An enzyme that catalyses the interconversion of the two sugars, glucose and fructose. As fructose is a lower energy compound compared with glucose, a mixture of glucose and fructose with the enzyme will end up almost entirely as fructose.

glucosinolates A class of molecules produced in the seeds and green tissue of a range of plants, in particular brassicas. Their natural role is thought to be involved in plant-insect interactions. Their importance in plant breeding is largely because of their negative influence on taste and their positive effect on the prevention of cancers of the alimentary tract.

glucuronidase See: beta-glucuronidase.

gluten A mixture of two seed storage protein classes, gliadin and glutenin, found in the endosperm of cereal (particularly wheat) grain. High levels of gluten impart elasticity to dough, and thus the composition of wheat glutens largely determines whether a specific flour is suitable for biscuit or bread making. Sensitivity of the lining of the intestine to gluten in some humans results in coeliac disease, a condition that requires a gluten-free diet.

glycoalkaloids A group of modified alkaloids, including solanine and tomatine, having a range of toxic effects in humans and other species. They are of particular significance in food plants from the Solanaceae.

glycoform One of several structures possible for a given glycoprotein, determined by the type and position of attachment of the component oligosaccharide(s). Certain glycoforms may exhibit different biological activities from one another because the oligosaccharide units mediate interactions with other cell components.

glycolysis The sequence of reactions that converts glucose into pyruvate, with the concomitant production of ATP.

glycoprotein A protein molecule modified by the addition of one or several oligosaccharide groups.

glycoprotein remodelling The use of restriction endoglycosidases to enzymatically remove oligosaccharide branches from glycoprotein molecules. Removal of one or more oligosaccharide branches can lessen or abolish the antigenicity of the glycoprotein, so allowing its injection for pharmaceutical purposes without incurring an unwanted immune response. See: glycoform.
glycosylation The covalent addition of sugar or sugar-related molecules to other classes of molecule, including proteins or nucleic acids.

glyphosate An active ingredient in some herbicides, killing plants by inhibiting the activity of plant enolpyruvyl-shikimate 3-phosphate synthase.

glyphosate oxidase An enzyme which catalyses the break-down of glyphosate, discovered in a strain of Pseudomonas bacteria which were found to produce unusually large amounts of the enzyme. The gene responsible has been incorporated into a variety of crop plants to enable them to tolerate applications of glyphosate-containing herbicides. It has also been used in conjunction with the CP4 EPSPS gene.

glyphosate oxidoreductase An enzyme from the micro-organism Ochrobactrum anthropi, which catalyses the break-down of glyphosate. If the encoding gene (called goxv247) is inserted and properly expressed in a plant, these plants become tolerant of the application of glyphosate- and/or sulfoisate-containing herbicides. An alternative to CP4 EPSPS or glyphosate oxidase encoded glyphosate tolerance.

GM food Abbreviation for genetically modified food. Food that contains above a certain legal minimum content of raw material obtained from genetically modified organisms.

GMO Abbreviation for genetically modified organism.

GMP Abbreviation for 1. guanosine 5′-monophosphate. Synonym: guanylic acid. 2. good manufacturing practice.

gobar See: biogas.

golden rice A biotechnology-derived rice, which contains large amounts of beta carotene (a precursor of vitamin A) in its seeds. Achieved by inserting two genes from daffodil and one from the bacterium Erwinia uredovora.

Golgi apparatus An assembly of vesicles and folded membranes within the cytoplasm of plant and animal cells that stores and transports secretory products (such as enzymes and hormones) and plays a role in formation of a cell wall (when this is present).

gonad One of the (usually paired) animal organs that produce reproductive cells (gametes). The most important gonads are the male testis, which produces spermatozoa, and the female ovary, which produces ova (egg cells). The gonads also produce hormones that control secondary sexual characteristics.

good laboratory practice (Abbreviation: GLP). Written codes of practice designed to reduce to a minimum the chance of procedural or instrument problems which could adversely affect a research project or other laboratory work.

good manufacturing practice (Abbreviation: GMP). Codes of practice designed to reduce to a minimum the chance of procedural or instrument/manufacturing plant problems which could adversely affect a manufactured product.

G-protein coupled receptor See: G protein.

graft 1. Verb. To place a detached branch or bud (scion) in close cambial contact with a rooted stem (rootstock) in such a manner that scion and rootstock unite to form a single plant. 2. Noun. Colloquial synonym for scion. See: grafting, graft chimera, graft hybrid.
**graft chimera** A plant which is a mosaic of two sorts of tissue differing in genetic constitution and assumed to have arisen as the result of a nuclear fusion following **grafting**. See: **graft hybrid**.

**graft hybrid** An individual formed from **graft** (2) and **stock** showing the characteristics of both progenitors. See: **graft chimera**.

**graft inoculation test** A test based on the use of a suspected viral carrier which is grafted to an indicator plant. If symptoms appear in the indicator plant, the viral **assay** is positive.

**graft union** The point at which a **scion** from one plant is joined to a **rootstock** from another plant.

**grafting** The process of making a **graft** (1).

**graft-versus-host disease** The rejection of transplanted organs by the recipient's immune system, due to attack of the recipient's T **lymphocytes** on the transplanted organ caused by differences in **major histocompatibility complex** proteins.

**Gram staining** A technique to distinguish between two major bacterial groups, based on whether or not their cell wall retains the Gram stain. Gram-positive bacteria are stained dark purple, while Gram-negative bacteria are only faintly coloured. Stain retention is determined by the structure of the **cell wall**.

**granum** (pl.: grana) Structure within the **chloroplasts**, appear as green granules with the light microscope and as a series of parallel lamellae with the electron microscope. They contain the **chlorophyll** and **carotenoid** pigments directly involved in photosynthesis.

**GRAS** Abbreviation for **generally regarded as safe**.

**gratuitous inducer** A substance that can induce **transcription** of a **gene** or genes, but is not a **substrate** for the induced enzyme(s).

**gravitropism** See: geotropism.

**green fluorescent protein** (Abbreviation: GFP). A **protein** derived from a species of jelly fish, that fluoresces when exposed to ultra violet light. Its encoding gene has been isolated and is replacing **GUS** as a **reporter gene** in plant transgenesis, since it can be assayed non-destructively in real time.

**green revolution** Name given to the dramatic increase in crop **productivity** during the third quarter of the 20th century, as a result of integrated advances in **genetics** and plant breeding, agronomy, and pest and disease control.

**Gro-luxa** A wide-spectrum fluorescent lamp suitable for artificial light for plant growth.

**growth cabinet** An enclosed space in which environmental conditions can be controlled. The degree of control over temperature, light and humidity is a function of the quality of the cabinet.

**growth curve** See: **growth phase**.

**growth factor** Any of various chemicals, particularly **polypeptides**, that have a variety of important roles in the stimulation of new **cell** growth and cell maintenance. They bind to the cell surface on receptors. Specific growth factors can cause new cell proliferation.
growth hormone (Abbreviation: GH). A group of hormones, secreted by the mammalian pituitary gland, that stimulates protein synthesis and growth of the long bones in the legs and arms. They also promote the breakdown and use of fats as an energy source, rather than glucose. Synonym: somatotropin.

growth inhibitor Any substance inhibiting the growth of an organism. The inhibitory effect can range from mild inhibition (growth retardation) to severe inhibition or death (toxic reaction). The concentration of the inhibitor, the length of exposure to it, and the relative susceptibility of the organisms exposed to the inhibitor, are all important factors which determine the extent of the inhibitory effect.

growth phase Each of the characteristic periods in the growth curve of a bacterial culture, as indicated by the shape of a graph of viable cell number versus time, namely: lag phase; logarithmic phase; stationary phase; death phase.

growth rate Change in an organism's mass per unit of time.

growth regulator A synthetic or natural compound that at low concentrations elicits and controls growth responses in a manner similar to hormones.

growth retardant A chemical that selectively interferes with normal hormonal promotion of growth and other physiological processes, but without appreciable toxic effects.

growth ring Rings visible in a cross-section of a woody stem, such as a tree trunk. Each ring represents the xylem formed in one year as a result of fluctuating activity of the vascular cambium.

growth substance Any organic substance, other than a nutrient, that is synthesized by plants and regulates growth and development. They are usually made in a particular region, such as the shoot tip, and transported to other regions, where they take effect.

GTP Abbreviation for guanosine 5'-triphosphate, a nucleotide which is important as a ligand for G proteins and as a direct precursor molecule for RNA synthesis. See: guanylic acid.

guanine (Abbreviation: G). One of the bases found in DNA and RNA. See: guanosine.

guanosine The (ribo)nucleoside resulting from the combination of the base guanine (G) and a D-ribose sugar. The corresponding deoxyribonucleoside is called deoxyguanosine. See: GTP, dGTP, guanylic acid.

guanosine triphosphate (guanosine 5-triphosphate) Abbreviation: GTP. See: guanylic acid.

guanylic acid Synonym for guanosine monophosphate (abbreviation: GMP), a (ribo)nucleotide containing the nucleoside guanosine. The corresponding deoxyribonucleotide is called deoxyguanylic acid.

guard cell Specialized epidermal cells found in pairs around a stoma. Their function is to control the opening and closing of the stoma through changes in turgor.

guide RNA An RNA molecule that contain sequences that function as a template during RNA editing. See: guide sequence.
guide sequence An RNA molecule (or a part of it) which hybridizes with eukaryotic mRNA and aids in the splicing of intron sequences. Guide sequences may be either external (EGS) or internal (IGS) to the RNA being processed and may hybridize with either intron or exon sequences close to the splice junction. See: split gene.

GURT Abbreviation for genetic use restriction technology.

GUS Abbreviation for beta-glucuronidase.

gus gene An *E. coli* gene that encodes for production of beta-glucuronidase (GUS). Because this activity is absent in plants, the gene is commonly utilized as a reporter gene to detect the occurrence of transformation events.

gymnosperm A class of plant (e.g. conifers) whose ovules and the seeds into which they develop are borne unprotected, rather than enclosed in ovaries, as are those of the flowering plants, the (angiosperms).

gynandromorph An individual in which one part of the body is female and another part is male; a sex mosaic.

**gynogenesis** Female parthenogenesis: after fertilization of the ovum, the male nucleus is eliminated and the haploid (gynogenetic) individual possesses the maternal genome only.

**gyrase** See: DNA helicase.

**h** Prefix used to designate the human form of an enzyme. For example, *hGH* is human growth hormone.

habituation The phenomenon whereby, after a number of sub-cultures, cells can grow without the addition to the tissue culture medium of previously obligatory factors. Such cells are then autonomous.

**HAC** Abbreviation for human artificial chromosome.

**haemoglobin** Protein containing iron, located in erythrocytes of vertebrates; important for the transportation of oxygen to the cells of the body.

**haemolymph** The mixture of blood and other fluids in the body cavity of an invertebrate.

**haemophilia** A sex-linked hereditary bleeding disorder in which it takes a long time for the blood to clot and abnormal bleeding occurs. This disease affects mostly males.

**hairpin loop** A region in one strand of a polynucleotide which, due to an inverted repeat in the sequence, may under appropriate conditions fold back on itself and form a limited segment of double-stranded DNA with a loop at one end.

**hairy root culture** A culture consisting of highly branched roots of a plant. A plant tissue is treated with the bacterium *Agrobacterium rhizogenes* containing the Ri plasmid, which causes the explant to grow highly branched roots from the sites of infection. Transgenes engineered into the plasmid can be expressed in these cultures.

**hairy root disease** A disease of broad-leaved plants, where a proliferation of root-like tissue is formed from the stem. Hairy root disease is a tumorous state similar to crown gall, and is induced by the bacterium *Agrobacterium rhizogenes*, when containing an Ri plasmid.
halophyte A plant species adapted to soils containing a concentration of salt that is toxic to most plant species. See: salt tolerance.

hanging droplet technique See: microdroplet array.

haploid A cell or organism containing one of each of the pairs of homologous chromosomes found in the normal diploid cell.

haplotype A specific allelic constitution at a number of loci within a defined linkage block.

haplozygous See: hemizygous.

hapten A small molecule, which by itself is not an antigen, but which as a part of a larger structure when linked to a carrier protein, can serve as an antigenic determinant.

haptoglobin A serum protein that interacts with haemoglobin during recycling of the iron molecule of haemoglobin. Synonym: alpha globulin.

hardening off Adapting glasshouse or controlled environment grown plants to outdoor conditions by reducing availability of water, lowering the temperature, increasing light intensity, or reducing the nutrient supply. The hardening-off process conditions plants for survival when transplanted outdoors.

Hardy-Weinberg equilibrium The frequencies of genotypes at a locus resulting from random mating at that locus; for two alleles, $A_1$ and $A_2$, with respective frequencies in a population of $p$ and $q$, the Hardy-Weinberg equilibrium frequencies are $p^2 A_1A_1$; $2pq A_1A_2$; $q^2 A_2A_2$. Departure from these frequencies is an indication that random mating is not occurring.

harvesting 1. The process involved in gathering ripened crops. 2. The collection of cells from cell cultures or of organs from donors for the purpose of transplantation.

heat shock protein (Abbreviation: HSP). A class of protein chaperones which are typically over-expressed as a response to heat stress. Two such proteins - HSP 90 and HSP 70 - have a role in ensuring that crucial proteins are folded into the correct conformation. Synonym: stress protein.

heat therapy See: thermotherapy.

helix A structure with a spiral shape. The normal state of double-stranded DNA is in the form of a double helix.

helminth A class of parasitic worms, especially those which are internal parasites of man and animals.

helper cell T cells that assist in stimulating B and T lymphocytes to develop into antibody-producing plasma cells and killer T cells, respectively.

helper plasmid A plasmid that provides a function or functions to another plasmid in the same cell.

helper T cell See: helper cell.

helper T lymphocyte See: helper cell.

helper virus A virus that provides a function or functions to another virus in the same cell.
hemicellulase An enzyme that catalyses the degradation of hemicellulose.

hemicellulose Any cellulose-like carbohydrate, but excluding cellulose itself. Together with pectin and lignin, hemicelluloses form the cell wall matrix.

ehemizygous The condition in which genes are present only once in the genotype and not in pairs. Occurs for all genes in haploids, for all genes located in the differential segments of the sex chromosomes in diploids, and in various aneuploids and deletion mutant heterozygotes. Synonym: haplozygous.

hemoglobin See: haemoglobin.

hemolymph See: haemolymph.

hemophilia See: haemophilia.

HEPA filter Abbreviation for high efficiency particulate air filter. A filter capable of excluding particles larger than 0.3ìm. HEPA filters are used in laminar air flow cabinets to ensure that the air is pathogen-free. See: pre-filter.

herbicide A substance that is toxic to plants; the active ingredient in agrochemicals intended to kill specific unwanted plants, especially weeds.

herbicide resistance The ability of a plant to remain unaffected by the application of a herbicide.

heredity Resemblance among individuals related by descent; transmission of traits from parents to offspring.

heritability The degree to which a given trait is controlled by inheritance, as opposed to being controlled by non-genetic factors. See: broad-sense heritability; narrow-sense heritability.

hermaphrodite 1. An animal that has both male and female reproductive organs, or a mixture of male and female attributes. 2. A plant whose flowers contain both stamen and carpels. Synonym: intersex.

heteroallele A gene having mutations at two or more different sites.

heterochromatin Regions of chromosomes that remain contracted during interphase and therefore stain more intensely in cytological preparations. These regions have a high content of repetitive DNA, and a low content of genes; thus they are for the most part genetically inactive. Opposite: euchromatin.

heteroduplex A double-stranded DNA molecule or DNA-RNA hybrid, where each strand is of a different origin. Where the two DNAs differ significantly in sequence, single-stranded regions will be revealed when the heteroduplex is observed under the electron microscope. A map of homologous and non-homologous regions of the two molecules may thereby be constructed (heteroduplex mapping). Synonym: hybrid DNA (DNA/RNA). See: heteroduplex analysis.

heteroduplex analysis The use of the electrophoretic mobility of heteroduplex DNA to estimate the degree of non-homology between the sequences of the two strands. Gel mobility tends to be reduced as the amount of sequence divergence increases, because the effective size of a fully complementary pair of strands is smaller than that of a partially complementary structure.
**heterogametic** Producing unlike gametes with regard to the sex chromosomes. In mammals, the XY male is heterogametic, and the XX female is **homogametic**.

**heterogeneity** See: **genetic heterogeneity**.

**heterogeneous nuclear RNA** (Abbreviation: hnRNA). Large RNA molecules, which are found in the **nucleus** of a eukaryotic cell and the precursors of **mRNA** and other RNA molecules.

**heterokaryon** A cell with two or more different nuclei as a result of **cell** fusion. See: **synkaryon**.

**heterologous** From a different source.

**heterologous probe** A **DNA probe** that is derived from one species and used to screen for a similar DNA sequence from another species.

**heterologous protein** See: **recombinant protein**.

**heteroplasmy** A condition in which two genetically different organelles are present in the same cell. The equivalent to **heterozygous** in the context of nuclear genes. **Opposite**: homoplasmy.

**heteroploid** Cells with nuclei containing chromosome numbers other than diploid.

**heteropyknosis** The property of certain chromosomes, or of their parts, to remain more dense during the **cell cycle** and to stain more intensely than other chromosomes or parts.

**heterosis** See: **hybrid vigour**.

**heterotroph** Organism non capable of self-nourishment utilizing carbon dioxide or carbonates as the sole source of carbon and obtaining energy from radiant energy or from the oxidation of inorganic elements, or compounds such as iron, sulphur, hydrogen, ammonium and nitrites. **Opposite**: autotroph.

**heterotrophic** (adj.) See: **heterotroph**.

**heterozygous** (adj.) See: **heterozygote**.

**heterozygote** An individual with non-identical alleles for a particular gene or genes. The condition is termed "heterozygous". **Opposite**: homogygote.

**Hfr** High-frequency recombination strain of **Escherichia coli**; in these strains, the **F factor** (plasmid) is integrated into the bacterial chromosome.

**hGH** Abbreviation for human growth hormone.

**high efficiency particulate air filter** See: HEPA filter.

**high throughput screening** Automated systems designed to process large numbers of assays, especially in the context of genotyping.

**histocompatibility** The degree to which tissue from one organism is tolerated by the immune system of another organism.

**histocompatibility complex** See: **major histocompatibility complex**.
histoglobulin The peptides present on the surface of nucleate cells, responsible for the differences between genetically non-identical individuals that cause rejection of tissue grafts between such individuals. Products of the major histocompatibility complex genes.

histology Science that deals with the microscopic structure of animal and plant tissues.

histone Group of water-soluble proteins rich in basic amino acids, closely associated with DNA in plant and animal chromatin. Histones are involved in the coiling of DNA in chromosomes and in the regulation of gene activity.

HLA Abbreviation for human-leukocyte-antigen system. See: major histocompatibility antigens.

hnRNA Abbreviation for heterogeneous nuclear RNA.

Hogness box Synonym for TATA box.

hollow fibre A tube of porous material, with an internal diameter of a fraction of a millimetre, making its ratio of surface area to internal volume very large. Employed as filters or in bioreactors as a method of retaining cells while allowing the easy removal of spent medium and/or products.

holoenzyme See: apoenzyme.

holometabolous An insect that undergoes complete metamorphosis to the adult from a morphologically distinct larval stage.

homeobox A highly conserved 180 bp DNA sequence that controls body part-, organ- or tissue-specific gene expression, most particularly involved in segmentation in animals (e.g. development of antennae or legs of Drosophila melanogaster), but also in a variety of other eukaryotes. It encodes a DNA-binding region, the homeodomain, which acts as a transcription factor.

homeodomain See: homeobox.

homeotic genes Genes that act in concert to determine fundamental patterns of development.

homeotic mutation A mutation that causes a body part to develop in an inappropriate position in an organism, such as the mutation in Drosophila melanogaster that causes legs to develop on the head in place of antennae.

homoallele One of a number of otherwise identical alleles which differ at the same site in their sequence. Homoalleles are inherited as strict allelic sequences; but heteroalleles, in principle, could through recombination create a genotype which contains a 'double' variant.

homodimer A protein comprising two identical polypeptide chains, or a dimer of identical residues.

homoduplex DNA A double-stranded fully complementary DNA molecule.

homoeologous Referring to chromosomes which are descended from a common progenitor, but which have evolved to be no longer fully homologous. Homoeologous chromosomes have similar gene content to one another, but are structurally altered in subtle ways to inhibit, and sometimes completely prevent their pairing with one another at meiosis.
homogametic Producing similar gametes with regard to the sex chromosomes. In mammals, the female is homogametic (XX), and the male is heterogametic (XY).

homogenotization An allele replacement technique, in which a bacterial cell is transformed with a plasmid containing an altered copy of the target sequence, and a double recombination event effects the substitution of the wild type allele by the altered one. An antibiotic resistance gene is usually fused to the altered copy in the plasmid, so that double recombinants can be selected.

homokaryon A cell with two or more identical nuclei as a result of fusion. Opposite: heterokaryon.

homologous 1. General definition: from the same source, or having the same evolutionary function or structure. 2. Of chromosomes: identical with respect to gene content and linear ordering. Homologous chromosomes pair and recombine with one another at meiosis. 3. Of DNA/proteins: identical, or nearly identical nucleotide/amino acid sequence.

homologous recombination The exchange of DNA fragments between the two non-sister chromatids of the same chromosome in the course of meiosis.

homology 1. The degree of identity between individuals, or characters. 2. The degree of identity of sequence (nucleotide or amino acid) between a number of DNA or polypeptide molecules.

homomultimer A protein consisting of a number of identical subunits.

homoplasmity The condition in which all copies of an organelle in a cell are genetically identical. Opposite: heteroplasmity.

homopolymer A polymer (nucleic acid, polypeptide, etc.) which contains only one kind of residue (e.g. the polynucleotide GGGGGGGGG...).

homopolymeric tailing See: tailing.

homoozygous (adj.) See: homozygote.

homozygote An individual that has two copies of the same allele for a given gene on its two homologous chromosomes. The condition is termed "homozygous". Opposite: heterozygote.

hormone A specific chemical, produced in one part of a plant or animal body, and transported to another part where, at low concentrations, it promotes, inhibits or quantitatively modifies a biological process.

host An organism that contains another organism or a cloning vector.

host-specific toxin A metabolite, produced by a pathogen, and which is responsible for the adverse effects of the pathogen. The toxin has a host specificity equivalent to that of the pathogen. Utilized for in vitro selection experiments to screen for tolerance or resistance to the pathogen.

hot spot See: recombinational hot spot.

HSA See: serum albumin.

HSP See: heat shock protein.
human artificial chromosome (Abbreviation: HAC). Analogous to yeast artificial chromosome, a construct comprising a human centromere and telomeres, which would allow for the cloning of very large fragments of DNA, and their transfer into human cells for the purpose of gene therapy. Not yet established as a working technology, although some partial success has been reported.

human growth hormone (Abbreviation: hGH). See: growth hormone.

human-leukocyte-antigen system (Abbreviation: HLA). See: major histocompatibility antigens.

humoral immune response See: antibody-mediated immune response.

Hup· Abbreviation for hydrogen-uptake positive.

hybrid 1. The offspring of two genetically unlike parents. 2. Of DNA molecules, see: heteroduplex.

hybrid arrested translation A method used to identify what protein(s) are encoded by a particular cloned DNA sequence. A total mRNA preparation, which contains many different mRNAs, is hybridized with cloned DNA, so that those mRNA molecules homologous to the cloned DNA will anneal to give DNA/RNA heteroduplexes. The non-annealed mRNA molecules can be translated in vitro and this is then compared to translation products from the untreated mRNAs. See: hybrid released translation.

hybrid cell See: synkaryon.

hybrid dysgenesis Infertility and an increased incidence of chromosome mutations thought to be caused by the activation of transposons.

hybrid released translation A method used to identify the gene product of a cloned gene. The cloned DNA is immobilized and hybridized with a mixed mRNA sample, so that only mRNA sequences homologous to the cloned DNA will be retained. These mRNA molecules are subsequently removed and translated in vitro. See: hybrid arrested translation.

hybrid seed 1. Seed produced by crossing genetically dissimilar parents. 2. In plant breeding, used colloquially for seed produced by specific crosses of selected pure lines, such that the F1 crop is genetically uniform and displays hybrid vigour. As the F1 plants are heterozygous with respect to many genes, the crop does not breed true and so new seed must be purchased each season.

hybrid selection The process of choosing individuals possessing desired characteristics from among a hybrid population.

hybrid vigour The extent to which a hybrid individual outperforms both its parents with respect to one or many traits. The genetic basis of hybrid vigour is not well understood, but the phenomenon is widespread, particularly in inbreeding plant species. Synonym: heterosis.

hybridization 1. The process of forming a hybrid by cross pollination of plants or by mating animals of different types. 2. The production of offspring of genetically different parents, normally from sexual reproduction, but also asexually by the fusion of protoplasts or by transformation. 3. The pairing of two DNA strands, often from different sources, by hydrogen bonding between complementary nucleotides.
**hybridoma** A synthetic **hybrid** cell, derived by fusing a B **lymphocyte** with a tumour cell. The former secretes a single antibody, while the latter confers the property of growing indefinitely in tissue culture. The underlying technology behind the **monoclonal antibody**.

**hydrogen-uptake positive** (Abbreviation: Hup'). A term describing a **micro-organism** that is capable of assimilating (or taking up) hydrogen gas.

**hydrolysis** A chemical reaction in which water is added across a covalent bond, often cleaving the molecule into two. Occurs for example when polynucleotides, polypeptides, and polysaccharides are broken into their component **monomers**. Thus sucrose can be hydrolysed to glucose and fructose; and **proteins** to individual amino acids.

**hydrophobic interaction** An interaction between a hydrophobic ('water-hating') part of a molecule and an aqueous environment. Particularly significant in establishing the **conformation** of molecules in solution, and thus their biological activity. Many enzymes have a structure where the **polypeptide** chain is folded to form a hydrophobic core and a hydrophilic ('water-loving') surface.

**hydroponics** The growing of plants without soil. Plants are fed with an aerated solution of nutrients, and the roots are either supported within an inert matrix, or are freely floating in the nutrient solution.

**hygromycin** An **antibiotic** used as selective agent in bacterial and **transgenic** plant cell cultures.

**hyperploid** The situation in which a particular chromosome or **chromosome** segment is present in more than the normal number. **Opposite:** **hypoploid**.

**hypersensitive response** 1. A specific reaction of a plant to attack by a **pathogen**. The plant cells surrounding the point of **infection** rapidly die and dry out, so that pathogen spread within the plant is prevented. Often associated with the interaction of race-specific **R genes** with a matching pathogen avirulence. 2. The abnormal response of an animal to the presence of a particular **antigen**.

**hypersensitive site** Regions in the **DNA** that are highly **susceptible** to digestion with **restriction endonucleases**.

**hypertonic** A solution with an **osmotic potential** greater than that of living cells. Treatment with such solutions leads to the **plasmolysis** of cells. **Opposite:** **hypotonic**.

**hypervariable region** The parts of both the heavy and light chains of an **antibody** molecule that enable it to bind to a specific site on an **antigen**.

**hypervariable segment** A region of a **protein** that varies considerably between strains or individuals.

**hypocotyl** The portion of an **embryo** or seedling below the **cotyledons**. A transitional area between **stem** and root.

**hypomorph** A mutation that reduces, but does not completely abolish gene expression.

**hypoplastic** Defective and reduced growth or development (e.g. dwarving and stunting in plants) resulting from an abnormal condition, for example disease or nutritional stress.

**hypoploid** The situation in which a particular chromosome or **chromosome** segment is present in less than the normal number. **Opposite:** **hyperploid**.
hypothalamic peptides Peptides generated in the vertebrate forebrain and concerned with regulating the body's physiological state.

hypotonic Osmotic potential less than that of living cells. Cells placed in a hypotonic solution will absorb water and display swelling and turgidity. Opposite: hypertonic.
Glossary of biotechnology for food and agriculture

I-P

I/E region Abbreviation for integration-excision region.

ICSI See: intracytoplasmic sperm injection.

identical twin See: monozygotic twin.

idiogram See: karyogram.

idiotype An identifying property or characteristic of an item or system. 1. A plant form expected on physiological grounds to represent an optimal type for the environment in which the plant is to be grown. 2. A classification of antibody molecules according to the antigenicity of the variable regions. Each idiotype is unique to a particular immunoglobulin raised to a particular antigen.

IgA/Igd/IgG/IgE/IgM See: antibody class.

IGS Abbreviation for 1. internal guide sequence. 2. intergenic spacer.

imaginal disc A mass of cells in the larvae of Drosophila melanogaster and other holometabolous insects that gives rise to particular adult organs, such as antennae, eyes or wings.

imbibition 1. The absorption of liquids or vapours into the ultramicroscopic spaces or pores found in materials. 2. The initial water uptake by seeds prior to germination.

immediate early gene A viral gene that is expressed promptly after infection.

immobilized cells Cells entrapped in matrices such as alginate, polyacrylamide and agarose, for use in membrane and filter bioreactors.

immortalization The genetic transformation of a cell type into a cell line which can proliferate indefinitely.

immortalizing oncogene A gene that, upon transfection, enables a primary cell to grow indefinitely in culture.

immune response The processes, including the synthesis of antibodies, that are used by vertebrates to respond to the presence of a foreign antigen. See: primary immune response; secondary immune response.

immunity The lack of susceptibility of an animal or plant to infection by a particular pathogen, or to the harmful effects of their toxins.

immunization The production of immunity in an individual by artificial means. Active immunization involves the introduction, either orally or by infection, of specially treated bacteria, viruses or their toxins so as to stimulate the production of antibodies. See: passive immunity.

immunoaffinity chromatography A purification technique in which an antibody is bound to a matrix and is used to isolate a protein from a complex mixture. See: affinity chromatography.
**immunoassay** An detection system for a particular molecule, which exploits the specific binding of an antibody raised against it. For measurement, the antibody can incorporate a radioactive or fluorescent label, or be linked to an enzyme which catalyses an easily monitored reaction such as a change in colour (see: ELISA). Synonym: **immunodiagnostics**.

**immunochemical control** See: immunotherapy.

**immunodiagnostics** See: immunoassay.

**immunogen** See: antigen.

**immunogenicity** The ability to elicit an immune response.

**immunoglobulin** See: antibody.

**immunoprophylaxis** The process of active or passive immunization. Active immunization with vaccines leads to long-term protection through mobilizing the organism's own immune system. Passive immunization is achieved by injection of antibody against a specific pathogen obtained either by fractionation of blood from an individual previously infected with the pathogen, or by monoclonal antibody technology. See: adoptive immunization, passive immunity.

**immunosensor** A biosensor having an antibody as the biological element.

**immunosuppression** The suppression of the immune response. Necessary following organ transplants from a genetically different donor in order to prevent the host rejecting the grafted organ.

**immunosuppressor** A substance, an agent or a condition that prevents or diminishes the immune response.

**immunotherapy** The use of an antibody or a fusion protein containing the antigen binding site of an antibody to cure a disease or enhance the well-being of a patient. Synonym: **immunochemical control**.

**immunotoxin** Protein drugs consisting of an antibody joined to a toxin molecule. Made by either chemically linking the molecules, or by fusing the genes for the toxin and the antibody, and expressing a fusion protein. The antibody portion of the molecule targets the toxin.

**impeller** An agitator that is used for mixing the contents of a bioreactor.

**in silico** In a computer file. In the present context, the use of data bases of DNA and protein sequence to help answer biological questions. This is growing area of biology as the amount of genomics and proteomics data continues to grow. See: bio-informatics.

**in situ** In the natural place or in the original place. 1. Experimental treatments performed on cells or tissue rather than on extracts from them. 2. Assays or manipulations performed with intact tissues.

**in situ colony hybridization** A procedure for screening bacterial colonies or plaques growing on plates or membranes for the presence of specific DNA sequences by the hybridization of nucleic acid probes to the DNA molecules present in these colonies or plaques. Synonym: **in situ plaque hybridization**.
**in-situ conservation** The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

**in situ hybridization** The visualization of *in vivo* location of macromolecules (particularly polynucleotides and polypeptides) by the histological staining of tissue sections or cytological preparations via labelled probes/antibodies.

**in situ plaque hybridization** See: *in situ* colony hybridization.

**in vitro** Outside the organism, or in an artificial environment. Applied for example to cells, tissues or organs cultured in glass or plastic containers.

**in vitro embryo production** (Abbreviation: IVEP). The combination of ovum pickup, *in vitro* maturation of ova, and *in vitro* fertilization. A potential means of overcoming the variability between donors in number of ova collected in embryo-transfer programmes.

**in vitro fertilization** (Abbreviation: IVF). A widely used technique in human and animal science, whereby the egg is fertilized with sperm outside the body before re-implanting into the uterus.

**in vitro maturation** (Abbreviation: IVM). Culture of immature ova in the laboratory, usually until they are ready for *in vitro* fertilization.

**in vitro mutagenesis** See: directed mutagenesis.

**in vitro transcription** The cell-free synthesis from DNA of RNA in the test tube. *Synonym:* cell-free transcription.


**in vivo** The natural conditions in which organisms reside. Refers to biological processes that take place within a living organism or cell under normal conditions.

**in vivo gene therapy** The delivery of a gene or genes to a tissue or organ of a complete living individual to alleviate a genetic disorder.

**inactivated agent** A virus, bacterium or other organism that has been treated to prevent it from causing a disease. See: attenuated vaccine.

**inbred line** The product of *inbreeding*, i.e. the intercrossing of individuals that have ancestors in common. In plants and laboratory animals, it refers to populations resulting from at least 6 generations of selfing or 20 generations of brother-sister mating, so that they have become, for all practical purposes, completely homozygous. In farm animals, the term is sometimes used to describe populations that have resulted from several generations of the mating of close relatives, without having reached complete homozygosity.

**inbreeding** Matings between individuals that have one or more ancestors in common, the extreme condition being self-fertilization, which occurs naturally in many plants and some primitive animals. *Synonym:* endogamy.

**inbreeding depression** The reduction in vigour over generations of *inbreeding*. This affects species which are normally outbreeding and highly heterozygous. See: hybrid vigour.
inclusion body A protein that is overproduced in a recombinant bacterium and forms a crystalline structure inside the bacterial cell.

incompatibility 1. Genetically or physiologically determined prevention of intermating. 2. A physiological interaction resulting in graft rejection or failure. 3. A function of a related group of plasmids. Incompatible plasmids share similar replication functions, and this leads to the exclusion of one or the other plasmid if they are present in the same cell. Plasmids belonging to one incompatibility group are very closely related.

incompatibility group Plasmids must belong to different incompatibility groups to co-exist within the same cell. A plasmid cloning vector should always belong to an incompatibility group different from that of the host bacterium's endogenous plasmids.

incomplete digest See: partial digest.

incomplete dominance A gene action in which heterozygotes have a phenotype that is different from either homozygote, and is usually intermediate between them.

incomplete penetrance Where the phenotype does not allow perfect prediction of the genotype as a result of interference in gene expression by the environment.

incubation 1. The hatching of eggs by means of heat, either natural or artificial. 2. Period between infection and appearance of symptoms induced by a pathogen. 3. The culture of cells and organisms.

incubator An apparatus in which environmental conditions (light, photoperiod, temperature, humidity, etc.) are fully controlled; used for hatching eggs, multiplying micro-organisms, culturing plants, etc.

indehiscent Describing a fruit or fruiting body that does not open to release its seeds or spores when ripe.

independent assortment The random distribution during meiosis of alleles (at different genes) to the gametes that is the case when the genes in question are located on different chromosomes or are unlinked on the same chromosome. See: linkage.

indeterminate growth The condition in which the terminal bud persists and produces successive lateral branches over an indefinite period. Opposite: determinate growth.

indirect embryogenesis Plant embryo formation on callus tissues derived from explants, including zygotic or somatic embryos and seedlings. Opposite: direct embryogenesis.

indirect organogenesis Plant organ formation on callus tissues derived from explants. Opposite: direct organogenesis.

inducer A low-molecular-weight compound or a physical agent that associates with a repressor protein to produce a complex that can no longer bind to the operator. Thus, the presence of the inducer turns on the expression of the gene(s) controlled by the operator.

inducible A gene or gene product whose transcription or synthesis is increased by exposure of the cells to an inducer or to a condition, e.g. heat. Opposite: constitutive.

inducible enzyme An enzyme that is synthesized only in the presence of the substrate that acts as an inducer.
**inducible gene** A gene that is expressed only in the presence of a specific metabolite, the inducer.

**inducible promoter** The activation of a promoter in response to either the presence of a particular compound, i.e., the inducer, or to a defined external condition, e.g., elevated temperature.

**induction** The act or process of causing some specific effect to occur; for example the transcription of a specific gene or operon, or the production of a protein by an organism after it is exposed to a specific stimulus.

**induction media** 1. Media used to induce the formation of organs or other structures. 2. Media causing variation or mutation in the tissues exposed to it.

**inembryonation** See: artificial inembryonation.

**infection** The successful colonization of any living organism by a pathogen.

**infectious agent** Synonym of pathogen.

**infiltrate** The entry of liquid into pores or other spaces.

**inflorescence** The flowers of a plant, and the way those flowers are arranged.

**inheritance** The transmission of genes and phenotypes from generation to generation.

**inhibitor** 1. Any substance or object that retards a chemical reaction. 2. A metabolite or modifier gene that interferes with a reaction or with the expression of another gene.

**initial** Cells in a meristem that remain permanently capable of differentiation, and which develop into tissues of particular structure and function.

**initiation** Causing something to start. 1. Early steps or stages of a tissue culture process. 2. Early stages of biosynthesis.

**initiation codon** See: start codon.

**initiation factor** Soluble protein required for the initiation of translation.

**inoculate** Deliberately introduce, in contrast to contamination. 1. In bacteriology, tissue culture, etc., placing an inoculum into (or onto) medium to initiate a culture. 2. In immunology, to carry out immunization. 3. In plant pathology, application of pathogen spores etc. on to plants under conditions where infection should result in the absence of resistance.

**inoculation cabinet** Small room or cabinet for inoculation (of tissue or micro-organism cultures) operations, often with a current of sterile air to carry contaminants away from the work area.

**inoculum** (pl.: inocula) 1. A small piece of tissue cut from callus, or an explant from a tissue or organ, or a small amount of cell material from a suspension culture, transferred into fresh medium for continued growth of the culture. See: minimum inoculum size. 2. Microbial spores or parts (such as mycelium). 3. Vaccine.
inorganic compound Historically, chemicals that could not be derived from living processes. In modern usage, chemicals that do not contain carbon, although carbonates and a few other simple carbon compounds are generally regarded as inorganic.

inositol A cyclic acid (hexahydroxycyclohexane) that is a constituent of certain cell phosphoglycerides. It is a nutrient frequently referred to as a "vitamin" in plant tissue culture. Also acts as a growth factor in some animals and micro-organisms.

inositol lipid A membrane-anchored phospholipid that transduces hormonal signals by stimulating the release of any of several chemical messengers.

insecticide A substance that kills insects.

insert 1. To incorporate a DNA molecule into a cloning vector; also used as a noun to describe such a DNA molecule. 2. To introduce a gene or gene construct into a new genomic site or into a new genome.

insertion element Generic term for DNA sequences found in bacteria capable of genome insertion. Postulated to be responsible for site-specific phage and plasmid integration. Synonym: insertion sequence.

insertion mutation Changes in the base sequence of a DNA molecule resulting from the random integration of DNA from another source. See: mutation.

insertion sequence See: insertion element.

insertion site 1. A unique restriction site in a vector DNA molecule into which foreign DNA can readily be inserted. This is achieved by treating both the vector and the insert with the relevant restriction endonuclease and then ligating the two different molecules, both having the same sticky ends. Synonym: cloning site. 2. The position of integration of a transposon.

instability A lack of consistent phenotype, usually as a result of uncontrolled genetic changes. These may be due to transposon activity, or in cell lines, to changes in karyotype.

insulin A peptide hormone secreted by the Langerhans islets of the pancreas, and that regulates the level of sugar in the blood.

integrating vector A vector that is designed to integrate cloned DNA into the host's chromosomal DNA.

integration The recombination process which inserts a small DNA molecule (usually by homologous recombination) into a larger one. If the molecules are circular, integration involves only a single crossing-over; if linear, then two crossings-over are required.

integration-excision region (Abbreviation: I/E). The portion of bacteriophage lambda (\(\delta\)) DNA that enables \(\delta\)-DNA to be inserted into a specific site in the \(E. coli\) bacteriophage lambda chromosome or excised from this site.

integument One of the layers that enclosed the ovule, and is the precursor of the seed coat.

intellectual property rights (Abbreviation: IPR). The legal framework, which includes patenting and plant variety protection, by which inventors control the commercial application of their work.
intensifying screen A plastic sheet impregnated with a rare-earth compound, such as calcium tungstate, which reacts to radiation by emitting light. When placed on one side of a piece of X-ray film with a radioactive sample on the other side, the intensifying screen will capture some of the radioactive energy which has passed through the film, exposing the X-ray film and so enhancing the sensitivity of the detection. Often used in Southern and northern blotting procedures.

intercalary 1. Meristematic tissue or growth not restricted to the apex of an organ, i.e. growth at nodes. 2. Referring to internal segments of a chromosomes (i.e. not at the ends).

intercalary growth A pattern of stem elongation typical of grasses. Elongation proceeds from the lower internodes to the upper internodes through the differentiation of meristematic tissue at the base of each internode.

intercalating agent A chemical capable of inserting between adjacent base pairs in a double-stranded nucleic acid. A prominent example is ethidium bromide.

intercellular space The pore space between cells, especially typical of leaf tissues.

interfascicular cambium Cambium that arises between vascular bundles.

interference The effect of one crossing over event in altering the probability of another crossing over event occurring at a nearby location. This probability can be either increased (positive interference) or decreased (negative interference), but the latter is the more usual.

interferon One of a group of small proteins synthesized by certain T cells of vertebrates, which inhibit virus replication. There are three types of interferon in humans. See cytokine.

intergeneric cross A hybrid made between parents belonging to two different genera.

intergenic regions Non-coding DNA located between genes; this comprises a variable but considerable proportion of all eukaryotic genomic DNA, and its function is largely unknown.

intergenic spacer (Abbreviation: IGS). Non-coding DNA separating tandemly arranged copies of a repeated gene sequence (typically ribosomal DNA). Of particular interest because, unlike the coding sequence itself, the spacers show high levels of interspecific sequence polymorphism, and are thus useful as assays for species identification.

interleukin A group of proteins that transmit signals between immune cells and are necessary for mounting normal immune responses. See cytokine.

internal guide sequence (Abbreviation: IGS). See guide sequence.

internal transcribed spacer (Abbreviation: ITS). Non-coding regions separating the individual components of the ribosomal DNA units. These regions show much more sequence polymorphism than the genic regions themselves, and therefore, like the intergenic spacers, are useful a source of genetic markers for the ribosomal DNA locus.

International Undertaking on Plant Genetic Resources The first comprehensive voluntary, international agreement (adopted in 1983) dealing with plant genetic resources for food and agriculture. Designed as an instrument to promote international harmony in matters regarding access to plant genetic resources for food and agriculture. Following extensive negotiations to revise the Undertaking in harmony with the Convention on Biological Diversity, the binding International Treaty on Plant Genetic Resources for Food and Agriculture was adopted by the 2001 FAO Conference.
International Treaty on Plant Genetic Resources for Food and Agriculture The international treaty resulting from the revision of the International Undertaking on Plant Genetic Resources was adopted by the 2001 FAO Conference as a binding international instrument to enter into force after ratification by 40 states. Its objectives are the conservation and sustainable use of plant genetic resources for food and agriculture and equitable sharing of the benefits of this use.

**internode** The region of a stem between two successive nodes.

**interphase** The stage in the cell cycle when the cell is not dividing and during part of which DNA replication occurs; it follows telophase of one mitotic division and extends to the beginning of prophase in the next division.

**intersex** Synonym of hermaphrodite.

**inter-simple sequence repeat** (Abbreviation: ISSR). A PCR-based molecular marker assay of genomic sequence lying between adjacent microsatellites. Primers carrying, at their 3'-end, sequence complementary to the repeat unit of the microsatellite will amplify this genomic DNA.

**interspecific cross** A hybrid made between parents belonging to two different species. See: intrageneric cross, intraspecific cross.

**intervening sequence** See: intron.

**intracellular** Occurring within a cell.

**intracytoplasmic sperm injection** (Abbreviation: ICSI). The micro-injection of a single sperm into the cytoplasm of a mature oocyte.

**intrageneric** Within a genus, such as an intrageneric cross, or intrageneric variation.

**intrageneric cross** A hybrid made between parents belonging to two species in the same genus. See: intraspecific cross, interspecific cross.

**intragenic complementation** Occurs when wild type phenotype is restored in an $F_1$ individual made by crossing two independent mutants, carrying different heteroalleles.

**intraspecific** Within a species, such as an intraspecific cross, or intraspecific variation.

**intraspecific cross** A hybrid made between parents belonging to the same species. See: intrageneric cross, interspecific cross.

**introgression** The introduction of new alleles or gene(s) into a population from an exotic source, usually another species. This is achieved by repeated backcrossing of the initial hybrid in order to eliminate all genetic changes except for the desired new gene(s).

**intron** A segment of the primary transcript of a eukaryotic gene, removed (before the mature mRNA is translated) in a process known as intron splicing. Some eukaryotic genes contain a large number of introns, which make up the bulk of the DNA sequence of the gene. Introns are also found in genes whose RNA transcripts are not translated, namely eukaryotic rRNA and tRNA genes. In these cases the intron sequence does not appear in the functional RNA molecule. Synonym: intervening sequence.

**invasiveness** The ability of a plant, particularly a weed, to spread beyond its presently established site, and become established in new locations.
**inversion**  A chromosome re-arrangement, which involves the re-orientation of a segment so that the order of a linear array of genes within it is reversed.

**inverted repeat** Two sequences of nucleotides occurring in one strand, where, relative to the first sequence, the second has complementary bases but in the inverted order. Under appropriate conditions this allows formation of a hairpin loop in the single strand. See: palindrome.

**ion channel** A protein integral to a cell membrane, through which selective ion transport occurs.

**IPR** Abbreviation for intellectual property rights.

**IPTG** Abbreviation for isopropyl-3-D-thiogalactopyranoside. A synthetic inducer of beta-galactosidase activity in many bacteria. Used in combination with the synthetic chromogenic substrate Xgal to differentiate recombinant from non-recombinant bacterial colonies in cloning strategies using plasmid vectors containing the lacZ gene: blue coloured colonies are produced when β-galactosidase activity is not disrupted by an insert; but when it is disrupted, the colonies are white. Hence white colonies are indicative of recombinant plasmids, and blue colonies of non-recombinant ones.

**irradiation** Illumination with electromagnetic radiation, typically of sufficiently high energy (low-wavelength UV or gamma, etc.) to disrupt biological macromolecules and hence induce mutations.

**IS element** Abbreviation for insertion sequence element. A short (800-1400 nucleotide pairs) DNA sequence found in bacteria that is capable of transposing to a new genomic location; DNA sequences contained within an IS element can be transposed along with the IS itself.

**isoallele** Multiple similar copies of a gene, usually located at independent positions in the genome, which encode similar gene products and produce the same, or a very similar phenotype. See: allele.

**isochromosome** A chromosome produced following an error in meiosis, in which the two arms are mirror images of each other. The presence of an isochromosome results in the duplication of all genes present on the originating chromosome arm.

**isodiametric** Commonly used to describe cells with equal diameters.

**iso-electric focusing gel** (Abbreviation: IEF gel). A variant of gel electrophoresis, in which macromolecules (usually proteins) are separated on the basis of differing iso-electric point, rather than on the basis of size.

**isoenzyme** See: isozyme.

**isoform** 1. A tissue-specific form of a protein. 2. Synonym of isoenzyme.

**isogamy** Fusion of gametes of similar size and structure.

**isogenic** A group of individuals that possesses the same genotype, irrespective of their being homozygous or heterozygous.

**isogenic stock** Strains of organisms that are genetically nearly identical, except with respect to identified genes. Generally produced by repeated backcrossing, or by transformation.
isolating mechanism The properties of an organism that prevent interbreeding (and therefore exchange of genetic material) between members of different species that inhabit the same geographical area.

isolation medium An optimum plant tissue culture medium suitable for explant survival, growth and development.

isomer 1. Structural isomers have the same chemical formula but different structures; e.g. leucine and isoleucine. 2. Stereoisomers are different topological forms of an otherwise single chemical structure, due to changes in bond configurations about some axis or plane of symmetry; eg, D- and L-glucose or cis- and trans-cinnamic acid.

isomerase Any of a class of enzymes that catalyse the re-arrangement of the atoms within a molecule, thereby converting one isomer into another.

iso-osmotic See: isotonic.

isotonic Solutions with the same osmotic potential, as a result of being of the same molar concentration. For protoplasts to avoid losing or gaining water, the medium they are suspended in must be isotonic with them. See: hypertonic, hypotonic, osmosis.

isotope One of two or more forms of an element that differ in the number of neutrons carried by the nucleus. Radioactive isotopes (radio-isotopes) are used as probes in many biochemical analyses.

isozyme A genetic variant of an enzyme. Isozymes for a given enzyme share the same function, but may differ in level of activity, as a result of minor differences in their amino acid sequence. Electrophoretic separation of isozymes has been used to distinguish between individuals and varieties.

ISSR Abbreviation for inter-simple sequence repeat.

ITS Abbreviation for internal transcribed spacer.

IVEP Abbreviation for in vitro embryo production.

IVF Abbreviation for in vitro fertilization.

IVM Abbreviation for in vitro maturation.

J See: joining segment.

Jiffy Pots made from wood pulp and peat, commonly used for transplanting tissue culture-derived plants into soil medium.

JIVET Abbreviation for juvenile in vitro embryo technology.

JIVT Abbreviation for juvenile in vitro embryo technology.

joining segment (Abbreviation: J). A small DNA segment that links genes in order to yield a functional gene encoding an immunoglobulin.

jumping gene See: transposable element.

jumping library See: chromosome jumping.
junk DNA See: repetitive DNA.

juvenile hormone A hormone secreted by insects from a pair of endocrine glands close to the brain. Its function is to inhibit metamorphosis so maintaining the larval features.

juvenile in vitro embryo technology (Abbreviation: JIVT or JIVET). A technology involving collection of immature eggs from young animals, their in vitro maturation and fertilization, and the transfer of the resultant embryos into recipient females. The method is designed to achieve rapid generation turnover.

juvenility Early phase of development in which an organism is incapable of sexual reproduction.

kanamycin An antibiotic of the aminoglycoside family that inhibits translation by binding to the ribosomes. Important as a substrate for selection of plant transformants.


kappa chain One of two classes of antibody light chains. The other is a lambda chain.

karyogamy The fusion of nuclei or nuclear material that occurs at fertilization during sexual reproduction.

karyogram A diagrammatic representation of the full chromosome set of a species, highlighting characteristic physical features of individual chromosomes.

karyokinesis The division of a cell nucleus. See: meiosis; mitosis.

karyotype The chromosome constitution of a cell, an individual, or of a related group of individuals, as defined both by the number and the morphology of the chromosomes, usually in mitotic metaphase; chromosomes arranged in order of length and according to position of centromere; also, the abbreviated formula for the chromosome constitution, such as 47, + 21 for human trisomy-21 (Down's syndrome).

kb Abbreviation for kilobase (of single-stranded nucleic acid).

kbp Abbreviation for kilobase pairs (of double-stranded DNA).

$k_{cat}$ The catalytic rate constant that characterizes an enzyme-catalysed reaction. The larger the $k_{cat}$ value, the faster the conversion of substrate into product.

$k_{cat}/K_m$ The catalytic efficiency of an enzyme-catalysed reaction. The greater the value of $k_{cat}/K_m$, the more rapidly and efficiently the substrate is converted into product.

$K_d$ Abbreviation for dissociation constant. Describes the strength of binding (or affinity) between molecules and their ligands. See: avidity.

kDa Abbreviation for kiloDalton. A unit of molecular mass equal to 1000 Dalton.

killer T cell T cells that kill cells displaying recognized antigens.

kilobase (Abbreviation: kb). A length of single-stranded nucleic acid composed of 1000 bases. One kilobase of single-stranded DNA has a mass of about 330 kiloDalton (exact mass depends on base composition).
kilobase pairs (Abbreviation: kbp). A length of double-stranded DNA composed of 1000 base pairs.

kinase An enzyme that catalyses the transfer of a phosphate group from a high energy state (as in ATP) to another molecule.

kinetics Dynamic processes involving motion. Often used as a suffix to indicate studies involving movement or rates of reactions. See: pharmacokinetics, enzyme kinetics

kinetin A cytokinin.

kinetochore Structure at the centromere of eukaryotic chromosomes. The kinetochore consists of inner and outer electron dense plates and a central zone containing repetitive DNA elements. Kinetochores are involved in the control of chromosome movement in cell division.

kinetosone Granular cytoplasmic structure which forms the base of a cilium or flagellum. Synonym: basal body.

kinin A substance promoting cell division. In plant systems, the prefix cyto- has been added (cytokinin) to distinguish it from kinin in animal systems.

Klenow fragment A truncated form of DNA polymerase I from E. coli, used extensively for the production of synthetic DNA molecules as it retains polymerase and 3'-exonuclease activities, but not 5'-exonuclease activity.

$K_m$ A dissociation constant that characterizes the binding of an enzyme to a substrate. The smaller the value of $K_m$, the tighter the binding of the enzyme to the substrate. Also called the Michaelis constant.

knockout A mutant individual, in which a single functional gene has been replaced by a non-functional form of the gene. Used to understand gene function via the comparison of the phenotypes of wild type and knockouts.

label A compound or atom that is attached to, or incorporated into, another molecule in order to allow detection of the latter's presence. Commonly, labels exploit radioactivity, fluorescence or antigenicity. Synonym: tag.

labelling The process of attaching or inserting a label into a molecule. Most often in the context of nucleic acids or proteins.

lac repressor-lac promoter system See: IPTG.

lactose A disaccharide sugar produced in milk, composed of one unit each of glucose and galactose.

lag phase 1. The state of apparent inactivity preceding a response to a treatment; also called a latent phase. 2. The initial growth phase, during which cell number remains relatively constant, prior to the onset of rapid cell division.

lagging strand The strand of DNA that is synthesized discontinuously during replication (because DNA synthesis can proceed only in the 5'→3' direction). See: Okazaki fragment.

lambda chain One of two classes of antibody light chains. The other is a kappa chain.
**lambda phage** A bacteriophage that infects *E. coli*, commonly used as a cloning vector. See: integration-excision region.

**lamella** A structure, plate or vesicle that is formed by two membranes lying parallel to each other.

**lamina** Blade or expanded part of a leaf.

**laminar air-flow cabinet** Cabinet designed for cell or tissue culture manipulations requiring a sterile environment. Achieved by a continuous, non-turbulent flow of filter-sterilized air over the working area. *Synonym:* laminar air-flow hood.

**laminarin** A storage polysaccharide of the brown algae.

**lampbrush chromosome** Large diplotene chromosomes present in oocyte nuclei, and particularly conspicuous in amphibians. These chromosomes have extended regions called loops, which are active sites of transcription. See: diplonema.

**landrace** In plant genetic resources, an early, cultivated form of a crop species, evolved from a wild population, and generally composed of a heterogeneous mixture of genotypes.

**latent agent** A pathogen, usually a virus, present in a host organism without producing any symptoms.

**latent bud** An inactive bud not held back by rest or dormant period, but which may start growth if stimulated.

**latent phase** See: lag phase.

**lateral bud** See: axillary bud.

**lateral meristem** A meristem giving rise to secondary plant tissues, such as the vascular and cork cambia.

**lawn** A uniform and uninterrupted layer of bacterial growth, typically on agar medium, in which individual colonies cannot be observed.

**layering** A technique for vegetative propagation, in which new plants produce adventitious roots before being severed from the parent plant.

**LCR** Abbreviation for ligase chain reaction.

**LD₅₀** Abbreviation for lethal dose₅₀%. The amount of a substance required to kill 50% of the test population. The higher the LD₅₀, the lower the toxicity of the chemical in that specific test.

**lead compound** A chemical that has demonstrated promising biological activity in preliminary assays.

**leader peptide** See: signal sequence.

**leader sequence** A variable length sequence of nucleotides at the 5' end of an mRNA molecule that precedes the AUG initiation codon where translation begins and is not itself translated into protein.

**leading strand** The strand of DNA that is synthesized continuously during replication.
leaf blade The usually flattened portion of the leaf.

leaf bud cutting A cutting that includes a short section of stem with attached leaf.

leaf margin The edge of a leaf.

leaf primordium A lateral outgrowth from the apical meristem, which will become a leaf when fully developed and expanded.

leaf roll A symptom of some virus diseases, characterized by curling of the leaves. Can also occur as a response to water stress.

leaf scar Mark left on a stem after leaf abscission.

leaflet Expanded leaf-like part of a compound leaf.

leaky mutant A mutant in which the gene product still retains some biological activity.

lectin A group of plant proteins that can bind to specific oligosaccharides on the surface of cells, causing the cells to clump together.

leptonema Stage in meiosis immediately preceding synapsis and post DNA replication, in which the chromosomes appear as single, fine, threadlike structures.

leptotene (adj.) See: leptonema.

lethal allele A mutant form of a gene that, in the homozygous state, is fatal.

lethal gene See: lethal allele.

lethal mutation See: lethal allele.

leukocyte White blood cell, up to 0.02 mm in diameter, of which there are normally 4-11 million per millilitre of human blood. There are several kinds, all involved in the body’s defence mechanisms. Granulocytes have granules in their cytoplasm; monocytes ingest and feed on bacteria and other micro-organisms that cause infection; lymphocytes include the B cells that are involved with the production of antibodies.

library A collection of cells, usually bacteria or yeast, that have been transformed with recombinant vectors carrying DNA derived from an unrelated organism. See: cDNA library, expression library, genomic library.

life cycle The sequence of events from a given developmental stage in one generation to the same stage in the following generation. In sexually reproduced organisms, the starting point is the fusion of gametes to form the zygote.

ligand A small molecule (e.g. activators, substrates and inhibitors of enzyme activity) bound to a protein by non-covalent forces; an ion or a molecule that binds to another chemical entity to form a larger complex.

ligase See: DNA ligase.
**ligase chain reaction** (Abbreviation: LCR). A technique for the detection and **amplification** of target DNA sequences. Two **oligonucleotides** are synthesized which between them are **complementary** to the entire target sequence, one to the 5'-side and one to the 3'-side. If the target sequence is present in the DNA sample under examination, the oligonucleotides will bind to it with their ends abutting in the centre, and a heat-stable ligase will join them into a complete polynucleotide. No ligation occurs if the target sequence is absent or if the match between synthetic oligonucleotides and target sequence is imperfect in the region where they abut. At a high temperature, the new **polynucleotide** dissociates from the original DNA template, and upon cooling, it and the original DNA serve as templates for a second cycle of hybridization, ligation and thermal dissociation. At each cycle there is a doubling of the number of new complete polynucleotides.

**ligate, ligation** The joining of two linear **double-stranded DNA** fragments by the formation of phosphodiester bonds.

**lignification** The thickening and strengthening of a plant cell wall with lignin.

**lignin** A group of high-molecular-weight amorphous polymers of phenylpropanoid compounds, giving strength to certain tissues. A major component of wood.

**lignocellulose** The combination of lignin, hemicellulose and cellulose that forms the structural framework of plant cell walls.

**LINE** Abbreviation for **long interspersed nuclear element**.

**lineage** A group of individuals, related by common descent, e.g. an in vitro cell line derived from a single cell.

**linear phase** The growth phase during cell culture when cell number increases arithmetically. The linear phase follows a period of exponential growth.

**linearized vector** A covalently closed circular DNA vector (typically a plasmid) which has been opened by restriction digestion to convert it to a linear molecule. In molecular cloning, DNA to be cloned is mixed with the linearized vector, and treated with ligase to join and recircularize the resulting hybrid molecule.

**linkage** The tendency of a set of genes to be inherited together more often than would be expected if they were assorting independently. exists between two genes when they are located sufficiently close to one another on the same chromosome that a proportion of gametes is produced without crossing-over occurring between them.

**linkage disequilibrium** See: gametic phase disequilibrium.

**linkage equilibrium** See: gametic phase equilibrium.

**linkage map** A linear or circular diagram that shows the relative positions of genes on a chromosome as determined by recombination fraction. See: genetic map.

**linked gene, linked marker** A gene or marker that is linked to another gene or marker.

**linker** A synthetic double-stranded oligonucleotide that carries the recognition sequence for one or more restriction endonucleases. The ligation of a linker to each end of a DNA fragment facilitates the preparation of the fragment for cloning into a vector. See: polylinker.
lipase A class of enzymes which break down lipids into their component fatty acids and glycerol. Lipases used in biotechnology are generally digestive, with a role in the breakdown of fats in food into their components, so that these can be used to make other materials.

lipid Any of a group of fats or fat-like compounds insoluble in water and soluble in fat solvents.

lipofection Delivery into eukaryotic cells of DNA, RNA or other compounds that have been encapsulated in liposomes.

lipopolysaccharide (Abbreviation: LPS). A compound containing lipid bound to a polysaccharide; often a component of microbial cells walls.

liposome A synthetic microscopic spherical structure consisting of a phospholipid bilayer membrane containing a user-defined aqueous solution. Liposomes can be used to transport relatively toxic drugs into diseased cells, where they can exert their maximum effect. DNA molecules may be entrapped in, or bound to the surface of, the vesicles, and subsequent fusion of the liposome with the cell membrane will deliver the DNA into the cell. Liposomes have been used to develop an efficient transfection procedure for Streptomyces bacteria.

liquefaction Enzymatic digestion (often by alpha-amylase) of gelatinized starch to form lower molecular weight polysaccharides.

liquid medium Culture solution, without a solidifying agent, for in vitro cell growth.

liquid membrane Thin films made up of liquids (as opposed to solids) which are stable in another liquid (usually water). Thus the liquid must not dissolve in the water, but nevertheless must be prevented from collapsing into small droplets.

liquid nitrogen Nitrogen gas condensed to a liquid with a boiling point of about -196 °C. Commonly used as a medium for long-term storage of biological materials. See: cryopreservation.

litmus paper A pH indicator paper. It turns red in acidic and blue in alkaline solutions.

live recombinant vaccine A vaccine created by the expression of a pathogen antigen in a non-pathogenic organism.

live vaccine A living, non-virulent form of a pathogenic micro-organism or virus used to elicit an antibody response for the protection against infection by a virulent form of the same pathogen.

living modified organism (Abbreviation: LMO). “Living organism that possess a novel combination of genetic material obtained through the use of modern biotechnology” (Convention on Biological Diversity). Synonym of GMO, but restricted to organisms that can endanger biological diversity.

LMO Abbreviation for living modified organism

locus (pl.: loci) A site on a chromosome.

lod score The logarithm of the odds of linkage between two loci. Used to measure the statistical support for linkage.
logarithmic phase The growth phase in cell culture, during which cell number doubles every 20-30 minutes. Synonym: exponential phase.

log phase Abbreviation for logarithmic phase.

long interspersed nuclear element (Abbreviation: LINE). Families of common DNA elements, of average length 6.5 kb, which are dispersed at numerous locations within the genome. The human genome contains over 500,000 LINEs (representing ca. 16% of the genome). They appear to represent degenerate copies of transposable elements. See: SINE.

long template A DNA strand, synthesized during PCR, which has a primer sequence at one end but is extended beyond the site that is complementary to the second primer at the other end.

long terminal repeat (Abbreviation: LTR). A characteristic sequence of nucleotides that occurs at each end of a retrovirus element that has become integrated into the host genome. Involved in the integration process.

long-day plant Plants requiring a period of short nights before the switch from vegetative to reproductive growth can be initiated. See: Short-day plant.

loop bioreactor Fermenters in which material is cycled between a bulk tank and a smaller tank or loop of pipes. The circulation helps to mix the materials and to ensure that gas injected into the fermenter is well distributed in the liquid. Particularly useful for photosynthetic fermentations, where the photosynthesizing organisms are passed through a system of many small transparent pipes, which allow the access of light.

LPS Abbreviation for lipopolysaccharide.

LTR Abbreviation for long terminal repeat.

luteinizing hormone A pituitary hormone which causes growth of the yellow body of the ovary and also stimulates activity of the interstitial cells of the testis.

luxury consumption Nutrient absorption by an organism in excess of that required for optimum growth and productivity.

lyase Any of a class of enzymes that catalyse either the cleavage of a double bond and the addition of new groups to a substrate, or the formation of a double bond.

lymphocyte White blood cells that are important components of the immune system of vertebrates. See: B cell, T cell.

lymphokine Generic name for proteins that are released by lymphocytes to act on other cells involved in the immune response. The term includes interleukins and interferons. A sub-class of cytokines. See: monokine.

lymphoma Cancer originating in the lymph nodes, spleen and other lympho-reticular sites.

lyophilize See: freeze-drying.

lysis The destruction or breakage of cells either by viruses or by chemical or physical treatment.

lysogen A bacterial cell whose chromosome contains integrated bacteriophage DNA.
lysogenic Bacteria or bacteriophages undergoing lysogeny.

lysogenic bacterium Bacterium harbouring temperate (non-virulent, lysogenic) bacteriophages.

lysogeny A condition in which a bacteriophage genome (pro-phage) survives within a host bacterium, either as part of the host chromosome or as part of an extrachromosomal element, and does not initiate lysis.

lysosome A membrane-bound sac within the cytoplasm of animal cells that contains enzymes responsible for the digestion of material in food vacuoles, the dissolution of foreign particles entering the cell and, on the death of the cell, the breaking down of all cell structures. The digestive system of the cell.

lysozyme A naturally occurring enzyme extracted from egg white protein and other animal and plant sources, which attacks the cell wall of gram-positive bacteria leading to cell lysis and death.

lytic A phase of the virus life cycle during which the virus replicates within the host cell, releasing a new generation of viruses when the infected cell undergoes lysis.

lytic cycle The steps in viral production that lead to cell lysis.

M13 A single-stranded DNA bacteriophage used as a vector for DNA sequencing.

M13 strand The single-stranded DNA molecule that is present in the infective form of bacteriophage M13.

MAAP Abbreviation for multiple arbitrary amplicon profiling.

mAb Abbreviation for monoclonal antibody.

macerate To disintegrate tissue to disrupt cells. Commonly achieved via mechanical shearing, plasmolysis or enzymatic cell wall degradation.

macromolecule Any high molecular weight molecule. Often used as a synonym for polymers.

macronutrient A major chemical element essential for normal growth and development. In tissue culture media, macronutrients are those required in concentrations above 0.5 millimole/litre.

macrophage Large white blood cells that ingest foreign substances and display on their surfaces antigens which are recognized by other cells of the immune system.

macropropagation Production of plant clones from growing parts.

macropore See: megaspore.

mad cow disease Colloquial term for bovine spongiform encephalopathy. See proteinaceous infectious particle

MADS box A highly conserved DNA sequence motif found in a large family of transcription factors, most of which play important roles in developmental processes. Most prominently, the MADS box genes known in flowering plants are intimately involved in the control of flower morphogenesis.
magenta A type of plastic container frequently used for plant micropropagation and tissue culture.

major histocompatibility antigen A cell-surface protein or glycoprotein that allows the immune system to distinguish foreign or "non-self" from "self". A better term is histoglobulin. These are the antigens that must be matched between donors and recipients during organ and tissue transplants to prevent rejection.

major histocompatibility complex (Abbreviation: MHC). The large cluster of genes that encode the major histocompatibility antigens in mammals.

malt extract A mixture of organic compounds prepared from malt, used as a culture medium additive.

malting Enzymatic reduction of starch to sugars in germinating grain, used in brewing.

mammary gland The milk-producing organ of female mammals.

management of farm animal genetic resources The sum total of technical, policy and logistical operations involved in understanding (characterization), using and developing (utilization), maintaining (conservation), accessing, and sharing the benefits of animal genetic resources.

mannitol A sugar alcohol widely distributed in plants. Commonly used as a nutrient and osmoticum in suspension media for plant protoplasts.

mannose A hexose component of many polysaccharides, occasionally used as a carbohydrate source in plant tissue culture media.

map 1. verb: to determine the relative positions of loci (genes or DNA sequences) on a chromosome. Linkage maps are obtained from the frequency of recombination between loci. Physical maps are obtained commonly by the use of in situ hybridization of cloned DNA fragments to metaphase chromosomes, or by somatic-cell hybrids or radiation hybrids. 2. noun: a diagram showing the relative position of, and distances between, loci on a chromosome.

map distance The standard measure of genetic distance between loci, expressed in centiMorgans (cM) or map units. Estimated from recombination fraction via a mapping function. For small recombination fractions, map distance in cM equals the recombination fraction in %.

map unit One centiMorgan (1 cM) See: map distance; crossing-over unit.

mapping The construction of a localized (around a gene), or broad-based (whole genome) genetic map. More generally, determining the location of a locus (gene or genetic marker) on a chromosome.

mapping function A mathematical expression relating observed recombination fraction to map distance.

mariculture See: aquaculture.

marker An identifiable DNA sequence that is inherited in Mendelian fashion, and which facilitates the study of inheritance of a trait or a linked gene.
marker gene  A gene of known function or known location, used for **marker-assisted selection** or genetic studies.

marker peptide  A portion of **fusion protein** that facilitates its identification or purification.

**marker-assisted introgression**  The use of **DNA** markers to increase the speed and efficiency of **introgression** of a new allele(s) or gene(s) into a breeding population. The markers will be closely linked to the **gene(s)** in question.

**marker-assisted selection** (Abbreviation: MAS). The use of **DNA** markers to improve response to selection in a population. The markers will be closely linked to one or more target loci, which may often be **quantitative trait loci**.

**MAS**  Abbreviation for **marker-assisted selection**.

**mass selection**  As practised in plant and animal breeding, the selection of a number of individuals, on the basis of their individual **phenotypes**, to interbreed to form the next generation.

**maternal effect**  An effect attributable to a genetic contribution of the female parent of the individual being evaluated.

**maternal inheritance**  Inheritance controlled by non-nuclear genes (e.g. **mitochondria**, **chloroplast**) that are transmitted only through the female line.

**matric potential**  A **water potential** component, always of negative value, resulting from the presence of solid (often finely divided) surfaces; primarily responsible for water uptake by a dry **seed** prior to germination.

**maturation**  The formation of gametes or spores.

**MCS**  Abbreviation for **multiple cloning site**. See: **polylinker**.

**MDA**  Abbreviation for multiple drop array. See: **microdroplet array**.

**mean**  In statistics, the arithmetic average; the sum of all measurements or values in a sample divided by the sample size.

**media**  See: **culture medium**; **medium**.

**median**  In a set of measurements, the central value above and below which there are an equal number of measurements.

**medium**  (pl.: media) 1. In plant tissue culture, a term for the liquid or solid formulation upon which plant cells, tissues or organs develop. See: **culture medium**. 2. In general terms, a **substrate** for plant growth, such as nutrient solution, soil, sand, etc., e.g. potting medium.

**medium formulation**  In tissue culture, the particular constituents for the culture medium, commonly comprising macro- and micro-elements, **vitamins**, plant **hormones**, and a **carbohydrate** source. Some formulations are very specific to the kind of **explant** or plant species that can be maintained; some are very general.

**mega yeast artificial chromosome**  A **yeast artificial chromosome** (YAC) which can carry particularly large inserts (up to 1Mbp) - standard YACs typically carry inserts of up to 500kbp.
megabase (Abbreviation: Mb). A length of DNA consisting of $10^6$ bases.

megabase cloning The cloning of large DNA fragments of the order of 1Mb.

megaDalton (Abbreviation: MDa). One megaDalton is equal to $10^6$ Daltons.

megagametophyte The female gametophyte; the plant that develops from a megaspore.

megaspore The female gametophyte in heterosporous plants. Synonym: macrospore.

meiosis The two-stage process in sexual reproduction by which the chromosome number is reduced from the somatic to the haploid number. The first division, in which homologous chromosomes pair and exchange genetic material, is followed by amitotic division. The nucleus divides twice, but the chromosomes only once, generating haploid nuclei, which develop into the gametes (egg and sperm in animals; egg and s in plants).

meiotic analysis The use of patterns of chromosome pairing at meiotic prophase and metaphase to detect relationships between chromosomes, from which can be deduced the relationship between the parents of the organism studied.

meiotic drive Any mechanism that causes a particular allele or chromosome to be over-represented in a population of gametes.

meiotic product See: gamete.

melanin Dark pigment, produced by specialized epidermal cells called melanocytes.

melting temperature (Abbreviation: $T_m$). The temperature at which a double-stranded DNA molecule denatures into separate single strands. $T_m$ is determined by the length of the molecule and its base composition. DNAs rich in G:C base pairs have higher $T_m$ than A:T rich DNA, because since three hydrogen bonds are formed between G and C, but only two between A and T.

membrane bioreactor A vessel in which cells are cultured on or behind a permeable membrane, which allows the diffusion of nutrients to the cells, but retains the cells themselves. A variation is the hollow-fibre reactor.

memory cell Long-lived B cells and T cells that mediate rapid secondary immune responses to a previously encountered antigen.

Mendel's Laws Two laws summarizing Gregor Mendel's theory of inheritance. The Law of Segregation states that each hereditary characteristic is controlled by two 'factors' (now called alleles), which segregate and pass into separate germ cells. The Law of Independent Assortment states that pairs of 'factors' segregate independently of each other when germ cells are formed. See: independent assortment; linkage.

Mendelian population A natural, interbreeding unit of sexually reproducing plants or animals sharing a common gene pool.

Mendelian segregation Occurs when alleles are inherited according to Mendel's Laws.

mericlinal Refers to a chimera with tissue of one genotype partly surrounded by that of another genotype.

mericloning A propagation method using shoot tips in culture to proliferate multiple buds, which can then be separated, rooted and planted out.
**meristele** The branch of a **stele** supplying the leaf.

**meristem** Undifferentiated but determined plant tissue, in which the cells are capable of active division and **differentiation** into specialized tissues such as shoots and roots.

**meristem culture** A tissue culture containing meristematic dome tissue without adjacent leaf **primordia** or stem tissue. The term may also imply the culture of meristemoidal regions of plants, or meristematic growth in culture.

**meristem tip** An **explant** comprising the **meristem** (meristematic dome) and usually one pair of leaf **primordia**. Also refers to explants originating from **apical meristem** tip or lateral or axillary meristem tip.

**meristem tip culture** Cultures derived from **meristem** tip **explants**. Used widely to achieve **virus** elimination and axillary shoot proliferation, less commonly for callus production.

**meristemoid** A localized group of **callus** cells, characterized by their accumulation of starch, **RNA** and **protein**, and giving rise to **adventitious** shoots or roots.

**merozygote** Partial **zygote** produced by a process of partial genetic exchange, such as **transformation** in bacteria.

**mesh bioreactor** See: **filter bioreactor**.

**mesoderm** The middle germ layer that forms in the early animal **embryo** and gives rise to parts such as bone and connective tissue.

**mesophile** A micro-organism able to grow in the temperature range 20-50 °C; optimal growth often occurs at about 37 °C. See: **psychrophile**, **thermophile**.

**mesophyll** Leaf parenchyma **tissue** found between epidermal layers.

**messenger RNA** Abbreviation: **mRNA**.

**metabolic cell** A cell that is not dividing. See: **metabolism**

**metabolism** The biochemical processes whereby nutritive material is converted to living matter, or aids in building living matter, or by which complex substances and food are broken down into simple substances.

**metabolite** A low-molecular-weight biological compound that is usually synthesized enzymically.

**metabolomics** The large-scale study of the full complement of **secondary metabolites** produced by a given species in all its tissues and growth stages.

**metacentric chromosome** A chromosome in which the **centromere** is located in the middle and, consequently, the chromosome arms are of about equal length.

**metal affinity chromatography** A chromatographic technique, in which a compound interacting with a specific metal ion can be captured by immobilizing the relevant ion on the column's solid matrix.

**metalloenzyme** An enzyme which requires the presence of a metal in order to be catalytically active.
metallothionein A protective protein that binds heavy metals such as cadmium and lead.

metaphase Stage of mitosis or meiosis (following prophase and preceding anaphase) during which the chromosomes, or at least the kinetochores, lie in the central plane of the spindle. The stage of maximum chromosome condensation, at which karyotypes are generally described. In the first division of meiosis, metaphase represents the stage at which meiotic analysis is generally performed.

metastasis The spread of cancer cells to previously unaffected organs.

methylation The addition of a methyl group (-CH₃) to a molecule, most commonly in the context of DNA where cytosine and, less often, adenine residues can be modified in this way, sometimes resulting in a change in transcription. See: epigenetic variation.

MHC Abbreviation for major histocompatibility complex.

Michaelis constant See: $K_m$.

microalgal culture Culture in bioreactors of microalgae (including seaweeds).

micro-array A large set of cloned DNA molecules immobilized as a compact and orderly pattern of sub-microlitre spots onto a solid matrix (typically a glass slide). Used to analyse patterns of gene expression, presence of markers, or nucleotide sequence. The major advantage of micro-arrays is the extent to which the process of genotyping can be automated, thereby enabling large numbers of individuals to be simultaneously genotyped at many loci. A similar approach may be used with other immobilized components for other purposes. Synonym: chip or DNA chip. See: somatic cell hybrid panel, radiation hybrid cell panel.

microbe See: micro-organism.

microbial mat Layered microbial populations, usually growing on the surface of a solid medium or on a membrane.

microbody A frequently spherical cellular organelle, bound by a single membrane, 20-60 nm in diameter, and containing a variety of enzymes.

micro-carrier Small particles used as a support material for (particularly mammalian) cells, which are too fragile to be pumped and stirred as bacterial cells are in a large-scale culture.

microdroplet array (Abbreviation: MDA). A technique used to simultaneously evaluate large numbers of media modifications, employing small quantities of medium into which are placed small numbers of cells or protoplasts. These form a monolayer at the droplet meniscus and can easily be examined. Synonyms: multiple drop array, hanging droplet technique.

micro-element A nutritional element required in very small quantities.

micro-encapsulation A process of enclosing a substance in very small sealed capsules from which material is released by heat, solution or other means.

micro-environment A small-scale environment in which the conditions (temperature, humidity, pH etc.) are distinct; typically used in connection with the surroundings of a living object.

microfibril Microscopic fibres visible only at the high magnification of the electron microscope.
microgametophyte See: pollen.

micrograft See: shoot-tip graft.

micro-injection The introduction of small amounts of (usually) liquid material (DNA, RNA, enzymes, cytotoxic agents) into a defined tissue or single cell with a fine, microscopic needle.

micro-isolating system Mechanical separation of single cells or protoplasts thus allowing them to proliferate individually.

micronucleus A nucleus, distinct from and smaller than the main nucleus, but lying within the same cell. They usually arise following abnormal meiotic or mitotic telophases, where individual chromosomes or chromosome fragments do not reach the pole.

micronutrient An essential element normally required in cell culture at concentrations under 0.5 millimole/litre.

micro-organism Organism visible only under magnification.

microplast Vesicle produced by subdivision and fragmentation of protoplasts or thin-walled cells.

microprojectile bombardment See: biolistics.

micropropagation Miniaturized in vitro multiplication and/or regeneration of plant material under aseptic and controlled environmental conditions.

micropyle 1. A small opening in the surface of a plant ovule through which the pollen tube passes prior to fertilization. 2. A small pore in some animal cells or tissues.

microsatellite A segment of DNA characterized by a variable number of copies (typically 5-50) of a sequence of around 5 or fewer bases (called a repeat unit). At any one locus (genomic site), there are usually several different "alleles" in a population, each allele identifiable according to the number of repeat units. This existence of multiple alleles (high level of polymorphism) has enabled microsatellites to be developed as powerful markers in many different species. They are detected by the polymerase chain reaction.

microspore The immature male gametophyte in seed plants; the haploid male cell that ripens into a pollen grain.

microtuber Miniature tuber, produced in tissue culture, which is readily regenerable into a normal tuberous plant.

microtubule Self-assembling components of the cytoskeleton. Microtubules are cylindrical protein polymers, interconnected by cross-bridging proteins, which structurally and dynamically organize functional activities in living cells. They form the spindle during mitosis.

middle lamella A thin exclusively plant membrane separating two adjacent protoplasts and remaining as a distinct cementing layer between adjacent cell walls.

mid-parent value The average of the phenotypic measure, with respect to a given trait, of the two parents used to generate the population being analysed.
**mineralization** The conversion of organic compounds into inorganic (mineral) ones. For example, the conversion of ethanol into carbon dioxide and water.

**minimum effective cell density** The cell density below which reproducible cell growth fails. The minimum density is determined by both the source function of the tissue (species, explant, cell line) and by the culture phase of the initial inoculum.

**minimum inoculum size** The critical volume of inoculum required to initiate culture growth, due to the diffusive loss of cell materials into the medium. The subsequent culture growth cycle is dependent on the inoculum size, which is determined by the volume of medium and size of the culture vessel.

**mini-prep** A small-scale preparation of plasmid or phage DNA. Used to purify cloned DNA from the DNA of the vector.

**minisatellite** A form of variable number tandem repeats in which the repeat unit size ranges from 10-100 bp. Used for DNA fingerprinting following Southern hybridization. Generally concentrated at the ends of chromosomes and in regions with a high frequency of recombination.

**minituber** Small tubers (5-15 mm in diameter) formed on shoot cultures or cuttings of tuber-forming crops, such as potato.

**mismatch** The occurrence of a non-complementary pairs of bases in a double helix of DNA, e.g. A:C, G:T.

**mismatch repair** A DNA repair process that corrects mismatched base pairs.

**missense mutation** A mutation that changes a codon for one amino acid into a codon specifying another amino acid.

**mist propagation** Application of fine droplets of water to maintain humidity around plantlets or cuttings, which have not yet developed effective roots.

**mite** Free-living and parasitic arachnids. Infestation of plant crops reduces yield through the destruction of leaf tissue. Also can infest plant tissue culture work areas, contaminating culture vessels, thereby spreading bacteria and fungi.

**mitochondrial DNA** (Abbreviation: mtDNA). A circular DNA found in mitochondria. In mammals, mtDNA makes up less than 1% of the total DNA, but in plants the amount is variable. It encodes rRNA and tRNA and some mitochondrial proteins (up to 30 in animals).

**mitochondrion** (pl.: mitochondria) Organelle possessing its own DNA which appear in all eukaryotic cells (and never in prokaryotic cells) and produce adenosine triphosphate as an energy source for the cell via oxidative phosphorylation. Mitochondria contain many enzymes of the respiratory cycle, although most of these proteins are nuclear encoded.

**mitogen** A substance that can cause cells to initiate mitosis.

**mitosis** Splitting of replicated chromosomes, and the division of the cytoplasm to produce two genetically identical daughter cells. On the basis of the appearance of the chromosomes, it is separated into five stages: interphase, prophase, metaphase, anaphase and telophase.

**mixed bud** A bud containing both rudimentary leaves and flowers.
mixoploid Groups of cells with variable (a mix of euploid, aneuploid, polyploid) chromosome numbers.

mobilization 1. The transfer between bacteria of a non-conjugative plasmid by a conjugative plasmid. 2. The transfer between bacteria of chromosomal genes by a conjugative plasmid.

mobilizing function The genes on a plasmid that give it the ability to facilitate the transfer of either a non-conjugative or a conjugative plasmid from one bacterium to another.

mode In a frequency distribution, the class having the greatest frequency.

model 1. A mathematical description of a biological phenomenon. 2. A simplified biological system used to test hypotheses (e.g. Arabidopsis thaliana as a model plant).

modern biotechnology The application of:

a. In vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (DNA) and direct injection of nucleic acid into cells or organelles, or

b. Fusion of cells beyond the taxonomic family,

that overcome natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection (Convention on Biological Diversity).

modification Enzymatic attachment of one or more chemical groups to a macromolecule, affecting its biological activity or properties. See: methylation, glycosylation, phosphorylation.

modifying gene A gene that affects the expression of some other gene.

MOET Abbreviation for multiple ovulation and embryo transfer.

molecular biology The study of living processes at the molecular level.

molecular chaperone See: chaperone.

molecular cloning The biological amplification of a DNA sequence via the mitotic division of a host cell into which it has been transformed or transfected. See: cloning.

molecular genetics The study of the expression, regulation and inheritance of genes at the level of DNA and its transcription products.

molecular marker A genetic marker which is assayed at the DNA level.

molecular pharming See: biopharming.

molecule The stable union of two or more atoms; some organic molecules contain very large numbers of atoms.

monoclonal antibody (Abbreviation: mAb). An antibody, produced by a hybridoma, directed against a single antigenic determinant of an antigen.

monocot Abbreviation for monocotyledon.
monocotyledon (Abbreviation: monocot). A flowering plant whose embryo has one cotyledon. Examples are cereals (corn, wheat, rice etc.), banana, and lily.

monoculture The agricultural practice of cultivating a single crop over a whole farm or area.

monoecious A plant species that has separate male and female flowers on the same plant (e.g. maize).

monogastric animal A non-ruminant animal with a simple stomach.

monogenic Trait controlled by a single gene. Opposite: multigenic, polygenic.

monohybrid Heterozygous with respect to one gene.

monohybrid cross A cross between parents differing in only one trait or in which only one trait is being considered.

monokine Generic name for proteins that are released by monocytes to act on other cells involved in the immune response. A sub-class of cytokines.

monolayer A single layer of cells growing on a surface.

monolignols The building blocks of lignin that undergo polymerization.

monomer A small molecule (in the biological sciences typically individual amino acids, nucleotides or monosaccharides) that can combine with identical or similar others to form a larger, more complex molecule called a polymer.

monomorphic Absence of variation for a marker, gene, chromosome, or genetically determined trait in a population.

monophyletic A group of organisms that are assumed to have originated from the same ancestor.

monoploid See: haploid.

monosaccharide A simple sugar (e.g. glucose, fructose). See: disaccharide, polysaccharide.

monosomic A form of aneuploidy in which a diploid organism lacks one member of a homologous chromosome pair.

mono-unsaturates Oils containing mono-unsaturated fatty acids (i.e. where one -CH₂-CH₂-group in the hydrocarbon chain is replaced by -CH=CH-).

monozygotic twin One of a pair of twins derived from a single fertilized egg. Synonym: identical twin.

morphogen A substance that stimulates the development of form or structure in an organism.

morphogenesis The development, through growth and differentiation, of form and structure in an organism.

morphogenic response The effect on the developmental history of a plant or its parts exposed to a given set of growth conditions or to a change in the environment.
**morphology** Shape, form, external structure or arrangement.

**mosaic** An organism or part of an organism that is composed of cells with different origin.

**mother plant** See: donor plant.

**motif** A **conserved sequence** of nucleotides or amino acids that can be associated with some function of, respectively, a length of **DNA** or a **protein**.

**movable genetic element** See: transposon.

**mRNA** Abbreviation for messenger RNA. The RNA molecule resulting from transcription of a **protein**-encoding gene, following any splicing (1). The information encoded in the mRNA molecule is translated into a gene product by the ribosomes.

**MRU** Abbreviation for minimum recognition units. See: dAb.

**mtDNA** Abbreviation for mitochondrial DNA.

**multi-copy** Describing plasmids which replicate to produce many copies per host bacterial cell.

**multigene family** A set of genes (not necessarily mapping to the same genomic location) that are related in nucleotide sequence and/or that produce polypeptides with similar amino acid sequences. Sequence similarity does not always result in functional similarity.

**multigenic** Trait controlled by several genes, as opposed to **monogenic**. *Synonym*: polygenic.

**multi-locus probe** A DNA sequence that hybridizes to a number of different genomic sites.

**multimer** A protein made up of more than one polypeptide chain.

**multiple alleles** The existence of more than two alleles at a locus in a population.

**multiple arbitrary amplicon profiling** A collective term for a number of related polymerase chain reaction techniques, all of which use arbitrary primers, and which generate a number of distinct amplification products. See: random amplified polymorphic DNA.

**multiple cloning site** (Abbreviation: MCS). See: polylinker.


**multiple ovulation and embryo transfer** (Abbreviation: MOET). A technology by which a single female that usually produces only one or two offspring can produce a litter of offspring. Involves stimulation of a female to shed large numbers of ova; natural mating or artificial insemination; collection of fertilized ova (either surgically, or non-surgically through the cervix); and transfer (usually non-surgical, through the cervix) of these fertilized ova to recipient females.

**multiplex** 1. The simultaneous amplification of a number of amplicons in a single polymerase chain reaction, achieved by including more than one set of primers in the reaction mix. 2. The inheritance pattern of alleles in autopolyploids. See: quadruplex.

**multivalent vaccine** A vaccine designed to elicit an immune response either to more than one infectious agent or to several different antigenic determinants of a single agent.
mutable gene A gene which has an unusually high rate of mutation.

mutagen An agent or process capable of inducing mutations (e.g. irradiation, alkylating agents).

mutagenesis Induction of heritable change(s) in the genetic constitution of a cell through alterations to its DNA.

mutant An organism or an allele bearing a mutation. Usually applied when a characteristic change in phenotype can be recognized.

mutation Any change in the genome with respect to a defined wild type. Can occur at the level of ploidy, karyotype, or nucleotide sequence. Most of the latter mutations are silent (i.e. cannot be associated with any change in phenotype), either because the DNA sequence affected is in the non-coding part of the genome, or because the specific change does not alter the function of a coding sequence. See: back mutation, single nucleotide polymorphism.

mutation pressure A constant mutation rate that adds mutant genes to a population; repeated occurrences of mutations in a population.

mutualism See: symbiosis.

mycelium (pl.: mycelia) Threadlike filament making up the vegetative portion of thallus fungi.

mycoprotein Fungal protein.

mycorrhiza Fungi that form an association with, or have a symbiotic relationship with roots of more developed plants.

mycotoxin Toxic substance of fungal origin, e.g. aflatoxin.

myeloma A plasma cell cancer.

myo inositol See: inositol.

naked bud A bud not protected by bud scales.

narrow-host-range plasmid A plasmid that can replicate in one, or at most a few, different bacterial species.

narrow-sense heritability The proportion of the phenotypic variance that is due to variation in breeding values; the proportion of the phenotypic variance that is due to additive genetic variance.

native protein The naturally occurring form of a protein.

natural selection The differential survival and reproduction of organisms because of differences in characteristics that affect their ability to utilize environmental resources.

necrosis Death of tissue evidenced by discoloration, dehydration and loss of organization.

negative autogenous regulation Inhibition of the expression of a gene or set of coordinately regulated genes by the product of the gene or the product of one of the genes. Synonym: negative self-regulation.
negative control system A mechanism by which a regulatory protein is required to turn off gene expression.

negative selection Selection against individuals possessing a certain character. Opposite: positive selection.

negative self-regulation See: negative autogenous regulation.

nematode Slender, unsegmented worms, often parasitic. Also known as eelworm, especially when phytoparasitic.

neo-formation See: organogenesis.

neomycin phosphotransferase II (Abbreviation: npt-II). An enzyme which detoxifies the antibiotic neomycin, used as a marker gene to select for successfully transformed cells in plant transgenesis. See: neo.

neoplasia Localized cell multiplication, forming a tumour. Generally the result of genetic transformation. Neoplastic cells differ in structure and function from the original cell type.

neoteny The retention of juvenile body characters in the adult state, or the occurrence of adult characters in the juvenile state.

net photosynthesis Photosynthetic activity minus respiratory activity, measured by the net absorption of carbon dioxide.

neutral mutation A mutation that changes the nucleotide sequence of a gene, but has no observable effect on the fitness of the organism.

neutral theory The theory that much of evolution has been primarily due to random drift of neutral mutations.

neutrophil A type of leukocyte involved in the early inflammatory response.

NFT Abbreviation for nutrient film technique.

nick To break (or a break in) a phosphodiester bond in one of the strands of a double-stranded DNA molecule.

nick translation A procedure for labelling DNA by treating a fragment with DNase to produce single-stranded nicks followed by excision of a nucleotide and repair of the gaps with radiolabelled nucleotide.

nicked circle During the extraction of plasmid DNA from a bacterial cell, one strand of the DNA often becomes nicked. This relaxes the torsional strain which normally ensures a supercoiled structure. Synonym: relaxed circle.

nif gene cluster Group of bacterial genes responsible for the biological fixation of atmospheric nitrogen.

nitrate The form of nitrogen that can be used directly by plants; a major component of inorganic fertilizers.
nitrification The natural process in which nitrogen in plant and animal wastes is oxidized, first to nitrates and then to nitrates, through the action of soil-borne microbes.

nitrocellulose A derivative of cellulose, which has the property of binding to many biological macromolecules, in particular DNA, RNA and protein. Filters made from nitrocellulose are commonly used in Southern and northern blotting experiments. Synonym: cellulose nitrate

nitrogen assimilation The incorporation of nitrogen into the cells of living organisms.

nitrogen fixation The conversion of atmospheric nitrogen gas to oxidized forms that can be assimilated by plants, particularly by blue-green algae and some genera of bacteria (e.g. *Rhizobium* spp.; *Azotobacter* spp.). An important source of nitrogen in unfertilized soils. See: nif gene cluster.

nitrogenous base The purines (adenine and guanine) and pyrimidines (cytosine, and thymine or uracil) that are present in DNA and RNA.

NO Abbreviation for nucleolar organizer.

*nod* box A DNA sequence that controls the transcriptional regulation of *Rhizobium* nodulation genes.

nodal culture The culture of a lateral bud and a section of adjacent stem tissue.

node Slightly swollen structure on the stem, where leaves and buds arise and where branches originate. Stems have nodes but roots do not.

nodular Term commonly used to describe the pebbly (rough) texture of a callus.

nodulation The formation of nodules on the roots of legumes following colonization by symbiotic nitrogen-fixing bacteria.

nodule Swollen globular structures formed on the roots of legumes, containing the nitrogen-fixing bacteria.

non repetitive DNA/RNA A nucleotide sequence which does not include a significant proportion of repetitive sequences of nucleotides.

non-additive genetic variation The proportion of the total genetic variation in a population that does not respond to simple mass selection and that causes specific pairwise crosses to depart from performance values predicted by the breeding values of the parents.

non-autonomous A term referring to biological units that cannot function by themselves; such units require the assistance of another unit, or "helper". Opposite: autonomous.

non-coding strand See: antisense DNA.

non-disjunction Failure of separation of homologous chromosomes or chromatids in mitosis or meiosis, resulting in too many chromosomes in some daughter cells and too few in others.

non-histone chromosomal protein In chromosomes, all of the proteins except the histones.
nonsense mutation A mutation which converts an amino-acid-specifying codon into a stop codon, e.g. a single base change from UAU to UAG generates the premature termination of the polypeptide chain at the position where a tyrosine was incorporated in the wild type.

non-target organism An organism which is affected by a treatment (e.g. pesticide application) for which it was not the intended recipient.

non-template strand The non-transcribed strand of DNA. Synonyms: sense strand, coding strand

non-virulent agent See: attenuated vaccine.

NOR Abbreviation for nucleolar organizer region.

northern blot A technique analogous to Southern blotting, but involving the transfer of RNA from an agarose gel to a membrane, prior to probing.

npt-II Abbreviation for neomycin phosphotransferase II.

nucellar embryo An embryo which has developed vegetatively from somatic tissue surrounding the embryo sac, rather than by fertilization of the egg cell.

nucellus Tissue forming the major part of the young ovule in which the embryo sac develops; Also known as megasporangium.

nuclear transfer A technology by which novel animals are generated by cloning a single diploid somatic cell. It involves inserting a single diploid cell from a culture of cells into an enucleated ovum. The resultant diploid ovum develops into an embryo that is placed in a recipient female, which gives birth to the cloned animal in the normal manner. Note that the term is somewhat of a misnomer, since it is a whole cell that is transferred, not just the nucleus.

nuclease A class of largely bacterial enzymes that degrade DNA or RNA molecules by catalysing the cleavage of the phosphodiester bonds that link adjacent nucleotides. For deoxyribonuclease (DNAse) the substrate is DNA, for ribonuclease (RNAse) the substrate is RNA, and for S1 nuclease, the substrate is single-stranded DNA or RNA. Endonucleases cleave at internal sites in the substrate molecule, while exonucleases progressively cleave from the end of the substrate molecule. Nucleases have varying degrees of base-sequence specificity, the most specific being the restriction endonucleases.

nucleic acid A macromolecule consisting of polymerized nucleotides. Two forms are found, DNA and RNA. Nucleic acids may be linear or circularized, and single- or double-stranded. See: helix.

nucleic acid probe See: DNA probe.

nuclein The term used by Friedrich Miescher to describe the nuclear material he discovered in 1869, which today is known as DNA.

nucleo-cytoplasmic ratio In a cell, the ratio of nuclear to cytoplasmic volume. This ratio is high in meristematic cells and low in differentiated cells.

nucleolar organizer (Abbreviation: NO). See: nucleolar organizer region.
nucleolar organizer region (Abbreviation: NOR). A chromosomal segment containing a large array of genes that encode ribosomal RNA; located at the secondary constriction of specific chromosomes.

nucleolus An RNA-rich nuclear organelle in the nucleus of eukaryotic cells, produced by a nucleolar organizer. It represents the storage place for ribosomes and ribosome precursors. The nucleolus consists primarily of ribosomal precursor RNA, ribosomal RNA, their associated proteins, and some, perhaps all, of the enzymatic equipment (RNA polymerase, RNA methylase, RNA cleavage enzymes) required for synthesis, conversion and assembly of ribosomes. Subsequently the ribosomes are transported to the cytoplasm.

nucleoplasm The non-staining or slightly chromophilic, liquid or semi-liquid, ground substance of the interphase nucleus and which fills the nuclear space around the chromosomes and the nucleoli. Little is known of the chemical composition of this ground substance, which is not easily defined. Sometimes called "karyoplasm" when it is gel-like, and "karyolymph" when it is a colloidal fluid.

nucleoprotein Conjugated protein composed of nucleic acid and protein; the material of which the chromosomes are made.

nucleoside A base (purine or pyrimidine) that is covalently linked to a 5-carbon (pentose) sugar. When the sugar is ribose, the nucleoside is a ribonucleoside; when it is 2-deoxyribose, the nucleoside is a deoxyribonucleoside. See: nucleotide.

nucleoside analogue A synthetic molecule that resembles a naturally occurring nucleoside.

nucleosome Spherical sub-units of eukaryotic chromatin that are composed of a core particle consisting of an octamer of histones (two molecules each of histones H2a, H2b, H3 and H4) and 146 bp of DNA.

nucleotide A nucleoside with one or more phosphate groups linked at the 3'- or 5'-hydroxyl of a pentose sugar. When the sugar is ribose, the nucleotide is a ribonucleotide; when it is 2-deoxyribose, the nucleotide is a deoxyribonucleotide. RNA and DNA are polymers of, respectively, ribonucleoside 5'-monophosphates and deoxyribonucleoside 5'-monophosphates. Nucleotides containing the bases adenine, guanine and cytosine (A, G, C) occur in both DNA and RNA; thymine (T) occurs only in DNA, and uracil (U) only in RNA. Ribonucleoside mono-, di-, and triphosphates for which a specific base is not assigned are abbreviated NMP, NDP, and NTP, while deoxyribonucleoside mono-, di-, and triphosphates are abbreviated dNMP, dNDP, and dNTP. Otherwise, the "N" is replaced by the base letter abbreviation. See: base pair.

nucleotide sequence See: sequence.

nucleus A dense protoplasmic membrane-bound region of a eukaryotic cell that contains the chromosomes, separated from the cytoplasm by a membrane; present in all eukaryotic cells except mature sieve-tube elements and red blood cells.

null allele An allele which produces no functional gene product.

null mutation See: amorph.

nullisomic (Adj.) See: nullisomy.

nullisomy An otherwise diploid cell or organism lacking both members of a homologous chromosome pair.
nurse culture Culturing cells from a suspension culture on a raft of filter paper above a callus tissue piece (nurse tissue). The filter paper serves to prevent tissue union but allows the flow of essential substances from the nurse to the isolated cells.

nutriceutical A conventional food product that has been modified (potentially by genetic engineering) to have improved nutritional characteristics and/or pharmaceutical properties.

nutrient cycle The passage of a nutrient or element through an ecosystem, including its assimilation and release by various organisms and its transformation into various organic or inorganic chemical forms.

nutrient deficiency Absence or insufficiency of an essential factor for normal growth and development.

nutrient film technique (Abbreviation: NFT). A hydroponic technique used to grow plants. NFT delivers a thin film of water or nutrient solution either continuously or through on-off cycles.

nutrient gradient A diffusion gradient of nutrients and gases that develops in tissues where only a portion of the tissue is in contact with the medium. Gradients are less likely to form in liquid media than in callus cultures.

nutrient medium (pl.: nutrient media) A solid, semi-solid or liquid formulation for in vitro cell or tissue growth.

ochre stop codon See: stop codon.

cryptic root. An organism, or a tissue whose cells contain eight haploid sets of chromosomes.

do power. The generic term for a group of female sex hormones which control the development of sexual characteristics and control oestrous.

oestrogen The generic term for a group of female sex hormones which control the development of sexual characteristics and control oestrous. AlterNAtive spelling: estrogen.

oestrous (adj.) See: oestrous.

oestrous cycle The cycle of reproductive activity shown by most sexually mature non-pregnant female mammals. AlterNAtive spelling: estrous.

oestrus In female mammals, the period of sexual excitement and acceptance of the male. Synonyms: rut, heat. AlterNAtive spelling: estrus (adj.: oestrous).

offset Young plant produced at the base of a mature plant.

offshoot Short, usually horizontal, stem produced near the crown of a plant.

offspring New individuals resulting from sexual or asexual reproduction. Synonym: progeny.

Okazaki fragment Replicated DNA fragments formed on the lagging strand in DNA synthesis from a double-stranded template. The fragments are subsequently joined together by DNA ligase. See: primosome.

OLA Abbreviation for oligonucleotide ligation assay.

oligomer A molecule formed by the covalent joining of a small (undefined) number of monomers. See: polymer.
oligonucleotide A nucleotide oligomer. Often synthesized for use as primers for in vitro DNA synthesis. See: polymerase chain reaction.

oligonucleotide ligation assay (Abbreviation: OLA). A diagnostic technique for determining the presence or absence of a single nucleotide polymorphism within a target DNA sequence, often indicating whether the gene is wild type (normal) or mutant (usually defective).

oligonucleotide-directed mutagenesis See: site-specific mutagenesis.

oligonucleotide-directed site-specific mutagenesis See: site-specific mutagenesis.

oligosaccharide Carbohydrate consisting of several linked monosaccharide units.

oncogene A gene that causes cells to grow in an uncontrolled (i.e. tumourous) manner. Oncogenes are mutant forms of normal functional genes (called proto-oncogenes) that have a role in regulating cell proliferation. See: cellular oncogene; dominant oncogene; immortalizing oncogene; recessive oncogene, p53 gene.

oncogenesis The progression of cytological, genetic and cellular changes that culminate in the development of a tumour.

onco-mouse A mouse that has been genetically modified to incorporate an oncogene, which acts as an animal model for studies of human cancer.

ontogeny Developmental life history of an organism.

oocyte The egg mother cell; it undergoes two meiotic divisions (oogenesis) to form the egg cell. The primary oocyte refers to the state before completion of the first meiotic division; the secondary oocyte after completion of the first meiotic division.

oogenesis The formation and growth of the egg in an animal ovary.

oogonium 1. A germ cell of the female animal, that gives rise to oocytes by mitotic division. 2. The female sex organ of algae and fungi.

oosphere The non-motile female gamete in plants and some algae.

oospore A spore developing from a zygote of certain algae and fungi, following the fusion of heterogametes.

opal stop codon See: stop codon.

open continuous culture A continuous culture system, in which inflow of fresh medium is balanced by outflow of a corresponding volume of spent medium plus cells. In the steady state, the rate of cell wash-out equals the rate of formation of new cells in the system. See: continuous culture; batch culture; closed continuous culture.

open pollination Pollination by wind, insects or other natural mechanisms.

open reading frame (Abbreviation: ORF). A sequence of nucleotides in a DNA molecule that has the potential to encode a peptide or protein: comprises a start triplet (ATG), followed by a series of triplets (each of which encodes an amino acid), and ending with a stop codon (TAA, TAG or TGA). The term is generally applied to sequences of DNA fragments, for which no function has yet been determined. The number of ORFs provides an estimate of the number of genes transcribed from the DNA sequence.
**operational definition** An operation or procedure that can be carried out to define or delimit something.

**operator** The region of DNA that is **upstream** from a **gene** or genes and to which one or more regulatory **proteins** (repressor or activator) bind to control the expression of the gene(s).

**operon** A functionally integrated genetic unit for the control of **gene expression** in bacteria. It consists of one or more genes that **encode** one or more **polypeptide(s)** and the adjacent site (**promoter** and **operator**) that controls their expression by regulating the **transcription** of the structural genes.

**opine** The condensation product of an **amino acid** with either a keto-acid or a sugar, produced by the plant host as a result of *Agrobacterium* infection, and used exclusively by the *Agrobacterium* as a carbon source for growth and reproduction within the plant.

**OPU** Abbreviation for **ovum pickup**.

**ORF** Abbreviation for **open reading frame**.

**organ** A tissue or group of **tissues** that constitute a morphologically and functionally distinct part of an organism.

**organ culture** The **aseptic** culture of complete living organs of animals and plants outside the body in a suitable **culture medium**. Animal organs must be small enough to allow the nutrients in the culture medium to penetrate all the cells.

**organellar gene** Genes located on organelles outside the nucleus.

**organelle** A membrane-bounded specialized region within a cell, such as the **mitochondrion** or dictyosome, that carries out a specialized function in the life of a cell.

**organic complex** A chemically undefined compound added to nutrient **media** to stimulate growth, e.g. coconut milk; malt extract; **yeast** extract; **casein** hydrolysate.

**organic evolution** See: **evolution**.

**organism** An individual living system, such as animal, plant or micro-organism, that is capable of reproduction, growth and maintenance.

**organized growth** The development under **tissue culture** conditions of organized **explants** (meristem tips or shoot tips, floral buds or organ primordia). **Opposite**: unorganized growth.

**organized tissue** Composed of normally differentiated cells.

**organogenesis** The initiation of **adventitious** or **de novo** shoots or roots from **callus**, **meristem** or suspension cultures. **See**: micropropagation; regeneration.

**organoid** An organ-like structure produced in culture.

**organoleptic** Having an effect on one of the organs of sense, such as taste or smell.

**origin of replication** The **nucleotide** position on a **DNA** sequence from which **DNA** synthesis (replication) is initiated.

**orphan gene** A gene or **DNA sequence** whose function is not known.
**orphan receptor** A receptor for which a cellular function or **ligand** has yet to be identified.

**ortet** The plant from which a **clone** is obtained. *Synonym: donor plant.*

**orthologous** Homologous genes/gene products that have evolved divergently *between* species; many rice genes have orthologues in other cereal genomes, because of the common ancestry of cereal species. *See: paralogous.*

**osmosis** Diffusion of water across a **semi-permeable** membrane from zones of low solute concentration to zones of higher solute concentration.

**osmotic potential** Change in the energy state of solvent brought about by dissolving a substance in the solvent - water in the biological sciences. The potential of aqueous solutions is always negative compared to pure water. Solvent flows from higher to lower osmotic potential solutions by **diffusion** or **osmosis**.

**osmoticum** A chemical agent (e.g. polyethylene glycol, mannitol, glucose or sucrose) employed to maintain the **osmotic potential** of a nutrient medium equivalent to that of the cultured cells, i.e. the medium and the cells are **isotonic**. Because of this osmotic equilibrium, cells are not damaged *in vitro*.

**outbreeding** A mating system characterized by the inter-breeding of genetically unrelated or dissimilar individuals. Since **genetic diversity** tends to be enhanced, and vigour or **fitness** of individuals increased by this process, it is often used to counter the detrimental effects of continuous inbreeding. *Synonym: exogamy.*

**outflow** The volume of growing cells that is removed from a **bioreactor** during a **continuous fermentation** process.

**ovary** 1. Enlarged basal portion of the **pistil** of a plant flower that contains the **ovules**. 2. The reproduction **organ** in female animals in which eggs are produced.

**overdominance** Where **heterozygote** performance is superior to that of either parental **genotype**.

**overhang** See: **extension**.

**overlapping reading frame** Start **codons** in different **reading frames** generate different **polypeptides** from the same **DNA** sequence.

**ovulation** The release of mammalian egg(s) from the ovary.

**ovule** The part of the **seed** plant’s reproductive organs that comprises the **nucellus**, the **embryo sac** and the integuments.

**ovum** (pl.: ova) Egg.

**ovum pickup** (Abbreviation: OPU). The non-surgical collection of ova from a female.

**oxidative phosphorylation** The enzymatic addition of a phosphate to **ADP** to make **ATP**, coupled to electron transport from a **substrate** to molecular oxygen. A critical reaction for the generation of cellular energy.
oxygen-electrode-based sensor Sensor in which an oxygen electrode, which measures the amount of oxygen in a solution, is coated with a biological material such as an enzyme which generates or absorbs oxygen when the appropriate substrate is present. When the biological reaction takes place, the amount of oxygen close to the electrode changes and the signal from the electrode changes, thus signalling the concentration of substrate.

p Denotes the shorter of the two chromosome arms, e.g. human 14p is the short arm of human chromosome 14.

P element A Drosophila transposon.

P₁, P₂ Generational symbols for the two parents of a given individual.

p53 gene A human tumour-suppressor transcription factor gene, damage or mutation to which is believed to be responsible for up to 60% of all human cancer tumours. If, in spite of the presence of p53 protein, a cell begins to divide uncontrollably following damage to its DNA, the p53 gene acts to prevent tumours by triggering apoptosis.

pachynema A mid-prophase stage in the first meiotic division, between zygonema and diplonema. Chromosomes appear as long, paired threads. Occasionally all four chromatids can be recognized.

pachytene (adj.) See: pachynema.

packaging cell line A cell line designed to produce viral particles that do not contain nucleic acid. After transfection of these cells with a full-size viral genome, fully infective viral particles are assembled and released.

packed cell volume (Abbreviation: PCV). The proportion of a cell culture volume that is occupied by cells. Cell volume is determined by sedimenting using low speed centrifugation.

PAGE Abbreviation for polyacrylamide gel electrophoresis.

pairing The pairing of homologous chromosomes during the prophase of the first meiotic division. Pairing is the first prerequisite before crossing over and recombination can occur. Synonym: synapsis.

pair-rule gene A gene that influences the formation of body segments in Drosophila.

palaeontology The study of the fossil record of past geological periods and of the phylogenetic relationships between extinct and contemporary plant and animal species.

palindrome A segment of double-stranded DNA, in which the order of bases, read 5’?3’ in one strand, is the same as that in the complementary antiparallel strand, also read 5’?3’. If the sequence is written in the normal convention, on two lines with paired bases shown one above the other, the base order on one strand runs in the opposite direction to that on the complementary strand. They are often found at the ends of transposable elements, and recognition sites for type II restriction endonucleases are also palindromes. Synonym: inverted repeat.

palisade parenchyma Elongated cells found just beneath the upper epidermis of leaves, typically rich in chloroplasts.

pAMP Ampicillin-resistant plasmid.
**panicle** An inflorescence, the main axis of which is branched; the branches bear loose racemose flower clusters. Rice is a prominent crop plant with a panicle inflorescence.

**panicle culture** Aseptic culture of immature panicle explants to induce microspore germination and development.

**panmictic population** A population in which mating occurs at random.

**panmixis** Random mating in a population.

**paper raft technique** See: nurse culture.

**PAR** Abbreviation for photosynthetically active radiation.

**par gene** One of a class of genes required for faithful plasmid segregation at cell division. Initially, par loci were identified on plasmids, but have also been found on bacterial chromosomes.

**paracentric inversion** A chromosomal rearrangement in which a segment of chromosome, excluding the centromere, is rotated.

**paraffin [wax]** A translucent, white, solid hydrocarbon with a low melting point. One use is as an embedding medium to support tissue for sectioning for light microscopy observation.

**Parafilmä** A stretchable film based on paraffin wax; used to seal tubes and Petri dishes. Parafilmä is a proprietary name which is incorrectly applied colloquially to similar products.

**parahormone** A substance with hormone-like properties that is not a secretory product (e.g. ethylene; carbon dioxide).

**parallel evolution** The development of different organisms along similar evolutionary paths due to similar selection pressures acting on them.

**paralogous** Homologous genes/gene products that have duplicated and evolved divergently within a species. e.g. beta- and gamma-globulin genes

**parameter** A value or measurement that varies with circumstances, and is used as a reference to quantify a situation or a process.

**parasexual cycle** A sexual cycle involving changes in chromosome number but differing in time and place from the usual sexual cycle; occurring in those fungi in which the normal cycle is suppressed or apparently absent.

**parasexual hybridization** See: somatic hybridization.

**parasite** An organism deriving its food from the living body of another organism.

**parasitism** The close association of two or more dissimilar organisms, where the association is harmful to the host, but beneficial to the parasite.

**parasporal crystal** Tightly packaged insect pro-toxin molecules that are produced by strains of *Bacillus thuringiensis* during the formation of resting spores.

**paratope** Synonym for antibody binding site.
parenchyma 1. A plant tissue consisting of spherical, undifferentiated cells, frequently with air spaces between them. 2. Loose connective tissue formed by large cells.

parenchymatous (adj.) See: parenchyma.

parthenocarpy The development of fruit without fertilization.

parthenogenesis Production of an embryo from an unfertilized egg.

partial digest Incomplete reaction of a restriction enzyme with DNA, such that only a proportion of the target sites are cleaved. Partial digests are often performed to give an overlapping collection of DNA fragments for use in the construction of a gene bank. Synonym: incomplete digest. Opposite: complete digest.

particle radiation High energy nuclear emissions, used as physical agents of mutagenesis. Three major types typically used: alpha (positively charged), beta (negatively charged), or neutrons (uncharged).

parts per million (Abbreviation: ppm). Unit of concentration: 1ppm = 1mg dissolved matter per litre of solution.

parturition The process of giving birth.

passage The transfer or transplantation of cells from one culture medium to another.

passage number The number of times cells in culture have been sub-cultured.

passage time Time interval between successive sub-cultures.

passive immunity 1. Natural acquisition of antibodies by the foetus or neonate (newborn) from the mother. 2. The artificial introduction of specific antibodies by the injection of serum from an immune animal. In both cases, temporary protection is conferred on the recipient. See: immunization, immunoprophylaxis.

pat gene A gene obtained from Streptomyces sp. encoding resistance to glufosinate-ammonium containing herbicides. (These inhibit plant synthesis of glutamine). Used widely as a means of transgenically inducing herbicide resistance in crop plants. Synonym: bar gene.

patent A legal permission to hold exclusive right - for a defined period of time - to manufacture, use or sell an invention.

paternal Pertaining to the father.

pathogen A disease-causing organism (generally microbial: bacteria, fungi, viruses; but can extend to other organisms: e.g. nematodes etc.). Synonym: infectious agent. See: latent agent.

pathogenesis related protein (Abbreviation: PR protein). One of a group of proteins that are characteristically highly expressed as part of a plant’s response to pathogen attack. Many of these proteins are similarly expressed following infection with a broad range of pathogens, indicating their role in the hypersensitive response.

pathogen-free Uncontaminated with pathogen.
**pathotoxin** Substance secreted by certain **pathogens**, in order to attack the **host** tissue. Some pathotoxins are also toxic to non-hosts, especially animals or humans.

**pathovar** Strain of a plant-attacking bacterium or fungus that can be differentiated from others by their interaction with specific **host cultivars**.

**PBR** Abbreviation for **plant breeders' rights**.

**pBR322** One of the first **plasmids** used for cloning **DNA** in **E. coli**.

**PCR** Abbreviation for **polymerase chain reaction**.

**PCR-RFLP** Alternative term for **cleaved amplified polymorphic sequence**.

**PCV** Abbreviation for **packed cell volume**.

**pectin** A group of naturally occurring complex **polysaccharides**, containing galacturonic acid, found in **plant cell walls**, where their function is to cement cells together. Used as a thickening agent in solid **culture media** and as a food additive.

**pectinase** Enzyme catalysing the **hydrolysis** of **pectin**. Used in conjunction with **cellulase** to solubilize plant **cell walls**.

**pedicel** Stalk or **stem** of the individual flowers of an inflorescence.

**pedigree** The ancestry of an individual.

**peduncle** Stalk or **stem** of a flower that is born singly; the main stem of an inflorescence.

**PEG** Abbreviation for **polyethylene glycol**.

**penetrance** The proportion of individuals in a **population** that **express** the **phenotype** expected from their **genotype** with respect to a specific gene. Measures the extent to which phenotype predicts genotype.

**peptidase** An enzyme that catalyzes the **hydrolysis** of a **peptide** bond.

**peptide** A sequence of **amino acids** linked by **peptide bonds**; a breakdown or build-up unit in **protein** metabolism. Typically used to describe low molecular weight species. **See**: **polypeptide**.

**peptide bond** The chemical bond holding **amino acid** residues together in peptides and **proteins**. The (CO-NH) bond is formed by the condensation, with loss of a water molecule, between the carboxyl (-COOH) group of one amino acid and the amino (-NH₂) of the next amino acid.

**peptide expression library** A collection of **peptide** molecules, produced by **recombinant** cells, in which the **amino acid** sequences are varied.

**peptide nucleic acid** (abbreviation: PNA). A synthetic **oligonucleotide** analogue, in which the sugar backbone is replaced by a **peptide** chain, upon which the **nucleoside** residues are strung. **Probes** made from PNA appear to have greater **specificity** than those made from **DNA**.

**peptide vaccine** A short chain of amino acids that can induce antibodies against a specific **infectious agent**.
peptidyl transferase An enzyme bound tightly to the large sub-unit of the ribosome, that catalyses the formation of peptide bonds between amino acids during translation.

peptidyl-tRNA binding site (Abbreviation: P-site). The site on a ribosome that hosts the tRNA to which the next amino acid for the growing polypeptide chain is attached.

perennial A plant that flowers continuously for several years.

pericentric inversion A chromosomal rearrangement in which a segment of chromosome, including the centromere, is rotated.

periclinal The orientation of cell wall or plane of cell division parallel to the reference surface.

periclinal chimera 1. Genotypically or cytoplasmically different tissues arranged in concentric layers. 2. A chimera in which one or more layers of tissue derived from one graft member enclose the central tissue derived from the other member of the graft.

pericycle Region of the plant bounded externally by the endodermis and internally by the phloem. Most roots originate from the pericycle.

periplasm The space between the cell (cytoplasmic) membrane of a bacterium or fungus and the outer membrane or cell wall. Synonym: periplasmic space.

permanent wilting point (Abbreviation: PWP). The moisture content of a soil below which plants wilt to such an extent that they fail to recover even when fully watered.

permeable Referring to a membrane, cell or cell system through which small molecules can diffuse.

persistence Ability of an organism to remain in a particular setting for a period of time after it is introduced.

persistent Chemicals with a long inactivation or degradation time, such as some pesticides. Persistent substances can become dangerously concentrated in the tissues of organisms at the top end of a food chain.

PERV Abbreviation for porcine endogenous retrovirus.

pesticide A toxic chemical product that kills harmful organisms (e.g. insecticides, fungicide, weedicides, rodenticides).

petal One of the parts of the flower that make up the corolla.

petiole Stalk of leaf. See: pedicel; peduncle.

Petri dish Flat round glass or plastic dish with a matching lid, used for small-scale culturing of organisms, germinating seeds etc. Also referred to as plates, hence to plate a culture.

PFGE Abbreviation for pulsed-field gel electrophoresis.

PG Abbreviation for polygalacturonase.

pH Logarithmic measure of acidity/alkalinity of a solution. A pH of 7 is neutral (e.g. pure water), whereas below 7 is acid and above 7 is alkaline.
phage Abbreviation for bacteriophage.

phagemids Cloning vectors that contain components derived from both phage and plasmid DNA.

phagocytes Immune system cells that ingest and destroy viruses, bacteria, fungi and other foreign substances or cells.

phagocytosis The process by which foreign particles invading the body are engulfed and broken down by phagocytes.

pharmaceutical agent See: therapeutic agent.

pharmacokinetics The quantitative measurement of how drugs move around the body, and the processes which control their absorption, distribution, metabolism, and excretion.

phase change The developmental change from one maturation state to another.

phase state The coupling or repulsion of two linked genes.

PHB Abbreviation for polyhydroxybutyrate.

pH-electrode-based sensor Sensor in which a standard pH electrode is coated with a biological material. Many biological processes raise or lower pH, and the changes can be detected by the pH electrode.

phenocopy An environmentally induced, non hereditary variation in an organism, resembling a genetically determined trait.

phenolic oxidation Common aspect of the wound response in plants. Phenolic oxidation is often indicated by blackening of tissue and it may be a precursor to growth inhibition or, in severe cases, to tissue necrosis and death.

phenolics Compounds with hydroxyl group(s) attached to the benzene ring, forming esters, ethers and salts. Phenolic substances produced from newly explanted tissues are liable to oxidise, and as a result form coloured compounds visible in nutrient media.

phenotype The visible appearance of an individual (with respect to one or more traits) which reflects the reaction of a given genotype with a given environment.

pheromone A hormone-like substance that is secreted by an organism into the environment as a specific signal to another organism, usually of the same species.

phloem Specialized vascular plant tissue for the transport of assimilates (generally sugars) from the point of synthesis (in the leaf) to other parts of the plant. It consists of sieve tubes, companion cells, phloem parenchyma and fibres.

phosphatase An class of enzymes that catalyze the hydrolysis of esters of phosphoric acid, removing a phosphate group from an organic compound.

phosphodiester (phospho-diester) bond A bond in which a phosphate group joins adjacent carbons through ester linkages. A condensation reaction between adjacent nucleotides results in a phosphodiester bond between 3’ and 5’ carbons in DNA and RNA.

phospholipase A2 An enzyme which degrades type A2 phospholipids.
**phospholipid** A class of lipid molecules in which glycerol is linked to a phosphate group and two fatty acyl groups. Contains both polar and non-polar regions. A major component of biological membranes. See: **inositol lipid**.

**phosphorolysis** The cleavage of a bond by orthophosphate; analogous to **hydrolysis** referring to cleavage by water.

**phosphorylation** The addition of a phosphate group to a compound.

**photoautotroph** See: **autotroph, heterotroph**.

**photo-bioreactor** Bioreactor dependent on sunlight, which is taken up by its content of plant material, usually algae.

**photoheterotroph** See: **heterotroph**.

**photoperiod** The length of daylight or period of daily illumination provided for growth.

**photoperiodism** The photoperiod required by a plant to switch from the vegetative to the reproductive stage.

**photophosphorylation** The formation of ATP from ADP and inorganic phosphate using light energy harvested by photosynthesis.

**photoreactivation** A light dependent **DNA repair** process.

**photosynthate** The carbohydrates and other compounds produced in photosynthesis.

**photosynthesis** A chemical process by which green plants synthesize organic compounds from carbon dioxide and water in the presence of sunlight.

**photosynthetic** Able to use sunlight energy to convert atmospheric carbon dioxide into organic compounds. Nearly all plants, most algae and some bacteria are photosynthetic.

**photosynthetic efficiency** Efficiency of converting light energy into organic compounds.

**photosynthetic photon flux** (Abbreviation: PPF). A measure of the intensity of light utilized by plants for **photosynthetic** activity.

**photosynthetically active radiation** (Abbreviation: PAR). The part of the radiant energy that is capturable by natural **photosynthetic** systems (approximately equivalent to the natural light spectrum of wavelengths 400-700nm).

**phototropism** The tendency of plants to direct shoot growth towards the source of light.

**phylogeny** The deduced evolutionary history of related organisms.

**physical map** An indication of the separation, in bp, between pairs of linked loci. See: **mapping**.

**phyto-** (Prefix) To do with plants.

**phytochemical** Molecules characteristically found in plants.
**phytochrome** A pigment, found in the cytoplasm of green plants, which can exist in two forms Pr (biologically inactive) and Pfr (biologically active). Pfr is converted into Pr by exposure to light of wavelength 730 nm. Involved in the timing of many plant processes, e.g. dormancy, leaf formation, flowering and germination.

**phytohormone** A substance that stimulates growth or other processes in plants. Major species are auxins, abscisic acid, cytokinins, gibberellins and ethylene.

**phytokinin** See: cytokinin.

**phytoparasite** Parasite on plants.

**phytoparasitic** (adj.) See: phytoparasite.

**phytopathogen** A plant pathogen.

**phytoremediation** The use of plants actively to remove contaminants or pollutants from either soils (e.g. polluted fields) or water resources (e.g. polluted lakes). An example is the exploitation of the Brazil water hyacinth (*Eichhornia crassipes*) to accumulate in its tissues toxic metals such as lead, arsenic, cadmium, mercury, nickel, and copper.

**phytosanitary** Plant health, including quarantine.

**phytostat** Apparatus designed for the semi-continuous chemostatic culture of plant cells.

**phytosterol** One of a group of biologically active phytochemicals present in the seeds of certain plants. Evidence suggests that human consumption of certain phytosterols, such as â-sitosterol, can help to lower total serum cholesterol and low-density lipoproteins levels, thereby reducing the risk of coronary heart disease.

**pigment** Compounds that are coloured by the light they absorb. Light absorption is exploited by plants both as a means of energy capture (see: photosynthesis) and as a signalling mechanism (see: phytochrome).

**pinocytosis** The engulfing of a minute droplet of liquid by a living cell.

**pipette** Widely used device for accurate dispensing of small volumes of liquids.

**pistil** Central organ of the flower, typically consisting of ovary, style and stigma. Usually referred to as the female part of a perfect flower.

**plant breeders’ rights** (Abbreviation: PBR). Legal protection of a new plant variety granted to the breeder or his successor in title. The effect of PBR is that prior authorization is required before the material can be used for commercial purposes.

**plant cell culture** In vitro growth of plant cells.

**plant cell immobilization** Entrapment of plant cells in gel matrices so that they are protected from physical damage. The cells are suspended in liquified droplets which are then allowed to harden. Commonly used matrices are alginates, agar or polyacrylamide.

**plant genetic resources** (Abbreviation: PGR). The reproductive or vegetative propagating material of: 1. cultivated varieties (cultivars) in current use and newly developed varieties; 2. obsolete cultivars; 3. primitive cultivars (landraces); 4. wild and weed species, near relatives of cultivated varieties; and 5. special genetic stocks (including elite and current breeder’s lines and mutants).
**plant growth regulator** An organic compound, either natural or synthetic, and other than a nutrient, that modifies or controls one or more specific physiological processes within a plant.

**plant hormone** See: plant growth regulator.

**plant variety protection** (Abbreviation: PVP). Synonym for plant breeders’ rights.

**plant variety rights** See: plant breeders’ rights.

**plant antibody** An antibody expressed transgenically in an engineered plant.

**plantlet** A small rooted shoot regenerated from cell culture following embryogenesis or organogenesis. Plantlets can normally develop into normal plants when transplanted to soil.

**plaque** A clear spot on an otherwise opaque lawn of bacteria, where cells have been lysed by phage infection.

**plasma** The fluid portion of the blood in which is suspended the white and red blood cells. Contains 8-9% solids, of which 85% is composed of the proteins fibrinogen, albumin, and globulin. The essential function of plasma is the maintenance of blood pressure and the transport of nutrients and waste.

**plasma cells** Antibody-producing white blood cells derived from B lymphocytes.

**plasma membrane** See: plasmalemma.

**plasmalemma** The lipid bilayer and associated proteins and other molecules that surrounding the protoplast, within the cell wall. Synonyms: cell membrane; plasma membrane.

**plasmid** An circular self-replicating non-chromosomal DNA molecule found in many bacteria, capable of transfer between bacterial cells of the same species, and occasionally of different species. Antibiotic resistance genes are frequently located on plasmids. Plasmids are particularly important as vectors for genetic engineering.

**plasmodesma** (pl.: plasmodesmata) Fine protoplasmic thread that connects adjacent plant cells by passing through the plant cell wall. Exploited by viruses as a conduit for cell to cell movement.

**plasmolysis** Shrinkage of protoplast caused by removal of water from a cell through osmosis when surrounded by a hypertonic solution.

**plastid** A general term for a number of plant cell organelles which carry non-nuclear DNA. Includes the pigment-carrying bodies: 1. chloroplasts in leaves, 2. chromoplasts in flowers, and 3. the starch-synthesizing amyloplasts in seeds.

**plastoquinone** One of a group of compounds involved in the transport of electrons as part of the process of photosynthesis.

**plate** 1. Verb: to distribute a thin film of micro-organisms or plant cells onto a solid medium. 2. Noun: refers to the two segments of a Petri dish or similar.

**platform shaker** See: shaker.

**plating efficiency** The percentage of inoculated cells which give rise to cell colonies when seeded into culture vessels.
pleiotropic (adj.) See: pleiotropy.

pleiotropy The simultaneous effect of a given gene on more than one apparently unrelated trait.

ploidy The number of complete sets of chromosomes per cell, e.g. one set: haploid, two sets: diploid, etc.

plumule The first bud of an embryo, or that portion of the young shoot above the cotyledons.

pluripotent See: totipotent.

plus tree See: elite tree.

PNA Abbreviation for peptide nucleic acid.

pneumatic reactor See: airlift fermenter.

point mutation A change in DNA sequence at a specific locus. The smallest change involves the substitution, deletion or insertion of a single nucleotide. See: single nucleotide polymorphism.

polar bodies In female animals, the products of a meiotic division that do not develop into a functional ovum. The first polar body comprises one of the two products of the first meiotic divisions, which may fail to divide at the second division. The second polar body comprises one of the products of the second division.

polar mutation A mutation that influences the functioning of genes that are downstream from the site of mutagenesis but are in the same transcription unit.

polar nuclei Two centrally located nuclei in the embryo sac that unite with a second sperm cell in a triple fusion. In some plant species (particularly the monocotyledons), the product of this fusion develops into the endosperm.

polar transport A directed movement within plants of compounds (usually endogenous plant growth regulators) mostly in one direction; polar transport overcomes the tendency for diffusion in all directions.

polarity The observed differentiation of an organism, tissue or cell into parts having opposed or contrasted properties or form.

pole cells A group of cells in the posterior of Drosophila embryos that are precursors to the adult germ line.

pollen Mature microspores of seed plants.

pollen culture The in vitro culture and germination of pollen grains to generate haploid plants. See: anther culture; microspore culture.

pollen grain The mature microspore, produced in the pollen sac of angiosperms or the microsporangium of gymnosperms. Unicellular, with variable shape and size, and an elaborately structured wall.
pollination Transfer of pollen from anther to stigma in the process of fertilization in angiosperms; transfer of pollen from male to female cone in the process of fertilization in gymnosperms.

poly-(A) polymerase Enzyme that catalyses the addition of adenine residues to the 3’ end of mRNA molecules, forming the characteristic poly-(A) tail.

poly-(A) tail See: polyadenylation.

polyacrylamide gel Inert electrophoresis matrix, formed by the polymerization of acrylamide monomer in the presence of the cross-linker N,N'-methylene-bis-acrylamide. Gels are usually supported between two glass plates, which need to be removed for post-electrophoresis manipulations. Sometimes referred to incorrectly as acrylamide gels.

polyacrylamide gel electrophoresis (Abbreviation: PAGE). Ubiquitous method for separating nucleic acids and proteins on the basis of their molecular size. The method relies on the migration through an inert matrix (polyacrylamide gel) of electrically charged molecules as a result of the imposition of an electric field.

polyadenylation Post-transcriptional addition of multiple adenine residues to the 3’ end of eukaryotic mRNA. Also called poly-(A) tailing. The adenine-rich 3’ terminal segment is called a poly (A) tail.

polycistronic A single mRNA that contains the information necessary for the production of more than one polypeptide. Particularly characteristic of prokaryotic mRNAs.

polyclonal antibody A serum sample that contains a mixture of distinct immunoglobulin molecules, each recognizing a different antigenic determinant of a given antigen.

polycloning site See: polylinker.

polyembryony The production of more than one embryo from a single egg cell (in animals) or from a range of embryogenic cell types (in plants). These embryos are genetically identical to one another.

polyethylene glycol (Abbreviation: PEG). A polymer having the general formula HOCH₂(CH₂OCH₂)ₙCH₂OH and available in a range of molecular weights. Thus PEG 1000 is a polyethylene glycol of average molecular weight 1000. PEG 4000 and 6000 are commonly used to promote cell or protoplast fusion, and to facilitate DNA uptake in the transformation of organisms such as yeast. Also used to concentrate solutions by withdrawing water from them via osmosis.

polygalacturonase (Abbreviation: PG). An enzyme which catalyses the breakdown of pectin. A tomato engineered to contain an antisense-PG gene succeeded in delaying the onset of softening, by inhibiting the expression of PG. This allowed the fruit to be picked at a riper stage than is conventionally possible, and represented the first commercialized genetically engineered crop plant.

polygene One of a number of genes, each of small effect, which together act to determine the phenotype of a quantitative trait. The result is continuous variation in the trait and a seemingly non-Mendelian mode of inheritance. See: quantitative trait locus, continuous variation.

polygenic Character controlled by many genes of small effect. See: polygene.
**polyhydroxybutyrate** (Abbreviation: PHB). A biopolymer, with physical properties similar to polystyrene, originally discovered in the bacterium *Alcaligenes eutropus*. The gene coding for this compound has since been transformed into both other bacteria and into some crop plants in order to produce a source of renewable raw material for the plastics industry. It is rapidly degraded by soil micro-organisms.

**polylinker** A synthetic segment of DNA, designed to include a number of different restriction endonuclease sites. When ligated to a DNA fragment that is to be cloned, this enables a wide choice of restriction endonucleases to be used for the cloning process. *Synonym*: multiple cloning site (MCS).

**polymer** A macromolecule synthesized by the chemical joining of many identical or similar monomers. For example, amino acids, monosaccharides and nucleotides give rise to proteins, polysaccharides and nucleic acids respectively. Water is eliminated between the monomers as they link to form chains. The individual monomer units condensed within a chain are often referred to as residues, a term which is also employed for the bases incorporated in polynucleotides.

**polymerase** An enzyme that catalyses the formation of polymers from monomers. A DNA polymerase synthesizes DNA from deoxynucleoside triphosphates using a complementary DNA strand and a primer. An RNA polymerase synthesizes RNA from ribonucleoside triphosphates and a complementary DNA strand.

**polymerase chain reaction** (Abbreviation: PCR). A widespread molecular biology procedure that allows the production of multiple copies (amplification) of a specific DNA sequence, provided that the base pair sequence of each end of the target is known. It involves multiple cycles of DNA denaturation, primer annealing, and strand extension, and requires a thermostable DNA polymerase, deoxyribonucleotides, and specific oligonucleotides (primers).

**polymerization** The chemical fusion of a number of identical or similar monomers to form a polymer. Common biological polymers are starch (polymerized monosaccharides), DNA (deoxyribonucleotides) and proteins (amino acids).

**polymer** The phenomenon whereby a number of genes at different loci (which may be polygenes) can act together to produce a single effect.

**polymorphism** 1. The occurrence of allelic variation at a locus. Polymorphism in nucleotide sequences has provided powerful diagnostic tools. *See*: DNA diagnostics, microsatellites, restriction fragment length polymorphism. 2. The occurrence of two or more forms in a population. *See*: balanced polymorphism, chromosomal polymorphism.

**polynucleotide** A linear polymer composed of covalently linked nucleotides. Each link is formed by a single phosphodiester bond. The term is used to describe DNA and RNA.

**polypeptide** A linear polymer composed of covalently linked amino acids. Each link is formed by a single peptide bond. Sometimes used as a synonym for protein, but also describes non-natural and low-molecular-weight polymers.

**polyploid** Organism, tissue or cells having more than two complete sets of chromosomes. Many crop plants are polyploid, including bread wheat (hexaploid, 6x), cotton and alfalfa (tetraploid, 4x), and banana (triploid, 3x).

**polysaccharide** A linear or branched polymer (e.g. starch, cellulose, etc.) composed of covalently linked monosaccharides, including cellulose, pectin and starch. *Synonym*: carbohydrate.
polysaccharide capsule See: capsule.

polysome A multi-ribosomal structure representing a linear array of ribosomes held together by mRNA.

polyspermy The entry of several sperm nuclei into the egg during fertilization, although only one actually fuses with the egg nucleus.

polytene chromosome Giant chromosomes produced by interphase replication without division, and consisting of many identical chromatids arranged side by side.

polyunsaturates Oils in which some of the carbon-carbon bonds are not fully hydrogenated - i.e. of the form -CH=CH-, rather than -CH₂-CH₂-.

polyvalent vaccine A recombinant organism into which antigenic determinants have been cloned from a number of pathogens, for use as a vaccine.

polyvinylpyrrolidone (Abbreviation: PVP). An occasional constituent of plant tissue culture isolation media. PVP is of variable molecular weight and of general formula (C₆H₉NO)n. Its antioxidant properties are used to prevent oxidative browning of excised plant tissues. Less frequently used as an osmoticum in culture media.

population A defined group of interbreeding organisms.

population density Number of cells or individuals per unit. The unit could be an area, or a volume of medium.

population genetics The branch of genetics that deals with frequencies of alleles and genotypes in breeding populations.

porcine endogenous retrovirus (Abbreviation: PERV). The provirus of a porcine retrovirus. The possibility that PERVs could be activated after xenotransplantation of pig organs into humans has raised concern that xenotransplantation may result in the transfer of novel infections to the human population.

position effect The influence of the location of a gene (particularly a transgene) on its expression and hence its effect on phenotype.

positional candidate gene A gene known to be located in the same region as a DNA marker that has been shown to be linked to a single-locus trait or to a QTL, and whose deduced function suggests that it could be the source of genetic variation in the trait in question.

positional cloning A strategy for gene cloning that relies on the identification of closely linked markers to the target trait, and then uses chromosome walking to identify, isolate and characterize the gene(s) responsible for the trait. The strategy is particularly appropriate when the biochemical basis of the target trait is unclear, thus precluding the use of a candidate gene approach.

positive control system A mechanism in which a regulatory protein(s) is required to turn on gene expression.

positive selectable marker See: dominant selectable marker.
positive selection A method by which cells that carry a DNA insert integrated at a specific chromosomal location can be selected, since this integration confers a predictable phenotype.

post-replication repair A recombination-dependent mechanism for repairing damaged DNA.

post-translational modification The addition of specific chemical residues to a protein after it has been translated. Common residues are phosphate groups (phosphorylation) and sugars (glycosylation).

potentiometric See: enzyme electrode.

PPF Abbreviation for photosynthetic photon flux.

ppm Abbreviation for parts per million.

PR protein Abbreviation for pathogenesis related protein.

precautionary principle The approach whereby any possible risk associated with the introduction of a new technology is avoided, until a full understanding of its impact on health, environment etc. is available. Particularly applied to the release of genetically modified organisms, since unlike many technologies, these cannot be recalled if problems arise.

precocious germination Early germination of a seed or embryo, prior to the full maturation of the embryo.

pre-filter A coarse filter used to screen out large particles from a fluid or gas, before it is passed through a much finer filter.

pre-mRNA See: primary transcript.

pressure potential The pressure generated within a cell, being the net difference between the cell's osmotic potential and the water potential of the external environment.

pre-transplant A stage in micropropagation - the rooting and hardening process prior to transfer to soil.

preventive immunization Infection with an antigen to elicit an antibody response that will protect the organism against future infections. Synonym: vaccination.

Pribnow box Consensus sequence near the mRNA start-point of prokaryotic genes. See: TATA box.

primary First in order of time or development.

primary antibody In an ELISA or other immunological assay, the antibody that binds to the target molecule.

primary cell A cell or cell line taken directly from a living organism, which is not immortalized.

primary cell wall The cell wall layer formed during cell expansion. Plant cells possessing only primary walls may divide or undergo differentiation.
primary culture A culture started from cells, tissues or organs taken directly from organisms. A primary culture may be regarded as such until it is sub-cultured for the first time. It then becomes a cell line.

primary germ layers See: germ layer.

primary growth 1. Apical meristem-derived growth; the tissues of a young plant. 2. Explant growth during the initial culture period.

primary immune response The immune response that occurs during the first encounter of a mammal with a given antigen.

primary meristem Meristem of the shoot or root tip giving rise to the primary plant body.

primary structure The linear sequence of residues making up a polymer such as a nucleic acid, polysaccharide or protein. See: secondary structure, tertiary structure and quaternary structure.

primary tissue A tissue that has differentiated from a primary meristem.

primary transcript The RNA molecule produced by transcription prior to any post-transcriptional modifications; also called a pre-mRNA in eukaryotes.

primer A short oligonucleotide annealed to a template of single-stranded DNA, providing a doubled stranded structure from which DNA polymerase will synthesize a new DNA strand to produce a duplex molecule.

primer walking A method for sequencing long (>1 kbp) cloned pieces of DNA. The initial sequencing reaction reveals the sequence of the first few hundred nucleotides of the cloned DNA. Using this, a new primer of about 20 nucleotides is synthesized, which is complementary to a sequence near the end of sequenced DNA, and used to sequence the next few hundred nucleotides of the cloned DNA. This procedure is repeated until the complete nucleotide sequence of the cloned DNA is determined.

primordium A group of cells which gives rise to an organ.

primosome A protein-replication complex that catalyses the initiation of synthesis of Okazaki fragments during discontinuous replication of DNA. It involves DNA primase and DNA helicase activities.

prion See: proteinaceous infectious particle.

probability The frequency of occurrence of an event.

proband The individual in a family in whom an inherited trait is first identified.

probe A labelled DNA or RNA sequence used to detect the presence of a complementary sequence by hybridization with a nucleic acid sample.

procambium A primary meristem that gives rise to primary vascular tissues and, in most woody plants, to the vascular cambium.

procaryote See: prokaryote, prokaryotic.

procaryotic (adj.) See: procaryote.
processed pseudo-gene A copy of a functional gene which has no promoter, no introns and which, consequently, is not itself transcribed.

production environment All input-output relationships, over time, at a particular location. The relationships include biological, climatic, economic, social, cultural and political factors, which combine to determine the productive potential of a particular enterprise. Production environments are classified as high-, medium- and low-input

production traits Characteristics of animals, such as the quantity or quality of the milk, meat, fibre, eggs, work, etc., they (or their progeny) produce, which contribute directly to the value of the animals for the farmer, and that are identifiable or measurable at the individual level.

productivity The amount of economically significant product generated within a given period of time from a specified quantity of resource.

pro-embryo A group of cells arising from the division of the fertilized egg cell or somatic embryo before those cells which are to become the embryo are recognizable.

progeny Synonym of offspring.

progeny testing With respect to discrete loci, the inference of the allelic state of an individual from the pattern of segregation among its offspring. For a quantitative trait, the use of progeny performance to estimate the breeding value of an individual.

progesterone A hormone produced primarily by the corpus luteum, but also by the placenta. Its function in mammals is to prepare the inner lining of the uterus for the implantation of a fertilized egg. Also made by non-placental animals, including fish.


prokaryote A member of the large group of organisms, including bacteria and blue-green algae, in which the chromosome is not enclosed within a nucleus, but instead exists as a linear or circular strand. Prokaryotes do not undergo meiosis and do not have functional organelles such as mitochondria and chloroplasts. See: eukaryote.

prolactin A hormone, produced by the anterior pituitary gland, that stimulates and controls lactation in mammals.

proliferation Increase by frequent and repeated reproduction; growth by cell division.

pro-meristem The embryonic meristem that is the source of organ initials or foundation cells.

promoter 1. A short DNA sequence, usually upstream of (5’ to) the relevant coding sequence, to which RNA polymerase binds before initiating transcription. This binding aligns the RNA polymerase so that transcription will initiate at a specific site. The nucleotide sequence of the promoter determines the nature of the enzyme that attaches to it and the rate of RNA synthesis. 2. A chemical substance that enhances the transformation of benign cells into cancerous cells. See: constitutive promoter.

promoter sequence See: promoter (1).
**pro-nuclear micro-injection** An early, low success-rate method to achieve **transgenesis** in animals, involving the micro-injection of many **gene** copies into one of the two **pro-nuclei** of a fertilized egg. Now being replaced by micro-injection into a culture of cloned embryos produced by nuclear transfer, which can be tested for expression of the **transgene** before transfer to recipient females.

**pro-nucleus** Either one of the two **haploid gamete** nuclei, just prior to their fusion in the fertilized **egg**.

**proofreading** The scanning of newly-synthesized **DNA** for structural defects, such as mismatched base pairs. A functional activity of most **DNA polymerases**.

**propagation** The duplication of a whole plant from a range of vegetative materials; adapted for **in vitro** culture as **micropropagation**.

**propagule** Any structure capable of giving rise to a new plant by asexual or sexual reproduction, including bulbils, leafbuds, etc.

**pro-phage** The **genome** of a **bacteriophage** integrated into the **chromosome** of a **lysogenic** bacterial cell, and replicated along with its host chromosome.

**prophase** The first stage of nuclear division. The stage during which **chromosome pairing** occurs in the first division of **meiosis** (see: **leptonema**, **zygonema**, **pachynema**, **diplonema**, **diakinesis**). In **mitosis** and the second division of meiosis, the chromosomes shorten and thicken as a result of coiling.

**protamine** A class of small basic **proteins** that replace the **histones** in the chromosomes of some **sperm** cells.

**protease** An enzyme that catalyses the **hydrolysis** of **proteins**, cleaving the **peptide** bonds that link **amino acids** in **protein** molecules. **Synonym**: peptidase.

**protein** A macromolecule composed of one or more **polypeptides**, each comprising a chain of **amino acids** linked by **peptide** bonds.

**protein crystallization** The production of a pure preparation of a **protein**. In this form, the three-dimensional structure of the molecule can be determined.

**protein drug** See: **therapeutic agent**.

**protein engineering** Generating **proteins** with modified structures that confer novel properties such as higher catalytic **specificity** or thermal stability.

**protein kinase** An enzyme that catalyses the addition of a phosphate group(s) to a **protein** molecule at the sites of serine, threonine or tyrosine residues.

**protein metabolic step** One step in the chain of reactions that take place in an organism and dictate the composition of that organism.

**protein sequencing** The process of determining the **amino acid** sequence of a **protein**. Usually achieved following initially partial **hydrolysis** of the **protein** into smaller **peptides** by enzymatic digestion.

**protein synthesis** The creation of **proteins** from their constituent **amino acids**, in accordance with the encoding gene **DNA** sequence.
**proteinaceous infectious particle** Believed to be the agent responsible for the class of diseases called spongiform encephalopathies, including **scrapie** in sheep, bovine spongiform encephalopathy (BSE; mad cow disease) in cattle and CJD in humans. It is an abnormal form of a brain **protein**, and has no detectable **nucleic acid** content. **Synonym:** prion.

**proteolysis** Enzymatic degradation of a **protein**.

**proteolytic** Having the ability to degrade **protein** molecules.

**proteome** The complete complement of **proteins** made by a given **species** in all its tissues and growth stages.

**proteomics** An approach that seeks to identify and characterize complete sets of **protein**, and **protein-protein** interactions in a given species. **See:** proteome, genomics.

**protoplasm** The essential, complex living substance of cells, upon which all vital functions of nutrition, secretion, growth and **reproduction** depend.

**protoplast** A bacterial or plant cell for which the **cell wall** has been removed either chemically or enzymatically, leaving its **cytoplasm** enveloped by a peripheral membrane. Protoplasts are spherical and smaller than the elongate, angular shaped and often vacuolated cells from which they have been released.

**protoplast culture** The culturing **in vitro** of plant **protoplasts**. Where protoplasts can be regenerated into whole plants, they represent an attractive target for genetic manipulation.

**prototroph** A nutritionally independent cell. **Opposite:** auxotroph.
**pro-toxin** A latent, non-active precursor form of a **toxin**.

**protozoan** (pl.: protozoa) A microscopic, single-cell organism.

**protruding end** *See: extension.*

**provenance** The geographical and/or genetic origin of an individual.

**provirus** A double stranded **DNA** copy of the single **RNA** strand of a **retrovirus**, which has been integrated into a **host** genome.

**pseudo-affinity chromatography** A chromatographic technique in which a **ligand** is immobilized selectively to retain enzymes or other **proteins**.

**pseudo-autosomal region** A section at one end of the X and Y chromosomes for which there is sufficient **homology** that there is **synapsis** between them during **meiosis**.

**pseudocarp** A fruit that incorporates, in addition to the **ovary** wall, other parts of the flower, such as the **receptacle** (e.g. strawberry). *Synonym: false fruit.*

**pseudogene** An incomplete or mutated copy of a gene which is not transcribed because it lacks a continuous **open reading frame**. Those that lack **introns** are called processed pseudogenes and are most likely **cDNA** copies synthesized from **mRNA** by reverse **transcriptase**

*Pseudomonas* spp. A widely distributed Gram-negative bacterial genus. Many of the soil forms produce a **pigment** that fluoresces under ultraviolet light, hence the descriptive term fluorescent *Pseudomonas*.

**P-site** Abbreviation for **peptidyl-tRNA binding site**.

**psychrophile** A micro-organism that can grow at temperatures below 30 °C and as low as 0 °C. *See: mesophile, thermophile.*

**PUC** A widely used **plasmid**, containing as a **marker** a galactosidase gene.

**pulsed-field gel electrophoresis** (Abbreviation: PFGE). A procedure used to separate very large (50 kbp to several Mbp) **DNA** molecules by altering the direction of electric current in a pulsed manner across a gel.

**punctuated equilibrium** The occurrence of **speciation** events in bursts, separated by long intervals of **species** stability.

**pure line** A strain in which all members are genetically nearly identical and are indistinguishable by **phenotype**. Usually created by repeated generations of self-fertilization or close inbreeding.

**purification tag** *See: affinity tag.*

**purine** A double-ring, nitrogen-containing **base** present in **nucleic acids**. **Adenine** (A) and **guanine** (G) are the two purines normally present in **DNA** and **RNA** molecules.

**PVP** 1. Abbreviation for **polyvinylpyrrolidone**. 2. Abbreviation for **plant variety protection**.

**PVR** Abbreviation for **plant variety rights**.
PWP Abbreviation for permanent wilting point.

pyrethrins Active constituents of pyrethrum (Tanacetum cinerariifolium) flowers, used as insecticides.

pyrimidine A single-ring, nitrogen-containing base present in nucleic acids. Cytosine (C) and thymine (T) are present in DNA, whereas uracil (U) replaces T in RNA. Thymine is a synonym for 5-methyluracil.

pyrogen Bacterial substance that causes fever in mammals.

pyrophosphate A phosphate ion dimer; may be released on hydrolysis of ATP.
Glossary of biotechnology for food and agriculture

Q-Z

q Denotes the longer of the two chromosome arms, e.g. human 10q is the long arm of human chromosome 10.

q-beta replicase A viral RNA polymerase secreted by a bacteriophage that infects *E. coli*. It has the property of being able to copy RNA sequences at a rapid rate.

QSAR Abbreviation for quantitative structure-activity relationship.

QTL Abbreviation for quantitative trait locus.

quadrivalent A chromosome configuration visible in late prophase and metaphase of the first meiotic division, where four chromosomes are linked by chiasmata. Can occur in autotetraploids when four homologous chromosomes pair, or in diploids as a result of heterozygosity for a reciprocal translocation between two non-homologous chromosomes.

quadruplex The inheritance of alleles in autotetraploids. A genotype AAAa will produce gametes AA, Aa in the ratio 3:1.

qualitative trait A trait that shows discontinuous variation - i.e. individuals can be assigned to one of a small number of discrete classes.

quantitative genetics The area of genetics concerned with the inheritance of quantitative traits that show continuous variation, as opposed to qualitative traits. Since many of the critical targets in both plant and animal breeding are of this type, most practical improvement programs involve the application of quantitative genetics.

quantitative inheritance Inheritance of measurable traits that depend on the cumulative action of many genes and/or involve a significant proportion of non-genetic determination.

quantitative structure-activity relationship (Abbreviation QSAR). A computer modelling technique that enables the prediction of the likely activity of a molecule before it is synthesized. QSAR analysis relies on recognizing associations of molecular structures and activity from historical data.

quantitative trait A measurable trait that shows continuous variation (e.g. height, weight, colour intensity, etc.) - i.e. the population cannot be classified into a few discrete classes.

quantitative trait locus (Abbreviation: QTL). A locus where allelic variation is associated with variation in a quantitative trait. The presence of a QTL is inferred from genetic mapping, where the total variation is partitioned into components linked to a number of discrete chromosome regions.

quantum speciation The rapid formation of new species, primarily by genetic drift.

quarantine Isolation for a period after arrival in a new location, to allow any pre-existing disease symptoms to appear. Used in the context of regulations restricting the sale or shipment of living organisms, usually to prevent disease or pest invasion of an area.

quaternary structure A level of protein structure where several individual molecules assemble together and form a functional cluster. A classic example is haemoglobin, a complex of four myoglobin-like units. See: tertiary structure.
**quiescent** A temporary suspension or reduction in the rate of activity or growth, while retaining the potential to resume prior activity. Applies particularly to cell division. See: dormancy.

**R genes** A class of plant genes conferring resistance to a specific strain (or group of strains) of a particular pathogen. Their primary function is to sense the presence of the pathogen and to trigger the defence pathways in the plant. R genes have been cloned from a number of plant species.

**R1** The first-generation offspring of a recombinant (genetically modified) organism. Not standard terminology. See: T0, T1, and T2.

**race** A distinguishable group of organisms of a particular species. Criteria for distinctness can be one or a combination of geographic, ecological, physiological, morphological, genetic and karyotypic factors.

**raceme** An inflorescence in which the main axis is elongated but the flowers are borne on pedicels that are about equal in length.

**rachilla** Shortened axis of a spikelet.

**rachis** Main axis of a spike; axis of fern leaf (frond) from which pinnae arise; in compound leaves, the extension of the petiole corresponding to the midrib of an entire leaf.

**radiation hybrid cell panel** (Abbreviation: RH). A somatic cell hybrid panel in which the chromosomes from the species of interest have been fragmented by irradiation prior to cell fusion. The resultant small fragments of chromosomes greatly increase the power of physical mapping in the species of interest.

**radicle** The portion of the plant embryo which develops into the primary root.

**radioimmunoassay** (Abbreviation: RIA). An assay based on the use of a radioactively labelled antibody, where the amount of radiation detected indicates the amount of target substance present in the sample.

**radioisotope** An unstable isotope that emits ionizing radiation. Synonym: radioactive isotope.

**raft culture** See: nurse culture.

**ramet** An individual member of a clone, descended from the ortet.

**random amplified polymorphic DNA** (Abbreviation: RAPD). A PCR-based genotyping technique in which genomic template is amplified with single, short (usually 10-mer) randomly chosen primers. Typical patterns consist of a small number of amplified products of up to 2 kbp in length, which are separated by electrophoresis.

**random genetic drift** See: genetic drift.

**random mutagenesis** A non-directed change of one or more nucleotide pairs in a DNA molecule.

**random primer method** A method for labelling DNA probes, mainly for Southern hybridization experiments. A mixture of short oligonucleotides is hybridized to a single-stranded DNA probe. In the presence of DNA polymerase and deoxyribonucleotides - one of which is labelled - DNA synthesis then generates labelled copies of probe DNA.
RAPD Abbreviation for **random amplified polymorphic DNA**.

rate-limiting enzyme The enzyme whose activity controls the output of final product from a multi-enzyme metabolic pathway.

rational drug design A systematic method of creating compounds by analysing their structure, function and stereochemical interactions.

reading frame The reading frame defines which sets of three nucleotides are read as triplets, and hence as codons, in DNA transcription. The start point is usually determined by the initiation codon, AUG. Thus the sequence AUGGCAAAA would be read as AUG/GCA/AAA not as A/UGC/CAA/AA. *See: open reading frame.*

read-through Transcription or translation that proceeds beyond the normal stopping point because of the absence of the usual transcription or translation termination signal of a gene.

recA A protein, found in most bacteria, that is essential for DNA repair and DNA recombination.

recalcitrant Of seeds, unable to survive drying and subsequent storage at low temperature. *See: field gene bank.*

receptacle Enlarged end of the pedicel or peduncle, to which other flower parts are attached.

receptor A trans-membrane protein located in the plasma membrane that can bind with a ligand on the extracellular surface, as a result of which it induces a change in activity on the cytoplasmic surface. More generally, a site in a molecule that allows the binding of a ligand.

receptor-binding screening A biotechnology-based method for drug discovery, which relies on the fact that many drugs act by binding to specific receptors on or in cells. Since receptors in vivo bind to hormones or to other cells, and thereby control the cell’s behaviour, a receptor bound with a drug will likely affect the normal activity of the cell.

recessive Describing an allele whose effect with respect to a particular trait is not evident in heterozygotes. *Opposite: dominant.*

recessive allele Allelic state of a gene, where homozygosity is required for the expression of the relevant phenotype. *Opposite: dominant allele.*

recessive oncogene A single copy of this gene is sufficient to suppress cell proliferation; the loss of both copies of the gene contributes to cancer formation. Synonym: anti-oncogene recessive-acting oncogene. *See: oncogene.*

recessive-acting oncogene *See: recessive oncogene.*

reciprocating shaker A platform shaker used for agitating culture flasks, with a back and forth action at variable speeds.

recognition sequence Synonym of recognition site.

recognition site A nucleotide sequence, typically 4-8bp long and often palindromic, that is recognized by, and at which a restriction endonuclease binds to the DNA. For some restriction endonucleases, the presence of a methylated residue within the recognition site abolishes recognition. *Synonym: recognition sequence; restriction site.*
recombinant A term used in both classical and molecular genetics. 1. In classical genetics: An organism or cell that is the result of meiotic recombinant. 2. In molecular genetics: A hybrid molecule made up of DNA obtained from different organisms. Typically used as an adjective, e.g. recombinant DNA.

recombinant DNA The result of combining DNA fragments from different sources.

recombinant DNA technology A set of techniques for manipulating DNA, including: the identification and cloning of genes; the study of the expression of cloned genes; and the production of large quantities of gene product.

recombinant human (Abbreviation rh). A prefix denoting molecules made through the use of recombinant DNA technology.


recombinant RNA RNA molecules joined in vitro by T4 RNA ligase.

recombinant toxin A single multifunctional toxic protein encoded by a recombinant gene.

recombinant vaccine A vaccine produced from a cloned gene.

recombinase A class of enzymes that are able to alter the arrangement of DNA sequences in a site-specific way.

recombination The production of a DNA molecule with segments derived from more than one parent DNA molecule. In eukaryotes, this is achieved by the reciprocal exchange of DNA between non-sister chromatids within an homologous pair of chromosomes during prophase of the first meiotic division.

recombination fraction The proportion of recombinant (with respect to two loci) gametes arising from meiosis. Linkage maps are based on estimates of recombination fraction between all pair-wise combinations of loci. See: map distance. Synonyms: recombination frequency, crossing-over unit.

recombination frequency Synonym: recombination fraction

recombinational hot spot A chromosomal region where recombination appears to occur more frequently than expected.

reconstructed cell A viable transformed cell resulting from genetic engineering.

reduction division The first division of meiosis in which the chromosome number is reduced from the somatic to the gametic number.

refugium (pl.: refugia) An area set aside to provide protection/escape from ecological consequences occurring elsewhere.

regeneration The growth of new tissues or organs to replace those injured or lost. In plant tissue culture, regeneration refers to the development of organs or plantlets from an explant. See: conversion; micropropagation; organogenesis.

regulator Substance regulating growth and development of cells, organs, etc.
**regulatory gene** A gene with the primary function of controlling the rate of synthesis of the products of one or several other genes or pathways.

**regulatory sequence** A DNA sequence involved in regulating the expression of a gene, e.g. a promoter or operator region (in the DNA molecule).

**rejuvenation** 1. Reversion from adult to juvenile stage. 2. The process of regular reproduction of seed stocks or collections in gene banks, in order to ensure continued viability.

**relaxed circle** See: nicked circle.

**relaxed circle plasmid** See: plasmid.

**relaxed plasmid** A plasmid that replicates independently of the bacterial chromosome and is present in 10-500 copies per cell.

**release factor** 1. A soluble protein that recognizes termination codons in mRNAs and terminates translation in response to these codons. 2. A hormone, produced by the hypothalamus, which stimulates the release of a hormone from the anterior pituitary gland into the bloodstream.

**remediation** The cleanup or containment of a hazardous waste disposal site to the satisfaction of the applicable regulatory agency. This can sometimes be accomplished with naturally occurring or engineered micro-organisms or plants. See: bioremediation.

**renaturation** Of DNA, the reforming of two complementary molecules into a double-stranded structure, following heat or chemical induction of dissociation (denaturation). Of protein, the resumption of three-dimensional conformation, allowing the molecule to function normally. Denaturation of many proteins is irreversible, but denatured DNA molecules will renature readily under appropriate chemical and physical conditions.

**rennin** An enzyme, secreted by cells lining the stomach in mammals, responsible for the clotting of milk. Used in the manufacture of certain dairy products.

**repeat unit** A sequence of nucleotides that occurs repeatedly, often in a head-to-tail arrangement (tandemly).

**repetitive DNA** DNA sequences that are present in a genome in many copies, some of it originating from retrotransposon activity. A substantial proportion of all eukaryotic genomes is composed of this class of DNA, whose biological function is uncertain. Sometimes referred to as 'junk DNA'.

**replacement** The addition of a cloned corrected copy of a defective gene. See: homogenotization.

**replacement therapy** The administration of metabolites, co-factors or hormones that are deficient as the result of a genetic disease.

**replica plating** Duplicating a population of bacterial colonies growing on agar medium in one Petri plate to agar medium in another Petri plate.

**replicase** A viral enzyme necessary for the replication of the virus in the host cell.

**replication** The in vivo synthesis of double-stranded DNA by copying from a single-stranded template.
replication fork Y shaped structure associated with DNA replication. It represents the point at which the strands of double-stranded DNA are separated so that replication can proceed.

replicative form (Abbreviation: RF). The molecular configuration of viral nucleic acid that is the template for replication in the host cell.

replicon The portion of a DNA molecule which can be replicated from a single origin of replication. Plasmids and the chromosomes of bacteria, phages and other viruses usually have a single origin of replication so that their entire genome constitutes a single replicon. Eukaryotic chromosomes have multiple origins of replication, so comprise several replicons. Also used to describe a DNA molecule capable of independent replication.

replisome The complete replication apparatus, present at a replication fork, that carries out the replication of DNA.

reporter gene A gene that encodes a product that can be readily assayed. Used as a marker to confirm the incorporation of a transgene into a cell, organ or tissue, and as a means of testing the efficiency of specific promoters.

repressible enzyme An enzyme whose activity can be diminished by the presence of a regulatory molecule.

repressible gene A gene whose expression can be diminished or extinguished by the presence of a regulatory molecule.

repression Inhibition of transcription by preventing RNA polymerase from binding to the transcription initiation site.

repressor A protein which binds to a specific DNA sequence upstream from the transcription initiation site of a gene and prevents RNA polymerase from commencing mRNA synthesis.

reproduction 1. Sexual reproduction: the regular alteration of meiosis and fertilization which provides for the production of offspring. The main biological significance of sexual reproduction lies in the phenomenon of recombination. 2. Asexual or agamic reproduction: the development of a new individual from a single cell or group of cells in the absence of meiosis. See: apomixis.

repulsion A double heterozygote in which the dominant (or wild-type) allele at one locus and the recessive (or mutant) allele at a second linked locus occur on the same chromosome (genetic constitution Ab/aB). Synonym: trans configuration. Opposite: coupling, cis configuration.

residue 1. See: polymer. 2. Materials remaining after degradation and/or attempted removal, e.g. pesticide residues in food.

resistance The ability to withstand abiotic (high temperature, drought etc.) or biotic (disease) stress, or a toxic substance. Often in the context of genetic determination of resistance.

resistance factor A plasmid that confers antibiotic resistance to a bacterium.

rest period A physiological condition of viable seeds, buds or bulbs that prevents growth even in the presence of otherwise favourable environmental conditions. Synonym: dormancy.
restitution nucleus A single nucleus arising from a failure of nuclear division, either during meiosis, in which a gamete is formed with the unreduced chromosome number; or at mitosis to give a cell with a doubled chromosome number.

restriction endonuclease A class of enzymes that cut DNA after recognizing a specific sequence. The three types of restriction endonuclease are: I. Where the cut occurs within a random sequence at sites >1kbp from the recognition sequence, and has both restriction and methylation activities. II: Cuts within, or near a short, usually palindromic recognition sequence. A separate enzyme methylates the same recognition sequence. III: Cuts 24-26bp downstream from a short, asymmetrical recognition sequence, requires ATP and has both restriction and methylation activities. Type II enzymes are the class used for most molecular biology applications.

restriction enzyme Synonym of restriction endonuclease.

restriction exonuclease A class of enzymes that degrade DNA or RNA, starting from either the 5'- or the 3'-end.

restriction fragment A shortened DNA molecule generated by the cleavage of a larger molecule by one or more restriction endonucleases.

restriction fragment length polymorphism (Abbreviation: RFLP). A class of genetic marker based on the detection of variation in the length of restriction fragments generated when DNA is treated with restriction endonucleases. Differences in fragment lengths arise due to genetic variation with respect to the presence or absence of specific recognition site(s). RFLPs were initially detected by Southern hybridization but are now detected by electrophoresis of digested PCR product.

restriction map The linear arrangement of restriction endonuclease recognition sites along a DNA molecule.

restriction site Synonym of recognition site.

reticulocyte A slightly immature red blood cell.

retro-element Any of the integrated retroviruses or the transposable elements that resemble them.

retroposon A transposable element that moves via reverse transcription but lacks the long terminal repeat sequences necessary for autonomous transposition. Much of the repetitive DNA that makes up a large proportion of eukaryotic genomes consists of silenced (i.e. inactive) retroposons. Synonym: retro-transposon.

retroviral vectors Gene transfer systems based on viruses that have RNA as their genetic material.

retrovirus A class of eukaryotic RNA viruses that, by using reverse transcription, can form double-stranded DNA copies of their genomes, which can integrate into the chromosomes of an infected cell. Pathogenic retroviruses include HIV and the causative agents of many vertebrate animal cancers.

reversal transfer Transfer of a culture from a callus-supporting medium to a shoot-inducing medium.

reverse genetics See: positional cloning.
reverse mutation See: reversion.

reverse transcriptase An enzyme that uses an RNA molecule as a template for the synthesis of a complementary DNA strand. Synonym: RNA-dependent DNA polymerase.

reverse transcription The synthesis of DNA from a template of RNA, accomplished by reverse transcriptase.

reversion Restitution of a mutant gene to the wild-type condition, or at least to a form that gives the wild-type phenotype; more generally, the appearance of a trait expressed by a remote ancestor. Synonym: reverse mutation.

RF Abbreviation for replicative form.

RFLP Abbreviation for restriction fragment length polymorphism.

rh Abbreviation for recombinant human.

rhizobacterium A micro-organism whose natural habitat is near, on, or in, plant roots.

Rhizobium (pl.: Rhizobia) Prokaryotic species which are able to establish a symbiotic relationship with leguminous plants, as a result of which elemental nitrogen is fixed or converted to ammonia. See: nitrogen fixation.

rhizosphere The soil region in the immediate vicinity of growing plant roots.

Ri plasmid A class of large conjugative plasmids found in the soil bacterium Agrobacterium rhizogenes, which can infect certain plants and cause hairy root disease. Like Ti plasmids, Ri plasmids include sequences that are transferred to plant cells and inserted into the plant's DNA as part of the infection process.

RIA Abbreviation for radioimmunoassay.

ribonuclease (Abbreviation: RNAse). Any enzyme that catalyses the hydrolysis of RNA.

ribonucleic acid (Abbreviation: RNA). An organic acid polymer composed of adenosine, guanosine, cytidine and uridine ribonucleotides. The genetic material of some viruses, but more generally is the molecule, derived from DNA by transcription, that either carries information (messenger RNA), provides sub-cellular structure (ribosomal RNA), transports amino acids (transfer RNA), or facilitates the biochemical modification of itself or other RNA molecules.

ribonucleoside See: nucleoside.

ribonucleotide See: nucleotide.

ribose A monosaccharide found in all ribonucleosides, ribonucleotides and RNA. Its close analogue, 2-deoxyribose, is similarly found in all deoxyribonucleosides, deoxyribonucleotides and DNA.

ribosomal binding site A sequence of nucleotides near the 5’ end of a bacterial mRNA molecule that facilitates the binding of the mRNA to the small ribosomal sub-unit. Also called the Shine-Delgarno sequence.
ribosomal DNA The coding locus for ribosomal RNA. This is generally a large and complex locus, typically composed of a large number of repeat units, separated from one another by the intergenic spacer. A repeat unit comprises a gene copy for each individual ribosomal RNA component, separated from one another by the internal transcribed spacer.

ribosomal RNA (Abbreviation: rRNA). The RNA molecules that are essential structural and functional components of ribosomes, where protein synthesis occurs. Different classes of rRNA molecule are identified by their sedimentation (S) values. E. coli ribosomes contain one 16S rRNA molecule (1541 nucleotides long) in one (small) ribosomal sub-unit, and a 23S rRNA (2904 nucleotides) and a 5S rRNA (120 nucleotides) in the other (large) sub-unit. These three rRNA molecules are synthesized as part of a large precursor molecule which also contains the sequences of a number of tRNAs. Special processing enzymes cleave this large precursor to generate the functional molecules. Constitutes about 80% of total cellular RNA.

ribosome The sub-cellular structure that contains both RNA and protein molecules and is the site for the translation of mRNA into protein. Ribosomes comprise large and small sub-units.

ribosome-inactivating protein (Abbreviation: RIP). A class of plant proteins that inhibit normal ribosome function, and are thus highly toxic. Type 1 RIPS consist of single polypeptide chain proteins; type 2 (e.g. ricin) consist of two proteins linked by a disulphide bridge, one the toxin and the other a lectin that attaches to recognition sites on a target cell.

ribozyme An RNA molecule that can catalyse chemical cleavage of itself or of other RNAs. Synonyms: catalytic RNA, gene shears.

ribulose A keto-pentose sugar (C₅H₁₁O₅) involved in the carbon dioxide fixation pathway of photosynthesis.

ribulose biphosphate (Abbreviation: RuBP). A five-carbon sugar combined with carbon dioxide to form a six-carbon intermediate in the first stage of the dark reaction of photosynthesis.

rinderpest Cattle plague; a viral infection of cattle, sheep and goats.

RIP Abbreviation for ribosome-inactivating protein.

risk analysis A process consisting of three components: risk assessment, risk management and risk communication performed to understand the nature of unwanted, negative consequences to human and animal health, or the environment.

risk assessment a scientifically based process consisting of the following steps: i) hazard identification; ii) hazard characterization; iii) exposure assessment; and iv) risk characterization.

risk communication The interactive exchange of information and opinions throughout the risk analysis process concerning hazards and risks, risk-related factors and risk perceptions, among risk assessors, risk managers, consumers, industry, the academic community and other interested parties, including the explanation of risk assessment findings and the basis of risk management decisions.
risk management The process, distinct from risk assessment, of weighing policy alternatives, in consultation with all interested parties, considering risk assessment and other factors relevant for the health protection of consumers and for the promotion of fair trade practices, and, if needed, selecting appropriate prevention and control options.

R-loops Single-stranded DNA regions in RNA-DNA hybrids formed in vitro under conditions where RNA-DNA duplexes are more stable than DNA-DNA duplexes.

RNA Abbreviation for ribonucleic acid.

RNA editing Post-transcriptional processes that alter the information encoded in RNAs.

RNA polymerase A polymerase enzyme that catalyses the synthesis of RNA from a DNA template.

RNAase Abbreviation for ribonuclease.

RNA-dependent DNA polymerase See: reverse transcriptase.

RNase Abbreviation for ribonuclease.

rol genes A family of genes, present on the Ri plasmid of Agrobacterium rhizogenes, that when transferred to a plant upon infection by the bacterium, induce the formation of roots. Used as a means of root induction on different species and cultivars of micropropagated fruit trees.

root The descending axis of a plant, normally below ground, which serves to anchor the plant and to absorb and conduct water and mineral nutrients.

root apex The apical meristem of a root; very similar to the shoot apical meristem in that it forms the three meristematic areas: the protoderm (develops into the epidermis); the procambium (the stele); and the growth meristem (the cortex).

root cap A mass of reinforced cells covering and protecting the apical meristem of a root.

root culture The culture of isolated apical or lateral root tips to produce in vitro root systems with indeterminate growth habits. Used to study mycorrhizal, symbiotic and plant-parasitic relationships.

root cutting Cutting made from sections of roots alone.

root hairs Outgrowths from epidermal cell walls of the root, specialized for water and nutrient absorption.

root nodule A small round mass of cells attached to the roots of leguminous plants, containing symbiotic nitrogen-fixing bacteroids, particularly Rhizobium spp.

root tuber Thickened root that stores carbohydrates.

root zone The volume of soil or growing medium containing the roots of a plant. In soil science, the depth of the soil profile in which roots are normally found.

rootstock The trunk or root material to which buds or scions are inserted in grafting. See: stock.
rotary shaker Rotating apparatus with a platform on which liquid media or cultures can be continuously shaken.

Roundup-ready Describing transgenic crop varieties that carry the bacterial gene which detoxifies the herbicide glyphosate, thereby making them resistant to its application.

rRNA Abbreviation for ribosomal RNA.

RuBP Abbreviation for ribulose biphosphate.

ruminant Animal having a rumen - a large digestive sac in which fibrous plant material is fermented by commensal microbes, prior to its digestion in a “true” stomach (the abomasum). Common farm ruminants are cattle and sheep.

runner A lateral stem that grows horizontally along the ground surface and gives rise to new plants either from axillary or terminal buds. Synonym: stolon.

rust A generic descriptor for various serious fungal plant pathogens, which infect the leaves and stems of crops. The appearance of spores is reminiscent of metallic rust, although the colour varies, according to species, from yellow to reddish-brown.

S phase The phase in the cell cycle during which DNA synthesis occurs.

S₁ mapping A method to characterise post-transcriptional modifications in RNA (removal of introns etc.) by hybridizing RNA with single-stranded DNA and treating with S₁ nuclease.

S₁ nuclease An enzyme obtained from the filamentous fungus Aspergillus oryzae which specifically degrades RNA or single-stranded DNA into its constituent mononucleotides, and cleaves nicked double-stranded DNA at the nick.

saccharification Following liquefaction, the hydrolysis of polysaccharides by glucoamylase to maltose and glucose.

saline resistance Synonym for salt tolerance.

Salmonella A genus of rod-shaped, Gram-negative bacteria that are a common cause of food poisoning.

salt tolerance The ability of a plant in soil or in culture to withstand a concentration of common salt (sodium chloride) which is damaging or lethal to most other plants. Breeding and selection for increased tolerance and resistance in crop plants is of great current interest. Synonym: saline resistance. An organism with extreme salt tolerance is a halophyte.

sap Fluid content of the xylem and phloem cells of plants. Fluid content of the vacuole generally referred to as cell sap.

saprophyte An organism (generally a fungus) that depends on dead plant or animal tissue for its source of nutrition and metabolic energy.

satellite DNA Highly repetitive DNA in plant and animal genomes, consisting of millions of copies of sequences typically in the range 5-500 bp long. Thousands of copies occur tandemly (head-to-tail) at each of many sites. It can be isolated from the rest of the genomic DNA by density gradient centrifugation.
satellite RNA A small, self-splicing RNA molecule that accompanies several plant viruses, including tobacco ringspot virus. *Synonym:* viroid.

**SC** Abbreviation for *synaptonemal complex*.

**SCA** Abbreviation for *specific combining ability*.

**scaffold** The central proteinaceous core structure of condensed eukaryotic chromosomes. The scaffold is composed of non-histone chromosomal proteins.

**scale up** Conversion of a process, such as fermentation of a micro-organism, from a small laboratory scale to a larger industrial scale.

**scanning electron microscope** (Abbreviation: SEM). An electron-beam-based microscope used to examine, in a three dimensional screen image, the surface structure of prepared specimens.

**SCAR** Abbreviation for *sequence characterized amplified region*.

**scarification** The chemical or physical treatment given to certain seeds having hard, impermeable seed coats in order to puncture or weaken the seed coat sufficiently to permit water uptake and germination.

**SCE** Abbreviation for *sister chromatid exchange*.

**scion** A twig or bud used for grafting onto another plant or rootstock.

**scion-stock interaction** The effect of a rootstock on a scion (and vice versa) in which a particular scion grafted onto a specific stock performs differently than it would either on its own roots or on a different rootstock.

**sclerenchyma** A strengthening tissue in plants, composed of cells with heavily lignified cell walls.

**SCP** Abbreviation for *single-cell protein*.

**scrapie** A spongiform encephalopathy disease of sheep. *See: proteinaceous infectious particle*.

**screen** Preliminary characterization of a sample collection on the basis of a set of simple established criteria (biochemical, anatomical, physiological, etc.). Often applied to the process of selection for specific purposes, such as for disease resistance or for improved agronomic performance in crop plants.

**SDS** Abbreviation for *sodium dodecyl sulphate*.

**SDS-PAGE** Abbreviation for *sodium dodecyl sulphate polyacrylamide gel electrophoresis*.

**secondary antibody** In an ELISA or other immunological assay system, the antibody designed to bind to the primary antibody, and to which a label is generally attached.

**secondary cell wall** The innermost layer of cell wall, giving rigidity to the cells. Characterized by its highly organized microfibrillar structure, and only formed in certain cells after cell elongation has ceased.
secondary growth Type of growth characterized by an increase in the thickness of stem and root, and resulting from the formation of secondary vascular tissues by the vascular cambium.

secondary immune response The rapid immune response that occurs during the second (and subsequent) encounters of the immune system of a mammal with a specific antigen. See: primary immune response.

secondary messenger A chemical compound within a cell that is responsible for initiating the response to a signal from a chemical messenger (such as a hormone) that cannot enter the target cell itself.

secondary metabolism The production by living organisms of substances not essential for primary metabolic functions or physiology. Their role is associated with interaction with the environment, for example for defence, as elicitors or as attractants. Some of these have useful pharmacological or nutritional properties, while others are toxic.

secondary metabolite Product of secondary metabolism.

secondary oocyte See: oocyte.

secondary phloem Phloem tissue formed by the vascular cambium during secondary growth in a vascular plant.

secondary plant product See: secondary metabolite.

secondary root A branch or lateral root.

secondary spermatocyte See: spermatocyte.

secondary structure Localized three dimensional conformations adopted by macromolecules, in particular nucleic acids and polypeptides. These arise as a result of the action of non-covalent forces generated by interactions between residues which are brought into close contact with one another. Examples are alpha-helix regions and beta-pleated sheets in proteins, and hairpin loops in nucleic acids. See: primary structure, tertiary structure, quaternary structure.

secondary thickening Deposition of secondary cell wall materials which result in an increase in thickness in stems and roots.

secondary vascular tissue Vascular tissue (xylem and phloem) formed by the vascular cambium during secondary growth in a vascular plant.

secondary xylem See: secondary vascular tissue.

secretion The transport of a molecule from the inside of a cell through the cell membrane.

seed Botanically, the matured ovule without accessory parts. Colloquially, anything which may be sown; i.e. seed potatoes (which are vegetative tubers); seed of wheat (karyopses) etc.
seed storage proteins Proteins accumulated in large amounts in protein bodies within seeds. They act as a source of amino acids during germination. Of interest in biotechnology: 1. As a major source of human and animal nutritional protein. 2. As a model expression system. Since they are produced in large amounts relative to other proteins, and are stored in stable, compact bodies in the plant seed, it may be possible to engineer transgenes which are expressed in the same way as seed storage proteins - i.e. in large amounts and in a convenient form.

segment-polarity gene A gene that functions to define the anterior and posterior components of body segments in Drosophila.

segregant An individual derived from a cross between two unlike parents.

segregation For genes, the separation of allele pairs from one another and their resulting assortment into different cells at meiosis. For chromosomes, the separation and re-assortment of the two homologues in anaphase of the first meiotic division. For individuals, the occurrence of different genotypes and/or phenotypes among offspring, resulting from chromosome or allele separation in their heterozygous parents.

selectable Having a gene product that, when present, enables the identification and preferential propagation of a particular genotype. See: reporter gene.

selectable marker A gene whose expression allows the identification of a specific trait or gene in an organism.

selection 1. Differential survival and reproduction of phenotypes. 2. A system for either isolating or identifying specific genotypes in a mixed population.

selection coefficient A measure of the intensity of selection at a locus, commonly abbreviated as s. It represents the proportionate reduction in the gametic contribution of a particular genotype, compared with the (generally most favoured) standard genotype.

selection culture A selection based on difference(s) in environmental conditions or in culture medium composition, such that preferred variant cells or cell lines (presumptive or putative mutants) are favoured over other variants or the wild type.

selection differential The difference between the mean of the individuals selected to be parents and the mean of the overall population; it represents the average superiority of the selected parents; commonly abbreviated as S.

selection pressure The intensity of selection acting on a population of organisms or on cells in culture. Its effectiveness is measured in terms of differential survival and reproduction, and consequently in changes in allele frequency in a population.

selection response The difference between the mean of the individuals selected to be parents and the mean of their offspring. Predicted response is calculated as the product of narrow-sense heritability and selection differential.

self-incompatibility In plants, the inability of the pollen to fertilize ovules (female gametes) of the same plant.

self-replicating elements Extrachromosomal DNA elements that have origins of replication for the initiation of their own DNA synthesis.

SEM Abbreviation for scanning electron microscope.

semen sexing Synonym of sperm sexing.

semi-conservative replication During DNA duplication, each strand of a parent DNA molecule acts as a template for the synthesis of a new complementary strand. Thus, one half of a pre-existing DNA molecule is conserved during each round of replication.

semi-continuous culture Cells in an actively dividing state which are maintained in culture by periodically draining off the medium and replenishing it with fresh medium.

semi-permeable membrane A natural or synthetic material which selectively allows the passage of certain ions or molecules.

semi-sterility The condition of partial fertility. Often associated with chromosomal aberrations or the result of mutagenesis.

senescence A late stage in the development of multicellular organisms, during which irreversible loss of function and degradation of biological components occur. The physiological ageing process in which cells and tissues deteriorate and finally die.

sense RNA The RNA transcript of the coding strand DNA (often represented as the (+)-strand). Opposite: antisense RNA. When both sense and antisense transcripts of a gene are present simultaneously, gene silencing is often the result.

tolerance In diagnostic tests, the smallest amount of the target molecule that the assay can detect.

sepsis Destruction of tissue by pathogenic micro-organisms or their toxins, especially through infection of a wound.

septate (adj.) See: septum.

septum A dividing wall or partition, which splits a structure into separate cells or compartments.

sequence The linear order of nucleotides along a DNA or RNA molecule, and the process of obtaining this. Genome sequencing aims to generate the linear order of all nucleotides present in the nuclear DNA of an organism.

sequence characterized amplified region (Abbreviation: SCAR). A molecular marker obtained by the conversion to a sequence-tagged site of a single random amplified polymorphic DNA product.

sequence divergence The percent difference in the nucleotide sequence between related nucleic acid sequences, or in the amino acid sequence in a comparison between related proteins.

sequence hypothesis The concept that genetic information exists as a linear DNA code, and that DNA and gene product sequence are collinear.


sequence-tagged site (Abbreviation: STS). Short unique DNA sequence (200-500 bp long) that can be amplified by PCR and is thus tagged to the site on the chromosome from which it was amplified.
serial division Splitting of excised shoot-tip material growing in vitro, in order to induce the development of greater numbers of plantlets.

serial float culture A technique whereby immature anthers are floated on a liquid medium, and continue their development through to the release of pollen.

serology The study of serum reactions between an antigen and its antibody. Mainly used to identify and distinguish between antigens, such as those specific to particular microorganisms or viruses.

serum Blood plasma that has had its clotting factor removed.

serum albumin A globular protein obtained from blood and body fluids. Bovine and human serum albumins are abbreviated BSA and HSA respectively.

sewage treatment A widespread biotechnological processes in developed economies. Methods vary widely, but all are designed for the biological break-down of human and animal waste in order to allow safe discharge into the environment.

sex chromosome Differentiated chromosome which is responsible for the determination of sex of the individual. For all mammals, a small number of flowering plants and many insects, female individuals carry a pair of X chromosomes, and males carry one X and one Y. For birds, reptiles and most amphibians, male individuals carry a pair of W chromosomes, and females carry one W and one Z. In some insects there is only one sex chromosome, X, and sex is determined by the number of these present. Synonym: allosome. Opposite: autosome.

sex determination Any method by which the distinction between males and females is established in a species, particularly at an early stage of foetal development.

sex duction The incorporation of bacterial genes into F factors and their subsequent transfer, by conjugation, to a recipient cell.

sex factor A bacterial episome (e.g. the F plasmid in E. coli) that enables the cell to be a donor of genetic material. The sex factor may be propagated in the cytoplasm, or it may be integrated into the bacterial chromosome.

sex hormones Steroid hormones that control sexual development in animals.

sex linkage Referring to genes present on one of the sex chromosomes, thus genetically linked to the sex of the individual.

sex mosaic Synonym of gynandromorph.

sexed embryos Embryos separated according to sex.

sex-influenced dominance The tendency for gene action to vary between the sexes within a species. For example, the presence of horns in some breeds of sheep appears to be dominant in males but recessive in females.

sex-limited Expression of a trait in only one sex; e.g. milk production in mammals; egg production in chickens.

sexual reproduction The process whereby two gametes fuse to form one fertilized cell (zygote).
shake culture An agitated suspension in culture providing adequate aeration for cells in the liquid medium. Usually achieved using platform shakers, or by constant stirring with a magnetic stirrer.

shaker A platform, with set or variable speed control, used to agitate vessels containing liquid cell cultures. Also described as a platform shaker.

shear Literally the sliding of one layer across another, with deformation and fracturing in the direction parallel to the movement. In the present context, used to describe 1. the forces that cells are subjected to in a bioreactor or a mechanical device used for cell breakage. 2. the intentional or unintentional fragmentation of large DNA molecules, achieved commonly by passing a concentrated DNA solution through a hypodermic needle. This treatment generates random breaks in the DNA, and the average size of fragments can be manipulated by varying the bore of the needle.

Shine-Dalgarno sequence A conserved sequence of prokaryotic mRNAs that is complementary to a sequence near the 5' terminus of the 16S ribosomal RNA and is involved in the initiation of translation. See: ribosomal binding site.

shoot apex See: shoot tip.

shoot differentiation The development of growing points, leaf primordia and finally shoots from a shoot tip, axial bud, or callus surface.

shoot tip The terminal bud (0.1 - 1.0 mm) of a plant, which consists of the apical meristem (0.05 - 0.1 mm) and the immediately surrounding leaf primordia and developing leaves, and adjacent stem tissue. Synonym: shoot apex.

shoot-tip graft A shoot tip or meristem tip grafted onto a prepared seedling or micropropagated rootstock in culture. Meristem tip grafting is mainly used for in vitro virus elimination from Citrus spp. and other plants. Synonym: micrograft.

short interspersed nuclear element (Abbreviation: SINE). Families of short (150-300 bp), moderately repetitive DNA elements of eukaryotic genomes. They appear to be DNA copies of certain tRNA molecules, created presumably by the unintended action of reverse transcriptase during retroviral infection.

short-day plant A plant which will not flower until triggered to do so by exposure to one or a number of dark periods equal to or longer than its critical period. Other plant species are long-day and some are daylength neutral. Genetic variation for daylength sensitivity is present in many crop species.

shotgun genome sequencing A strategy for sequencing a whole genome, in which the genomic DNA is initially fragmented into pieces small enough to be sequenced. Specialized computer software is then used to piece together the individual sequences to create long contiguous tracts of sequenced DNA.

shuttle vector A plasmid capable of replicating in two different host organisms because it carries two different origins of replication and can therefore be used to transfer genes from one to the other. Synonym: bifunctional vector.

sib-mating The deliberate crossing of siblings. Generally done where self-incompatibility prevents the production of self-fertilized progeny.
siderophore A low molecular weight entity that binds very tightly to iron. Siderophores are synthesized by a variety of soil micro-organisms to ensure that the organism is able to obtain sufficient amounts of iron from the environment.

sieve cell A long and slender sieve element in vascular plants, characterized by relatively unspecialized sieve areas and tapering end walls that lack sieve plates.

sieve element The phloem cell concerned with longitudinal conduction of food materials.

sieve plate Perforated wall area in a sieve tube element, through which strands connecting sieve tube protoplasts can pass.

sieve tube A tube within the phloem tissue of a plant, composed of joined sieve elements.

sigma factor The sub-unit of prokaryotic RNA polymerases responsible for the initiation of transcription at specific initiation sequences.

signal peptide See: signal sequence.

signal sequence A stretch of 15-30 amino acid residues at the N terminus of a protein, which is thought to enable the protein to be secreted (pass through a cell membrane). The signal sequence is removed as the protein is secreted. Synonyms: signal peptide, leader peptide.

signal transduction The biochemical events that conduct the signal of a hormone or growth factor from the cell exterior, through the cell membrane, and into the cytoplasm. This involves a number of molecules, including receptors, ligands and messengers.

signal-to-noise ratio A specifically produced response (signal) compared to the response level (noise) when no specific stimulus (activity) is present.

silencing Loss of gene expression either through an alteration in the DNA sequence of a structural gene, or its regulatory region; or because of interactions between its transcript and other mRNAs present in the cell (see: antisense RNA).

silent mutation See: mutation.


SINE Abbreviation for short interspersed nuclear element.

single-cell line See: cell strain.

single-cell protein (Abbreviation: SCP). Protein produced by micro-organisms, particularly yeast. Used as either a feed or a food additive.

single copy A gene or DNA sequence which occurs only once per (haploid) genome. Many structural genes are single copy.

single domain antibody See: dAb.

single node culture Culture of separate lateral buds, each carrying a piece of stem tissue.
single nucleotide polymorphism (Abbreviation: SNP). A genetic marker resulting from variation in sequence at a particular position within a DNA sequence. SNPs are commonly the result of transition changes (A for G, T for C), but also transversions (G or A for T or C) and single base deletions. Such variation is extensive throughout all genomes, and offers the particular advantage of being detectable without the need for gel electrophoresis.

single primer amplification reaction (Abbreviation: SPAR). A PCR-based genotyping technique in which genomic template is amplified with a single primer.

double-strand conformational polymorphism (Abbreviation: SSCP). A technique for detection of mutations in a defined DNA sequence. Single-stranded polynucleotides are electrophoretically separated on non-denaturing gels. Intrachain base pairing results in a limited number of conformers stabilized by intrachain loops, and mutated DNA shows on electrophoresis an altered assortment of such conformers.

sire Male animal chosen for breeding.

sister chromatid exchange (Abbreviation: SCE). Reciprocal interchanges of the two chromatid arms within a single chromosome.

site-specific A term used to describe any process or enzyme which acts at a defined sequence within a DNA or RNA molecule.

site-specific mutagenesis The induction of mutations, by molecular biology techniques, in one or more specific nucleotides within a defined coding sequence in order to create altered forms of the gene product. Used to define the active sites of proteins and for protein engineering.

sitosterol See: phytosterol.

six-base cutter Type II restriction endonucleases whose recognition site and cleavage site consist of a characteristic sequence of six nucleotide pairs. See: four-base cutter.

small nuclear ribonucleoprotein (Abbreviation: snRNP). A complex of small nuclear RNA and nuclear protein, heavily involved in the post-transcriptional processing of mRNA, especially the removal of introns. snRNPs are a major component of spliceosomes.

small nuclear RNA (Abbreviation: snRNA). RNA transcripts of 100-300 bp that associate with proteins to form small nuclear ribonucleoprotein particles. Most snRNAs are components of the spliceosomes.

SNP Abbreviation for single nucleotide polymorphism.

snRNA Abbreviation for small nuclear RNA.
snRNP Abbreviation for small nuclear ribonucleoprotein.

sodium dodecyl sulphate (Abbreviation: SDS). A detergent used to solubilize protein and DNA from biological materials. Specific use in sodium dodecyl sulphate polyacrylamide gel electrophoresis.

sodium dodecyl sulphate polyacrylamide gel electrophoresis (Abbreviation: SDS-PAGE). A widely employed electrophoretic method for the separation of proteins from biological samples. The sodium dodecyl sulphate gives a uniform charge density to the surface of proteins or nucleic acids, so that their rate of migration through the gel is determined largely by their molecular weight.

soil amelioration The improvement of poor soils. Includes the fungal and bacterial break down of plant organic matter, to form humus; the release of minerals - such as phosphates - to the soil, making them available to plants; the fixation of nitrogen. Can sometimes include an element of bioremediation.

soil-less culture Growing plants in nutrient solution without soil. *Synonym: hydroponics.*

solid medium Nutrient medium solidified by the addition of a gelling agent, commonly agar.

somaclonal variation Epigenetic or genetic changes induced during the callus phase of plant cells cultured *in vitro.* Sometimes visible as changed phenotype in plants regenerated from culture.

somatic Referring to cell types, structures and processes other than those associated with the germ line.

somatic cell Cells not involved in sexual reproduction, i.e. not germ cells.

somatic cell embryogenesis The process of differentiation of somatic embryos either from explant cells (direct embryogenesis), or from callus generated from explants (indirect embryogenesis). *Synonym: asexual embryogenesis.*

somatic cell gene therapy The delivery of a transgene(s) to a somatic tissue in order to correct a physiological defect.

somatic cell hybrid panel A panel of cells created by cell fusion, typically involving a reference species (e.g. hamster) and the species of interest (e.g. sheep) with each member of the panel containing a different mixture of chromosomes from the two species. By relating the presence or absence of cloned fragments (via in situ hybridization) or PCR products to the presence or absence of particular chromosomes from the species of interest, such panels can be used for physical mapping.

somatic cell variant A somatic cell with unique characters not present in the other cells, and which could be selected for by an appropriate screen.

somatic embryo An organized embryo-like structure. Although morphologically similar to a zygotic embryo it is initiated from somatic plant cells. Under in vitro conditions, somatic embryos go through developmental processes similar to embryos of zygotic origin. Each somatic embryo is potentially capable of developing into a normal plantlet.

somatic hybridization Naturally occurring or induced fusion of somatic protoplasts or cells of two genetically different parents. The difference may be as wide as interspecific. Wide synthetic hybrids formed in this way (i.e. not via gametic fusion) are known as cybrids. Not all cybrids contain the full genetic information (nuclear and non-nuclear) of both parents.
somatic hypermutation The high frequency of mutation that occurs in the gene segments encoding the variable regions of immunoglobulins during the differentiation of B lymphocytes into antibody producing plasma cells.

somatic reduction Halving of the chromosomal number of somatic cells; a possible method of producing "haploids" from somatic cells and calli by artificial means.

somatocrinin Growth hormone-releasing hormone. See: growth hormone.

somatostatin Growth hormone-inhibiting hormone. See: growth hormone.

somatotropin See: growth hormone.

sonication Disruption of cells or DNA molecules by high frequency sound waves.

SOS response The synthesis of a whole set of DNA repair, recombination and replication proteins in bacteria suffering severe DNA damage (e.g. following exposure to UV light).

source DNA The DNA from an organism that contains a target gene, and used as the starting material in a cloning experiment.

source organism A bacterium, plant or animal from which DNA is purified and used in a cloning experiment.

Southern blot A nitrocellulose or nylon membrane to which DNA fragments previously separated by gel electrophoresis, have been transferred by capillary action. See: blot.

Southern hybridization A procedure in which a cloned, labelled segment of DNA is hybridized to DNA restriction fragments on a Southern blot.

spacer sequence A DNA sequence separating neighbouring genes; spacer sequences are not usually transcribed.

SPAR Abbreviation for single primer amplification reaction.

sparger A device that introduces, into a bioreactor, air in the form of fine bubbles.

spatial autocorrelation statistics A set of statistical parameters aimed to depict the spatial (geographical) pattern of genetic diversity in a population.

speciation The evolutionary differentiation of a pre-existing species into one or more distinct species.

species A class of individuals capable of interbreeding, but which is reproductively isolated from other such groups having many characteristics in common. A somewhat arbitrary and sometimes blurred classification; but still quite useful in many situations.

specific combining ability (Abbreviation: SCA). A component of genetic variance calculable where a number of genotypes are intercrossed in all possible combinations. The SCA measures the deviation of the performance of a particular cross from the average general combining ability of its two parents.

specificity For diagnostic tests, the ability of a probe to react precisely and uniquely with its target molecule.
spent medium After sub-culture, medium which is discarded because it has been depleted of nutrients, dehydrated, or accumulated toxic metabolic products.

sperm Abbreviation for spermatozoon.

sperm competition Competition between different spermatozoa to fertilize the egg cell of a single female.

sperm sexing The separation of mammalian sperm into those bearing an X chromosome and those bearing a Y chromosome, in order to be able to produce, via artificial insemination or in vitro fertilization, animals of a specified sex. Methods for achieving this include the inactivation of X-bearing or Y-bearing sperm by antibodies recognizing sex-specific sperm surface peptides, and fluorescence-activated cell sorting.

spermatid Immature spermatozoon. One of the four cells formed at the end of the second meiotic division in spermatogenesis.

spermatocyte The premeiotic parental cell of the spermatids; the primary spermatocyte before the initiation of the first meiotic division; the secondary spermatocyte after completion of the first meiotic division, but before the initiation of the second division. Synonym: sperm mother cell.

spermatogenesis The series of cell divisions in the testis as a result of which the formation and the maturation of the male gametes (i.e. sperm) are achieved.

spermatogonium (pl.: spermatogonia) Primordial male germ cell. These can either divide by mitosis to produce daughter cells, or enter a growth phase and differentiate into a primary spermatocyte.

spermatozoon (Abbreviation: sperm). (pl.: spermatozoa) The mature, mobile gametic cell of male animals, produced in the testis.

spheroplast (AlteRNAtive spelling: sphaeroplast). A microbial or plant cell from which most of the cell wall has been removed, usually by enzymatic treatment. Strictly, in a spheroplast, some of the cell wall remains, while in a protoplast the cell wall has been completely removed. In practice, the two words are often used interchangeably.

spike 1. An inflorescence in which the main axis is elongated and the flowers are sessile. 2. The deliberate addition of a known quantity of a known substance to an analytical sample, used to validate the analytical technique.

spikelet The unit of inflorescence in grasses, made up of a small group of florets.

spindle An intracellular fibrous structure, involved in the control of chromosome movement in mitosis and meiosis.

spliceosome A complex of small nuclear ribonucleoproteins and other proteins that assemble on an immature mRNA and catalyse the excision of an intron. See: splicing.

splicing 1. During the maturation of eukaryotic mRNA, the process that removes intron sequences and covalently joins exon sequences. Synonym: editing. 2. In recombinant DNA technology, the term refers to the ligation of two fragments of DNA together.
splicing junction The DNA sequence immediately surrounding the boundary between an exon and an intron. There is a degree of sequence conservation in these regions, allowing the identification of introns in newly sequenced genes.

split gene In eukaryotes, the encoding DNA of many structural genes is made up of exons and introns. This commonly found pattern of interruption in the coding sequence is referred to as a 'split gene'.

spontaneous mutation A mutation occurring in the absence of any known mutagen.

sporangium (pl.: sporangia) A reproductive structure in plants that produces spores. A megasporangium produces megaspores, which give rise to the female gametophyte; in seed plants it is represented by the ovule. A microsporangium produces microspores, which give rise to the male gametophyte; it is represented in seed plants by the pollen sac.

spore 1. A reproductive cell that develops into an individual without union with other cells; some spores such as meiospores are the product of the germ line, but others are asexual in nature. 2. A small, protected resting body, often synthesized by micro-organisms when nutrient levels are low.

spore mother cell Synonym of sporocyte.

sporocyte A diploid germ line cell that is the parent of the four haploid spores generated by meiosis.

sporophyll A leaf that bears sporangia.

sporophyte The diploid generation in the life cycle of a plant, and that produces haploid spores by meiosis.

sport An individual plant, or portion thereof, showing a recognizably different phenotype from the parent, presumably as a result of spontaneous mutation. Novel traits displayed by some sports can become of great agricultural worth, but generally they are disadvantageous.

ssDNA Abbreviation for single-stranded DNA.

SSR Abbreviation for simple sequence repeat. See: microsatellite.

stacked genes Refers to the insertion of two or more genes into the genome of an organism. An example would be a plant carrying a Bt transgene giving insect resistance, and a bar transgene giving resistance to a specific herbicide.

stages of culture (I-IV) See: micropropagation.

staggered cuts Symmetrically cleaved phosphodiester bonds that lie on both strands of double-stranded DNA, but are not opposite one another.

stamen Floral structure made up of an anther and a filament. The stamen is the male organ of a flower.

standard deviation A statistical measure of variability in a population of individuals or in a set of data.

standard error A statistical measure that indicates the predictive accuracy over all individuals of a mean value derived from a sample population.
**starch** The major plant **carbohydrate** storage substance, particularly but not exclusively found in seeds, and used both as food and feed source and for various industrial processes. A large water-insoluble heterogenous group of **polysaccharides**, consisting of various proportions of the two glucose **polymers**, **amylose** and **amylopectin**. Starch is broken down into simple metabolisable sugars **in vivo** by the action of **amylases**.

**start codon** The codon which specifies the first **amino acid** of a **polypeptide** chain and at which the **ribosome** starts the process of **translation**. In bacteria, this is either AUG (translated as **n-formyl methionine**) or, rarely, GUG (**valine**). In eukaryotes, it is always AUG and is translated as methionine. The start codon sets the **reading frame** for translation. **Synonym**: **initiation codon**.

**starter culture** **Micro-organisms** that are deliberately added to foods to alter flavour, colour, texture, smell, or taste.

**stationary culture** A culture maintained without agitation.

**stationary phase** The plateau of the growth curve, during which **cell number** remains relatively constant, following the **logarithmic phase**. **See**: **growth phases**.

**steady state** In a **continuous fermentation** process, the condition under which the number of cells removed with the **outflow** is exactly balanced by the number of newly synthesized cells.

**stele** The central **vascular** cylinder, inside the cortex, of roots and stems of higher plants.

**stem** The main body of the above-ground portion of a tree, shrub, herb or other plant; the ascending axis, whether above or below ground, of a plant.

**stem cell** An undifferentiated **somatic cell** that is capable of either division to give rise to daughter stem cells, or differentiating into any specialized cell type given the appropriate signals. Cultured stem cells are critical to the concept of **therapeutic cloning**.

**sterile** 1. Medium or object free of **viable** micro-organisms (**see**: disinfect). 2. Incapable of producing viable gametes.

**sterile room** Dedicated space for the carrying out of activities that require **sterile** conditions. Can usually be achieved more economically with a **laminar air-flow cabinet**.

**sterility** Complete or partial failure of an individual to produce functional gametes or **viable** zygotes under a given set of environmental conditions.

**sterilize** 1. The elimination of micro-organisms, using heat, irradiation, **filtration** or chemicals. 2. The operation of making an animal incapable of producing offspring.

**Steward bottle** Flask developed for the growth of cells and tissues in a liquid medium, in which they can be periodically submerged during rotation.

**sticky end** **See**: **extension**.

**stigma** Receptive portion of the **style**, to which **pollen** adheres.

**stirred-tank fermenter** A growth vessel in which cells or micro-organisms are mixed by mechanically-driven impellers.

**stock** The lower portion of a graft. **See**: **rootstock**.
**stock plant** The source plant from which cuttings or explants are obtained. Stock plants should be well maintained to optimize explant and cutting quality.

**stock solution** Pre-prepared solution of commonly used reagents.

**stolon** A lateral stem that grows horizontally along the ground surface. Used by some plant species as a mechanism for dispersal, since stolon nodes can differentiate into normal stems and roots, giving rise to a daughter plant removed from the parent.

**stoma** (pl.: stomata) 1. Any of various small openings or pores in an animal body, especially an opening resembling a mouth in various invertebrates. 2. A pore in the epidermis of the leaf or stem of a plant, which allows the exchange of gases, including water vapour, to and from the intercellular spaces. Sometimes used loosely to refer to the pore along with its associated pair of guard cells. *Synonym*: stomate. *See*: stomatal complex.

**stomatal complex** Includes the stoma, together with its guard cells and, when present, any related subsidiary cells.

**stomatal index** A measurement of the surface density of stomata. This parameter has been found useful in comparing leaves of different sizes. Relative humidity and light intensity during leaf development affect the value of stomatal index.

**stop codon** A set of three nucleotides for which there is no corresponding tRNA molecule to insert an amino acid into the polypeptide chain. Protein synthesis is hence terminated and the completed polypeptide released from the ribosome. Three stop codons are known: UAA (ochre), UAG (amber) and UGA (opal). *Synonyms*: chain terminator; nonsense codon, termination codon.

**STR** Abbreviation for sequence tandem repeat. *See*: tandem repeat.

**strain** A group of individuals derived by descent from a single individual within a species.

**stratification** Subjection of moist seeds to a period of low temperature (+2 to +4 °C) to break dormancy.

**streptavidin** A microbial protein with a high affinity for the B complex vitamin biotin. The specific interaction of these two molecules has been exploited in labelling technology and in applications where a specific molecule needs to be captured or purified.

**stress** Non-optimal conditions for growth. Stresses may be imposed by biotic (pathogens, pests) or abiotic (environment, such as heat, drought etc.) factors.

**stress protein** *See*: heat shock protein.

**stringency** Reaction conditions (notably temperature, salt concentration and pH) that affect the annealing process of single-stranded DNA or RNA to make double-stranded DNA or RNA, or DNA/RNA hybrids. At high stringency, duplexes form only between strands with perfect complementarity; lower stringency allows the annealing of strands with some degree of mismatch.

**stringent plasmid** A plasmid that can only replicate at the same time as does the main bacterial chromosome, and is present as a single or, at most, several copies per cell.

**stroma** The supporting connective tissue of an organ or plastid.
**structural gene** A gene that encodes a polypeptide, with either enzymatic or structural functions, and that is required for the normal **metabolism** and growth of a cell or organism.

**structure-functionalism** The scientific tradition that stresses the relationship between a physical structure and its function, e.g. the related disciplines of anatomy and physiology.

STS Abbreviation for **sequence-tagged site**.

**style** Slender column of tissue that arises from the top of the **ovary** and terminates in the **stigma**, and through which the **pollen** tube must grow to achieve fertilization.

**sub-clone** A procedure in which a large cloned **DNA** molecule is divided into smaller fragments, each one of which is then separately cloned.

**sub-culture** Division and transfer of a portion of a culture to fresh medium. Sometimes used to denote the adding of fresh liquid to a suspension culture. **Synonym**: passage.

**sub-culture interval** The time between consecutive sub-cultures of cells.

**sub-culture number** The number of times cells, etc., have been sub-cultured.

**subgenomic promoter** A **promoter** added to a **virus** for a specific **heterologous** gene, resulting in the formation of **mRNA** for that **gene** alone.

**subspecies** Population(s) of organisms sharing certain characteristics that are not present in other populations of the same species.

**sub-strain** Derived from a **strain** by the isolation of an individual or group of individuals having properties or markers not shared by the strain as a whole.

**substrate** 1. A compound that is altered by an enzyme. 2. Food source for growing cells or micro-organisms. 3. Material on which a sedentary organism lives and grows.

**sub-unit vaccine** One or more immunogenic **proteins**, either purified from the **pathogen** itself or produced from a cloned pathogen gene. A **vaccine** composed of a purified **antigenic** determinant that is separated from the virulent organism.

**sucker** A shoot that arises from an underground **root** or **stem**. Of particular significance to grafted plants, since the sucker will be genotypically **rootstock**, rather than **scion**.

**suckering** Type of vegetative **propagation** where lateral buds grow out to produce an individual that is a **clone** of the parent.

**sucrose density gradient centrifugation** A procedure used to fractionate nucleic acids on the basis of their size.

**superbug** Jargon for a particular engineered **strain** of **Pseudomonas**, in which various hydrocarbon-degrading genes, derived from different plasmids, were combined into one genotype. This provided the basis for the precedent-setting legal decision that declared that genetically engineered organisms were patentable. See: **Chakrabarty decision**

**supercoil** The conformation of a **double-stranded DNA** molecule placed under torsional **stress** as a result of interactions with **proteins**. The stress is accommodated by a twist imposed on the duplex. A left-handed supercoil favours unwinding of the **double helix**; a right-handed supercoil favours tighter winding.
**supercoiled plasmid** The predominant *in vivo* form of most *plasmids*, in which the *DNA* is coiled around *histone*-like *proteins*. When supporting *proteins* are stripped away during DNA extraction from the bacterial cell, the plasmid molecule also tends to supercoil around itself *in vitro*.

**supergene** A group of tightly linked genes that are co-inherited, and may be functionally related.

**supernatant** The liquid phase remaining after insoluble materials are pelleted by *centrifugation* or precipitation.

**suppressor mutation** A mutation that reverses the effect of an earlier mutation, e.g. a mutation in a *gene* for a tRNA that permits it to read and override an amber mutation.

**suppressor-sensitive mutant** An organism that can grow in the presence, but not in the absence of a second genetic factor (the suppressor).

**susceptible** Inability to withstand injury due to biotic or *abiotic stress*. *Opposite*: *resistance*, *tolerance*.

**suspension culture** A type of culture in which cells and/or clumps of cells grow and multiply while suspended in a liquid medium.

**symbiont** An organism living in *symbiosis* with another, dissimilar organism.

**symbiosis** The close association of two different kinds of living organisms where there is benefit to both or where both receive an advantage from the association. A prominent example is the colonization of *Rhizobium* spp. inside the roots of leguminous plants.

**sympatric speciation** The evolution of new *species* by *populations* that inhabit the same or overlapping geographic regions.

**sympodial** A type of plant development in which the *terminal bud* of the *stem* stops growing due either to its abortion, or to its differentiation into a floral *meristem*. Frequently, the uppermost *lateral bud* then takes over the further axial growth of the stem.

**synapsis** Synonym of chromosome pairing.

**synaptonemal complex** (Abbreviation: SC). A ribbon-like *protein*aceous structure formed between paired *homologous chromosomes* at the end of the first meiotic *prophase*. The SC binds the *chromatids* along their length, and facilitates *crossing over*.

**synchronous culture** A culture in which the *cell cycle* is synchronized for the majority of the cells present. Synchrony can be induced by the addition of drugs which arrest the cell cycle at specific stages.

**syncytium** A group of cells in which cytoplasmic continuity is maintained; the effect is of a multinucleate cell.

**syndrome** A group of specific characters that occur together, and are characteristic of a particular disease or genetic condition (e.g. Down's syndrome).

**synergid** One of the two *haploid* nuclei at the micropylar end of the *embryo sac* of higher plants. The third *nucleus* is the *egg*.
synergism An interaction between two organisms (e.g. *Rhizobium* and legumes) in which the growth of one is helped by the other. **Opposite:** antagonism.

syngamy Synonym of fertilization.

synkaryon The initial hybrid nucleus of the zygote, formed by the fusion of the gametic nuclei upon fertilization. A hybrid nucleus formed by the fusion of two different somatic cells during somatic cell hybridization is called a heterokaryon.

synteny The occurrence of two or more loci on the same chromosome, without regard to their genetic linkage. Increasingly used to describe the conservation of gene order between related species.

T Abbreviation for thymine.

T cell Lymphocytes which pass through the thymus gland during maturation. Different kinds of T cells play important roles in the immune response. **Synonym:** T lymphocyte. See: T-cell-mediated (cellular) immune response.

T cell receptor An antigen-binding protein, located on the surface of mammalian killer T cells, which mediates the cellular immune response. T cell antigen encoding genes are assembled from gene segments by somatic recombination processes that occur during lymphocyte differentiation.

T lymphocyte See: T cell.

T₀, T₁ and T₂ Successive generations of plants following a transformation event. The parent transformed plant is T₀, its immediate progeny is T₁, and the progeny of the T₁ are T₂ plants etc. Of particular interest is the stability of transgene expression from T₀ to T₂, and beyond.

T4 DNA ligase An enzyme, present in bacteria infected with bacteriophage T4, which catalyses the joining (ligation) of, and repairs nicks in, duplex DNA molecules. Ligation activity requires that one DNA molecule has a 5'-phosphate group, and that the other has a free 3'-hydroxyl group.

tag See: label.

tailing The in vitro addition, to the 3'-hydroxyl ends of a double-stranded DNA molecule, of multiple copies of a single nucleotide by the enzyme terminal transferase. **Synonym:** homopolymeric tailing.

tandem array See: tandem repeat.

tandem repeat Two (or more) contiguous identical DNA sequences. The orientation can be either head-to-tail, or head-to-head. **Synonyms:** tandem array, sequence tandem repeat.

tank bioreactor A fermentation vessel designed to grow large scale quantities of a microorganism (bacteria, yeast or fungi). Most tank bioreactors are designed to be stirred mechanically, since this allows effective distribution throughout the culture of gas and nutrients. Alternative bioreactors use fibre or membrane surfaces to immobilize the cultured cells.

tap root Root system in which the primary root has a much larger diameter than any lateral roots (e.g. carrot). **Opposite:** fibrous root.
**Taq polymerase** A heat-stable **DNA polymerase** isolated from the thermophilic bacterium *Thermus aquaticus*, widely used in **PCR**.

**target** In diagnostic tests, the molecule or **nucleic acid** sequence assayed in a sample. In **mutagenesis**, the **gene sequence** that needs to be altered to generate the desired change in **phenotype**.

**target site duplication** A short sequence of **DNA** duplicated when a **transposable element** inserts at a new locus; usually found at each end of the insertion.

**targeted drug delivery** A method of delivering the activated form of a **drug** molecule to the site in the body where it is needed, rather than allowing it reach the target by uncontrolled diffusion.

**targeting vector** A cloning **vector** carrying a **DNA** sequence capable of participating in a recombinational event at a specified chromosomal location in the **host** cell.

**TATA box** A widely conserved adenine- and thymine-rich **DNA** sequence found 25-30 bp **upstream** of the **transcription** initiation point of many eukaryotic genes. The TATA box is implicated in the promotion of gene **transcription** as it acts as a binding site for **RNA polymerase**. Analogous to the **Pribnow box** in prokaryotic promoters. **Synonym**: Hogness box.

**tautomeric shift** The transfer of a hydrogen atom from one position in an organic molecule to another position. Tautomers can have widely different biological activities, as the shift can induce a significant change in the **conformation** of the molecule.

**tautomerism** A type of isomerism in which the two isomers arising from a **tautomeric shift** are in equilibrium.

**T-cell-mediated (cellular) immune response** The synthesis of antigen-specific **T cell** receptors and the development of killer T cells in response to an encounter of immune system cells with an unrecognized immunogenic molecule.

**T-DNA** The **DNA** segment of the **Ti plasmid**, present in pathogenic *Agrobacterium tumefaciens*, that is transferred to plant cells and inserted into the plant's **DNA** as part of the **infection** process. **Wild type** T-DNA encodes enzymes that induce the plant to synthesize specific **opines** that are required for bacterial growth. In engineered T-DNAs, these genes are replaced by a **transgene**(s).

**telomerase** An enzyme that maintains the structure of the **telomere** by adding the required repetitive sequences to the ends of eukaryotic chromosomes.

**telomere** The structure found at the end of eukaryotic chromosomes containing specialized repetitive (and widely conserved across species) **DNA** sequences, which are necessary to assure the completion of a cycle of **DNA** replication.

**telophase** The last stage in each mitotic or meiotic division, in which the chromosomes coalesce at each pole of the dividing cell.

**temperate phage** A phage (**virus**) that invades but does not normally destroy (lyse) the host bacterial cell. Under specific circumstances, the **lytic cycle** is induced, resulting in the release of infective phage particles.

**temperature-sensitive mutant** An organism that can grow at one temperature but not at another.
**temperature-sensitive protein** A protein that is functional at one temperature but loses function at another (usually higher) temperature.

**template** An RNA or single-stranded DNA molecule, used by polymerases to generate a complementary nucleotide strand.

**template strand** See: anticoding strand.

**terminal bud** A branch tip, an undeveloped shoot containing rudimentary floral buds or leaves, enclosed within protective bud scales.

**terminal transferase** An enzyme that catalyses the addition of nucleotides to the 3’ end of a DNA molecule.

**terminalization** Repelling movement of the centromeres of bivalents in the diplotene stage of the meiotic prophase, that appears to move visible chiasmata toward the ends of the bivalents.

**termination codon** See: stop codon.

**termination signal** In transcription, a nucleotide sequence that specifies RNA chain termination.

**terminator** 1. A DNA sequence just downstream of the coding segment of a gene, which is recognized by RNA polymerase as a signal to stop synthesizing mRNA. 2. A term used in GMO technology for a transgenic method which genetically sterilizes the progeny of the planted seed, thereby preventing the use of farm-saved seed.

**terminator codon** See: stop codon.

**terminator gene** A specific variety-level genetic use restriction technology. A patented technique.

**terminator region** A DNA sequence that signals the end of transcription.

**tertiary structure** The three-dimensional conformation taken up by complete macromolecules as a result of intramolecular interactions, such as hydrogen-bonding. See: primary structure, secondary structure, quaternary structure.

**testcross** A cross between a genetically unknown individual and a recessive tester to determine whether the individual in question is heterozygous or homozygous for a certain allele. It can also used as a method to test for linkage, i.e. to estimate recombination fraction.

**testis** (pl.: testes) Male sex organ where spermatozoa mature and are stored.

**testosterone** Male hormone, synthesized in the testis of mammals; used to induce sex reversal in fish.

**test-tube fertilization** See: in vitro fertilization.

**tetracycline** An antibiotic that interferes with protein synthesis in prokaryotes. A gene encoding resistance to tetracycline has been widely used as a marker to distinguish between transformed and non-transformed cells in the production of transgenic plants.
tetrad The four haploid cells formed after the second meiotic division in plants (pollen tetrads) or fungi (ascospores).

tetraploid An organism, or a tissue whose cells contain four haploid sets of chromosomes.

tetrasomic (Noun: tetrasome). Pertaining to a nucleus or an organism with four members of one of its chromosomes, whereas the remainder of its chromosome complement is diploid. Chromosome formula: 2n + 2.

tetratype In fungi, a tetrad of spores that contains four different types; e.g. AB, aB, Ab and ab.

TGGE Abbreviation for thermal gel gradient electrophoresis.

thallus Plant body without true roots, stems, or leaves.

therapeutic agent A compound used for the treatment of a disease or for improving the well-being of an organism. Synonyms: pharmaceutical agent, drug.

therapeutic cloning The potential use of stem cells to grow, in vitro, tissue or organs for use in transplantation. Because these cells would be obtained from, and would therefore be genetically identical to the patient's own cells, problems of transplant rejection would be overcome. The technique would also remove the difficulty of identifying an organ donor.

thermal gel gradient electrophoresis (Abbreviation: TGGE). A method for separating DNA fragments according to their mobility under increasingly denaturing conditions imposed by heat.

thermal shock Exposure to reduced or increased temperature for a significant period.

thermolabile Not resistant to heat, often in the context of a molecule which is unstable upon heating. Opposite: thermostable.

thermophile An organism which is adapted to high temperatures, such as in hot springs and geysers, smoker vents on the sea floor, and domestic hot water pipes. A wide range of bacteria, fungi and simple plants and animals can grow at temperature up to 50 °C; thermophiles grow and reproduce at above 50 °C. They can be classified, according to their optimal growth temperature, into simple thermophiles (50-65 °C); thermophiles (65-85 °C), and extreme thermophiles (>85 °C). See: mesophile, psychrophile.

thermosensitivity Loss of biological activity of a molecule at high temperature.

thermostable A molecule which retains its biological activity at some specified higher temperature. Opposite: thermolabile.

thermotherapy Exposure to elevated temperatures, a technique mainly used for virus or mycoplasma elimination, taking advantage of the higher thermostability of the host over its pathogen. Synonym: heat therapy.

thinning 1. Removal of older stems to promote new growth. 2. Removal of excess fruits to improve the size and quality of the remaining fruits. 3. Removal of seedlings spaced too closely for optimum growth.

thymidine The deoxyribonucleoside resulting from the combination of the base thymine (T) and the sugar 2-deoxy-D-ribose. See: TTP.
**thymidine kinase** (Abbreviation: tk). An enzyme that allows a cell to utilize an alternate metabolic pathway for incorporating thymidine into DNA. Used as a **selectable marker** to identify transfected eukaryotic cells.

**thymidine triphosphate** Abbreviation: TTP; dTTP is strictly correct but rarely used.

**thymidylic acid** (Abbreviation: TMP or dTMP). Synonym for thymidine 5'-monophosphate, a deoxyribonucleotide containing the nucleoside thymidine.

**thymine** (Abbreviation: T). One the bases found in DNA. See: thymidine.

**Ti plasmid** Tumour-inducing plasmid. A large plasmid present in pathogenic Agrobacterium tumefaciens, responsible for the induction of tumours in plant with crown gall disease. Engineered forms of this plasmid are central to the production of transgenics in many crop species. See: T-DNA.

**tissue** A group of cells of similar structure which sometimes performs a special function.

**tissue culture** The *in vitro* culture of cells, tissues or organs in a nutrient medium under sterile conditions.

**titre** 1. The concentration of infectious virus particles present in a suspension. 2. A measure of antibody concentration, given by the highest dilution of the sample that results either in a useable immunoassay, or in the formation of visible precipitate when challenged by the appropriate antigen.

**tk** Abbreviation for thymidine kinase.

**TMP** Abbreviation for the deoxyribonucleotide thymidine 5'-monophosphate. See: thymidylic acid.

**tolerance** Incomplete resistance to a given biotic or abiotic stress. Tolerant genotypes are less inhibited by the stress, but are not immune.

**tonoplast** The cytoplasmic membrane bordering the vacuole of plant cells. It plays a prominent role in regulating the osmotic pressure exerted by the cell sap.

**topo-isomerase** See: DNA topo-isomerase.

**totipotency** The ability of a cell or tissue to be induced to regenerate into a complete organism.

**totipotent** (adj.) See: totipotency.

**toxicity** The extent to which a toxic compound negatively affects a given trait.

**toxin** A compound produced by one organism, which is deleterious to the growth and/or survival of another organism of the same or different species.

**tracer** A substance (typically a radioactive isotope or a fluorescent dye) that can be detected by physical means, and which is used to analyse the progress of a chemical reaction or a biological process.

**tracheid** An elongated, tapering xylem cell, with lignified pitted walls, adapted for solute conduction and physical support. Found in conifers, ferns and related plants.
trait One of the many characteristics that define an organism. The phenotype is a description of one or more traits. Synonym: character.

**trans configuration** See: repulsion.

**trans heterozygote** A double heterozygote that contains two mutations arranged in the trans configuration.

**trans test** See: complementation test.

**trans-acting** 1. A term describing substances that are diffusable and that can affect spatially separated entities within cells. 2. A genetic element (e.g. a promoter sequence) that is effective only when present in the trans configuration.

**trans-acting factor** Any of the multiple ancillary DNA-binding proteins that interact with the cis-regulatory DNA sequences to control gene expression.

**transcapsidation** The partial or full coating of the nucleic acid of a virus particle with the coat protein of a different virus.

**transcript** An RNA molecule that has been synthesized from a specific DNA template. In eukaryotes, the primary transcript produced by RNA polymerase is often processed or modified in order to form functional mRNA, rRNA or tRNA. See: splicing.

**transcription** Synthesis of RNA from a DNA template via RNA polymerase.

**transcription factor** A protein that regulates the transcription of genes.

**transcription unit** A segment of DNA that contains signals for the initiation and termination of transcription, and is transcribed into one RNA molecule.

**transcriptional anti-terminator** A protein that prevents RNA polymerase from terminating transcription at specific transcription termination sequences.

**transcriptional roadblock** A DNA-binding protein which affects the rate at which RNA polymerases transcribe genes. The protein/DNA complex interferes with the passage of the elongation complex. In some cases these obstacles are readily bypassed, but in others a significant level of pausing or termination occurs, and this can then act as a control point for gene expression.

**transducing phage** See: transduction.

**transduction** 1. Genetic: the transfer by means of a viral vector of a DNA sequence from one cell to another. 2. Signal: any process that helps to produce biological responses to events in the environment (e.g. transduction of hormone binding into cellular events by hormone receptors).

**transfection** The infection of a cell with isolated viral DNA (or RNA), resulting in the production of intact viral particles.

**transfer RNA** See: tRNA.

**transferase** A class of enzymes that catalyses the transfer of a group of atoms from one molecule to another.
**transformant** A cell or organism that has been genetically altered through the integration of a **transgene**. Primary: the first generation following the **transformation** event. Secondary: progeny of the primary transformant.

**transformation** 1. The uptake and integration of DNA in a cell, in which the introduced DNA is intended to change the **phenotype** of the recipient **organism** in a predictable manner. 2. The conversion, by various means, of cultured animal cells from controlled to uncontrolled cell growth, typically through **infection** with a **tumour virus** or **transfection** with an **oncogene**.

**transformation efficiency or frequency** The fraction of a cell population that takes up and integrates the introduced **transgene**; expressed as the number of transformed cells recovered divided by the total number of cells in a **population**.

**transforming oncogene** A gene that, upon **transfection**, converts a previously immortalized cell to the malignant **phenotype**.

**transgene** An isolated **gene sequence** used to transform an **organism**. Often, but not always, the transgene has been derived from a different species than that of the recipient.

**transgenesis** The introduction of a **gene** or genes into animal or plant cells, which leads to the transmission of the input gene (**transgene**) to successive generations.

**transgenic** An individual in which a **transgene** has been integrated into its **genome**. In transgenic eukaryotes, the transgene must be transmitted through **meiosis** to allow its **inheritance** by the **offspring**.

**transgressive variation** The appearance, in a segregating generation, of individuals showing expression of a **trait** outside the extremes defined by the parent of the **cross** that was used to generate the **population**.

**transient expression** Short-term activity of a **transgene** following its introduction into **target tissue**. Transient expression usually implies non-integration of the transgene into the **host genome**.

**transition** The substitution in DNA or RNA of one purine by another purine, or of one pyrimidine by another pyrimidine. **See**: **transversion**, **base substitution**.

**transition stage** The period between juvenile and reproductive stages of growth.

**transition-state intermediate** In a chemical reaction, an unstable and high-energy configuration assumed by reactants on the way to making products. Enzymes are thought to bind and stabilize the transition state, thus lowering the energy of activation needed to drive the reaction to completion.

**translation** The process of polypeptide synthesis in which the amino acid **sequence** is determined by mRNA, mediated by tRNA molecules, and carried out on ribosomes.

**translational initiation signal** **See**: initiation codon.

**translational start codon** **See**: initiation codon.

**translational stop signal** **See**: termination codon.
translocation 1. The movement of nutrients or products of metabolism from one location to another. 2. Change in position of a segment of a chromosome to another, non-homologous chromosome.

transposable (genetic) element A DNA element that can move from one location in the genome to another. Synonym: transposon.

transposase An enzyme encoded by a transposon gene that catalyses the movement of a DNA sequence to a different site in a DNA molecule.

transposition The process whereby a transposon or insertion sequence inserts itself into a new site on the same or another DNA molecule. The exact mechanism is not fully understood and different transposons may transpose by different mechanisms. Transposition in bacteria does not require extensive DNA homology between the transposon and the target DNA.

transposon Synonym of transposable genetic element.

transposon tagging A method of gene isolation that exploits the disruption of normal gene expression that is the result of an insertion of a transposon within, or close to the target. Since the sequence of the transposon is known, this can be used as a DNA probe to define the DNA fragment containing the target gene. Large-scale experiments to generate populations of gene mutations are colloquially referred to as gene machines.

transversion The substitution in DNA or RNA of one purine by a pyrimidine or vice versa. See: transition, base substitution.

tribrid protein A fusion protein that has three segments, each encoded by parts of different genes.

trichome A short filament of cells, resulting in a hair-like structure.

tri-hybrid The hybrid offspring of a cross between parents carrying contrasting alleles at three loci.

trinucleotide repeat Tandem repeats of three nucleotides that are present in many genes. Commonly trinucleotide repeats have undergone variable expansion in copy number, forming the basis of microsatellite markers, and occasionally resulting in the formation of alleles giving rise to genetic disease.

tripartite mating A process in which conjugation is used to transfer a plasmid vector to a target cell when the plasmid vector is not self-mobilizable.

triplet A sequential group of three nucleotides in DNA or RNA. See: codon.

triploid A cell, tissue or organism containing three times the haploid number of chromosomes.

trisomic (adj.) See: trisomy.

trisomy The presence in a diploid cell or organism of an extra chromosome of one homologue (chromosome formula: 2n + 1). See: disomy; monosomic.

triticale The hybrid man-made species formed by the crossing of tetraploid or hexaploid wheat with diploid rye.
tRNA Abbreviation for transfer RNA. Small RNA molecules that transfer amino acids to the ribosome during protein synthesis. Each tRNA binds just one species of amino acid and recognizes a specific codon in the mRNA, thus implementing the genetic code.

tropism Plant response to an external stimulus, resulting in the bending/turning of stem or root growth. Typical tropisms are phototropism (light), geotropism (gravity) or hydrotropism (water).

true-to-type Conforming to the phenotype of the breed/variety.

trypsin A proteolytic enzyme used in vivo for the digestion of peptides. It acts by hydrolysing peptide bonds on the carboxyl side of the amino acids arginine and lysine.

trypsin inhibitor Substances inactivating trypsin, typically found in seed tissue of certain plants, where they are thought to have evolved as anti-feedant agents against insect predators.

TTP Abbreviation for thymidine 5'-triphosphate. TTP is required for DNA synthesis since it is a direct precursor molecule. See: thymidine, thymidylic acid.

tubulin The major protein component of the microtubules of eukaryotic cells.

tumble tube A glass tube mainly used in vitro to agitate and consequently aerate suspension cultures. The tube, which is commonly attached to a slowly revolving platform, is closed at both ends, with a side-neck opening.

tumor-suppressor gene A gene that regulates cell growth. If such a gene becomes dysfunctional, and potentiating damage occurs to the cell, then uncontrolled growth and a cancer may result. See: p53 gene, oncogene.

tumour virus A virus capable of transforming a cell to a malignant phenotype.

tumour-inducing plasmid See: Ti plasmid.

tunica The outer one- to four-cell layer region of the apical meristem, where cell division is anticlinal, i.e. perpendicular to the surface. See: apical meristem.

turbidostat An open continuous culture in which a pre-selected biomass density is uniformly maintained by automatic removal of excess cells. The fresh medium flows in response to an increase in the turbidity (usually corresponding to cell density) of the culture.

turgid Swollen, distended; referring to a cell that is extended as a result of adequate water uptake. Loss of turgidity in plant cells is a sign of water deficit.

turgor potential See: pressure potential.

turgor pressure The pressure within a cell resulting from the absorption of water into the vacuole and the imbibition of water by the protoplasm.

turion An underground bud or shoot from which an aerial stem arises. See: sucker.

twin One of two individuals originating from the same zygote.

U Abbreviation for uracil.
ubiquitin A small protein, present in all eukaryotic cells, which plays an important role in tagging proteins destined for proteolytic cleavage (because they are damaged or no longer needed).

ultrasonication See: sonication.

UMP Abbreviation for the (ribo)nucleotide uridine 5'-monophosphate. See: uridylic acid.

understock Host plant for a grafted scion, a branch or shoot from another plant; an understock may be a fully grown tree or a stump with a living root system.

undifferentiated Undifferentiated cells are those which have not been committed to become part of a specialized tissue.

unencapsidated A virus not enclosed by a coat protein or capsid.

unequal crossing over Abnormal meiotic event, in which one chromatid contains a duplication and the other a deletion. Often arises in a region containing repeated DNA sequences, which can pair out of register.

unicellular Tissues, organs or organisms consisting of a single cell.

uniparental inheritance The inheritance of genes exclusively from one parent, e.g. chloroplast DNA is inherited either maternally (many angiosperms) or paternally (most gymnosperms).

unisexual Higher organisms (animals or plants) possessing either male or female reproductive organs, but not both.

univalent An unpaired chromosome at the first division of meiosis.

universal donor cell Cells that, after introduction into a recipient, will not induce an immune response that leads to their rejection.

universality Referring to the genetic code, the triplet codons are translated to the same amino acid, with minor exceptions, in virtually all species.

unorganized growth In vitro formation of tissues with few differentiated cell types and no recognizable structure; typical structure of calli formed in tissue culture. Opposite: organized growth.

upstream 1. The stretch of DNA lying in the 5' direction from the site being considered. Where the reference point is the initiation of transcription, the first transcribed base is designated +1 and upstream nucleotides are marked with minus signs, e.g. -1, -10; 2. In chemical engineering, those phases of a manufacturing process that precede the biotransformation step. Refers to the preparation of raw materials for a fermentation process. Also called upstream processing.

upstream processing See: upstream (2).

uracil (Abbreviation: U). One the bases found in RNA. See: uridine.

uridine The (ribo)nucleoside resulting from the combination of the base uracil (U) and the sugar D-ribose. See: uridylic acid, uridine triphosphate.
uridine triphosphate (uridine 5'-triphosphate) (Abbreviation: UTP). Required for RNA synthesis since it is a direct precursor molecule. See: uridylic acid.

uridylic acid Synonym for uridine 5'-monophosphate (abbreviation: UMP), a (ribo)nucleotide containing the base uracil. See: uridine triphosphate.

utilization of farm animal genetic resources The use and development of animal genetic resources for the production of food in a sustainable system of agriculture.

UTP See: uridine triphosphate.

V region Variable region in antibodies. See: CDR.

v/v Abbreviation for volume per volume. The relative proportion of each liquid in a mixture.

vaccination See: preventive immunization.

vaccine A preparation of dead or attenuated (weakened) pathogens, or of derived antigenic determinants, that can induce the formation of antibodies in a host, and thereby produce host immunity against the pathogen. See: sub-unit vaccine, viral vaccine, DNA vaccine, inoculum.

Vaccinia The cowpox virus used to vaccinate against smallpox and, experimentally, as a carrier of genes for antigenic determinants cloned from other disease organisms.

vacuole A fluid-filled membrane-bound cavity inside many plant cells, in which various plant products and by-products are stored.

variable domain Regions of antibody molecules that have different amino acid sequences in different antibody molecules. These regions are responsible for the antigen-binding specificity of the antibody.

variable expressivity Variation in the phenotype caused by different alleles of the same gene and/or by the action of other genes and/or by the action of non-genetic factors.

variable number tandem repeat (Abbreviation: VNTR). A DNA sequence, present as tandem repeats, for which the number of copies varies greatly between unrelated genotypes.

variable surface glycoprotein (Abbreviation: VSG). One of a battery of antigenic determinants expressed by a micro-organism to elude immune detection.

variance A statistical term representing a measure of the dispersion of data from the overall mean. Used to quantify the variability of a population.

variant An individual that is genetically distinct from others in the population.

variation Differences between individuals within a population or among populations.

variegation The occurrence, within a single tissue, organ or organism, of mosaicism. Usually referring to plants showing either both green and albino colouration in a leaf, or flecks of contrasting colour in a flower. The origin of variegation can be through viral infection, nutritional deficiency, or genetic instability caused by transposon activity. See also: chimera
**variety** 1. A naturally occurring subdivision of a species, with distinct morphological characters. 2. A defined strain of a crop plant, selected on the basis of phenotypic (sometimes genotypic) homogeneity.

**vascular** Plant tissue specialized for the conduction of water or nutrients.

**vascular bundle** A strand of tissue containing primary xylem and primary phloem (and procambium if present) and frequently enclosed by a bundle sheath of parenchyma or fibres.

**vascular cambium** In biennials and perennials, cambium giving rise to secondary phloem and secondary xylem.

**vascular plant** Plant species possessing organized vascular tissues.

**vascular system** 1. A specialized network of vessels for the circulation of fluids throughout the body tissue of an animal. 2. The system of vascular tissue in plants.

**vector** 1. An organism, usually an insect, that carries and transmits pathogens. 2. A small DNA molecule (plasmid, virus, bacteriophage, artificial or cut DNA molecule) that can be used to deliver DNA into a cell. Vectors must be capable of being replicated and contain cloning sites for the introduction of foreign DNA.

**vegetative propagation** See: asexual propagation.

**velocity density gradient centrifugation** A procedure used to separate macromolecules based on their rate of movement through a density gradient.

**velogenetics** The combined use of marker-assisted selection and embryo technologies such as OPU, IVM and IVF, in order to increase the rate of genetic improvement in animal populations.

**vermiculite** Material made from expanded mica used as a rooting medium and as a soil additive.

**vernalization** Chilling juvenile plants for a minimum period in order to induce flowering. Some plants require veRNAlization to flower, but others have no such requirement.

**vessel** A series of xylem elements whose function is to conduct water and nutrients in plants.

**vessel element** A type of cell occurring within the xylem of flowering plants. Many are water-conducting vessels.

**viability** The capability to live and develop normally.

**viability test** Assay of the number or percent of living cells or plants in a population following a specific treatment. Often used to describe quality of seed following long-term storage.

**viable** Capable of normal completion of life cycle.

**vibrio** Comma-shaped bacterium.

**vir genes** A set of genes on a Ti plasmid that prepare the T-DNA segment for transfer into a plant cell.
viral coat protein A protein present in the layer surrounding the nucleic acid core of a virus.

viral oncogene A viral gene that promotes tumour development in a host.

viral pathogen A disease-causing virus.

viral vaccine Vaccine consisting of live viruses, genetically engineered to avoid causing the disease itself.

virion A complete infectious virus particle.

viroid A plant pathogenic agent, composed of an infectious single-stranded low molecular weight RNA, and no coat protein.

virulence The degree of ability of an organism to cause disease. The relative infectiousness of a bacterium or virus, or its ability to overcome the resistance of the host metabolism.

virulent phage A phage that destroys its host bacterium.

viruliferous A vector (usually insect) organism that carries virions and spreads the virus from host to host by mechanical means.

virus An infectious particle composed of a protein capsule and a nucleic acid core (DNA or RNA), which is dependent on a host organism for replication.

virus-free Plant, animal, cell, tissue or meristem which exhibits no viral symptoms or contains no identifiable virus particles.

virus-tested Description of an organism or a cell stock certified as being free of certain specified viruses following recognized procedures of virus diagnosis.

vitamin Naturally occurring organic substance required by living organisms in small amounts to maintain normal health.

vitrified Cultured tissue having leaves and sometimes stems with a glassy, transparent or wet and often swollen appearance. The process of vitrification is a general term for a variety of physiological disorders that lead to shoot tip and leaf necrosis. Synonym: water soaked.

viviparous (adj.) See: vivipary.

vivipary 1. A form of reproduction in animals in which the developing embryo obtains its nourishment directly from the mother via a placenta or by other means. 2. A form of asexual reproduction in certain plants, in which the flower develops into a bud-like structure that forms a new plant when detached from the parent. 3. The development of young plants in the inflorescence of the parent plant.

$V_{\text{max}}$ The maximal rate of an enzyme-catalysed reaction. $V_{\text{max}}$ is the product of $E_o$ (the total amount of enzyme) and $K_{\text{cat}}$ (the catalytic rate constant).

VNTR Abbreviation for variable number tandem repeat.

volatilization The conversion of a solid or liquid into a gas or vapour.

VSG Abbreviation for variable surface glycoprotein.
**w/v** Abbreviation for weight per volume. The relative proportions of solid and liquid in a solution.

**walking** See: chromosome walking; primer walking.

**wall pressure** Pressure that a cell wall exerts against the turgor of the cell contents. Wall pressure is equal and opposite to the turgor potential.

**wash-out** The loss of the slower growing micro-organism when two organisms are being grown together.

**water potential** The pressure gradient that induces the flow of water, particularly with reference to plant water uptake from the soil, comprising the net effects of suction, solutes and matric forces.

**water soaked** See: vitrified.

**water stress** Occurs when plants are unable to absorb enough water to replace that lost by transpiration. Short-term water stress leads to turgor loss (wilting). Prolonged stress leads to cessation of growth, and eventually plant death.

**wax** Water-insoluble esters of long-chain acids with long-chain alcohols. Waxes form protective waterproof layers on leaves, stems, fruits, animal fur and integuments of insects.

**weed** A plant growing where it is not wanted. Generally used to describe plants which colonize readily, and can compete for resources with a planted crop.

**weediness** The ability of a plant to colonize a disturbed habitat and compete with cultivated species.

**western blot** A technique whereby a complex mixture of size-separated proteins is fixed to a solid support, and then probed with a labelled antibody. Useful, for example, for the measurement of levels of production of a specific protein in a particular tissue or at particular developmental stage.

**wet weight** See: fresh weight.

**wetting agent** A substance (usually a detergent) that improves the contact of a liquid to a solid surface by reducing its surface tension.

**wild type** The most frequent allele or genotype found in nature, or a specified organism against which mutants are defined.

**wilt** Drooping of stems and foliage due to loss of cell turgor. May be caused by water stress or by disease.

**wilting point** The moisture content of soil at which plants start to wilt, but not to the extent that they fail to recover when placed in a humid atmosphere. See: permanent wilting point.

**wobble hypothesis** An explanation of how one tRNA may recognize more than one codon. The first two bases of the mRNA codon and anticodon pair properly, but the third base in the anticodon has some flexibility that permits it to pair with either the expected base or an alternative.

**x** The basic number of chromosomes in a polyploid series, monoploid/haploid = x; diploid = 2x; triploid = 3x; etc.
xanthophyll A yellow oxygen-containing carotenoid, present in chloroplasts.

**X-chromosome** See: sex chromosome.

**xenia** The immediate effect of pollen on some characters of the endosperm.

**xenobiotic** A chemical compound that is not produced by, and often cannot be degraded by, living organisms.

**xenogeneic** Refers to organs, genetically engineered (“humanized”) to decrease the chance of rejection, that have been grown in an animal of another species for potential transplant to humans.

**xenotransplantation** The transplantation of tissue or organs from one species to another species, typically from pigs to humans. Zoonoses are an important issue.

**xerophyte** A plant very resistant to drought, typically adapted to extremely dry environments.

**X-linked** The presence of a gene on the X-chromosome.

**X-linked disease** A genetic disease caused by an allele at a locus on the X-chromosome.

**xylem** A complex tissue specialized for the conduction of water and mineral nutrients in solution. Xylem may also function as a supporting tissue, particularly secondary xylem.

**YAC** Abbreviation for yeast artificial chromosome.

**Y-chromosome** See: sex chromosome.

**yeast** A unicellular ascomycete fungus, commonly found as a contaminant in plant tissue culture.

**yeast artificial chromosome** (Abbreviation: YAC). A vector which can be propagated in budding yeast (Saccharomyces pombe), consisting of the minimal elements required for a chromosome to replicate, and allowing for the cloning of large DNA fragments (hundreds of kilobase pairs).

**yeast episomal vector** (Abbreviation: YEp). A cloning plasmid vector for the yeast Saccharomyces cerevisiae maintained as an extrachromosomal nuclear DNA molecule.

**yeast extract** A mixture of substances from yeast. See: organic complex.

**Z-DNA** A form of DNA, in which the double helix is wound in a left-hand, instead of a right-hand, manner. DNA adopts the Z conformation when purines and pyrimidines alternate on each strand, e.g. 5′CGCGCGCG 3′ or 3′GCGCGCGC5′. Synonym: zig-zag DNA.

**zig-zag DNA** See: Z-DNA.

**zinc finger** A DNA-binding protein motif, characterized by two closely spaced cysteine and two histidine residues that serve as ligands for a single Zn^{2+} ion. When bound, the structure takes on a conformation in which amino acid side chains protrude in a way that allows interaction with the DNA major groove.

**zone of elongation** The section of the young root or shoot just behind the apical meristem, in which the cells are enlarging and elongating rapidly.
zoo blot Hybridization of cloned DNA from one species to DNA from a range of other organisms to determine the extent to which the cloned DNA is evolutionarily conserved.

zoo FISH Fluorescence in situ hybridization technique, probing metaphase chromosomes of one species with DNA from another species. The technique allows inferences to be made regarding the evolutionary relationships between species. See: Fluorescence in situ hybridization.

zoonosis A disease that is communicable from animals to humans.

zoospore A spore that possesses flagella and is therefore motile.

zygonema Stage of meiotic prophase during which chromosome synapsis occurs.

zygospore A thick-walled resistant spore developing from a zygote resulting from the fusion of gametes in the course of isogamy.

zygote The diploid cell formed by the fusion of two haploid gametes during fertilization in eukaryotic organisms with sexual reproduction.

zygotene (adj.) See: zygonema.

zymogen Inactive enzyme precursor that after secretion is chemically altered to the active form of the enzyme.