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**avoidance:** Ability of an organism to prevent an injurious stress, pathogen, or predator from penetrating its tissues (e.g., drought avoidance may be achieved through restriction of water loss or by expansion of the root system to a greater supply of water).

**awn:** A bristlelike extension of varying length originating from the lemma of the rice spikelet. Present in some varieties.

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***Bacillus thuringiensis* (Bt):** A bacterium that kills insects; a major component of the microbial pesticide industry and a subject in biotechnology.

**backcross:** A cross of an  $F_1$  hybrid or heterozygote with an individual of genotype identical to that on one or the other of the two parental individuals; matings involving a hybrid genotype are used in genetic analyses to determine linkage and crossing-over values. Desired character such as insect resistance is transferred into an improved variety carrying it as a recurrent parent to reinforce or increase the gene frequency of the character.

**backcross breeding:** (i). A system of breeding whereby recurrent backcrosses are made to one of the parents of a hybrid, accompanied by selection for a specific character(s). (ii). This is a type of repeated selection where a specific gene can be incorporated into otherwise superior cultivars. One of the parental varieties is highly productive and commercially successful but lacks a specific gene (e.g. disease resistance). This trait is usually present in the other parental variety. After each back cross, hybrid plants are identified with the gene under consideration and are back crossed again with the repeating parent. This technique is easy when traits are added which are easily inherited, dominant, and easily identified in hybrid plants. An advantage of the back crossing method is that extensive testing is not necessary. This method is used to create hybrid varieties in self fertilizing crops and to establish male sterility in parental lines. Marker-assisted backcrossing is routinely applied in breeding programs for gene introgression.

**backcross (donor) parent:** That parent of a hybrid with which it is again crossed or with which it is repeatedly crossed; backcrosses may involve

individuals of genotype identical to the parent rather than the parent itself.

**backcross-assisted selection (BCAS):** A method that allows the selection of plants carrying a favourable recessive allele at each generation, limiting the need for a progeny test, which is common in traditional backcrossing; in cases where the traditional means of selection are limited by environmental conditions (e.g., the presence of an abiotic or a biotic stress such as drought). This selection strategy is superior to conventional ones; particularly in genetic transformation approaches, where the transgenes can be used as markers, BCAS may show a considerable advantage.

**back mutation:** A reverse mutation in which a mutant gene reverts to the original standard form and/or wild type; it is rare to forward mutations, but often strongly selected for; the AMES test relies on back mutation for the detection of mutagens.

**backcross ratio:** The proportion of heterozygotes to recessive homozygotes expected in a backcross.

**bacteria (sing. bacterium):** These are unicellular microorganisms. They are typically a few micrometres long and have many shapes including spheres, rods, and spirals. The study of bacteria is bacteriology, a branch of microbiology. Bacteria are ubiquitous in every habitat on Earth, growing in soil, acidic hot springs, radioactive waste, seawater, and deep in the earth's crust. Some bacteria can even survive in the extreme cold and vacuum of outer space. There are typically 40 million bacterial cells in a gram of soil and a million bacterial cells in a millilitre of fresh water. Bacteria are prokaryotes. Unlike animals and other eukaryotes, bacterial cells do not contain a nucleus or other membrane-bound organelles.

**bacterial artificial chromosomes (BAC):** Pieces of plant DNA that have been cloned inside living bacteria; they can be used as probes to detect complementary DNA sequences within large pieces of DNA via hybridization techniques, or for marker-assisted selection by faster selection of segregant-bearing genes for a particular trait and to develop future crop varieties faster.

**bacterial chlorophyll:** Chlorophylls (bacteriochlorophylls a, b, c, d, e, and g) found in photosynthetic bacteria. They differ from plant chlorophyll in chemical construction and absorption spectra characteristics.

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**base pair (bp):** The nitrogenous bases (adenine-thymine/uracil; guanine-cytosine) that pair in double-stranded DNA or RNA molecules; 1,000 bp = 1 kb.

**base pairing:** A complementary binding by means of hydrogen bonds of a purine to a pyrimidine base in nucleic acids.

**base population:** The initial set of genotypes from which selections will be taken to establish a breeding population, e.g., the wild forest; it is also sometimes referred to in the same meaning as recruitment population (in the first generation they are actually the same, and it can be referred to as one of the populations in a stratified tiered structure).

**basic number (of chromosomes):** The haploid number of chromosomes in diploid ancestors of polyploids, represented by "x".

**basic seed:** A class of seed in a seed certification programme that is the last step in the initial seed multiplication and is intended for the production of certified seed. Seed stock used for the same purposes as basic seed, but not under a certification programme is referred to as "the equivalent of basic seed".

**basidioma (fungi):** A basidium-producing structure; a fruit-body containing basidia. pl. basidiomata.

**basidiomycetes:** The club fungi, a major group of fungi that all produce a structure (basidium) on which basidiospores are produced. Includes mushrooms and toadstools.

**basidiospore:** From a basidium of Basidiomycetes-produced haploid sexual spore that is formed after meiosis and exogenously laced up from a sterigma.

**basidium:** A club-shaped structure on which spores are produced.

**BC<sub>1</sub>, BC<sub>2</sub>, BC<sub>3</sub> (=B<sub>1</sub>, B<sub>2</sub> etc):** Symbols indicating the first, second, third, etc. backcross generations.

**B cells:** Type of lymphocyte responsible for antibody-mediated immunity; mature in the bone marrow and circulate in the circulatory and lymph systems where they transform into antibody-producing plasma cells when exposed to antigens.

**B chromosome:** Any chromosome of a heterogeneous group of chromosomes present in several plant species, which differ in their morphology, numerical variation, meiotic pairing, and mitotic behaviour from normal A chromosomes; they are also called supernumerary chromosomes, accessory chromosomes or extra chromosomes; a B chromosome

derives from the A chromosome complement by aberrant division processes and subsequent modifications; up to 12 and more B chromosomes were observed in addition to the diploid A chromosome complement (e.g., in rye).

**Beer's law:** Beer's law describes the light penetration into a crop canopy if the foliage distribution is uniform in horizontal line.

**behaviour genetics:** A branch of genetics dealing with the inheritance of different types and/or forms of behaviour.

**berry:** (i). Any fleshy simple fruit with one or more seeds and a skin, as a tomato, banana, grape, etc.; a several-sided indehiscent fruit with a fleshy pericarp and without a stony layer surrounding the seeds. (ii). In common parlance and in cuisine, refers generically to any small, edible fruit with multiple seeds. Aggregate fruits such as the blackberry, the raspberry, and the boysenberry are also berries in this sense, but not the botanical. These fruits tend to be small, sweet, juicy, and of a bright colour contrasting with their background to make them more attractive to animals that eat them, thus dispersing the seeds of the plant. Examples of botanical berries include the tomato, grape, litchi, kumquat, plantain, avocado, persimmon, eggplant, guava, uchuva (ground cherry), and chile pepper.

**best linear prediction (BLP) :** A statistical method that utilizes matrix algebra to predict the breeding values for any trait or selection index; in BLP, fixed effects are assumed to be known; BLP is especially suited for analyses of messy or unbalanced data.

**beta-carotene:** A form of carotene, precursor to vitamin A; a red-orange pigment found in plants and plant-eating animals, and also found in dark green and dark yellow fruits and vegetables. Beta carotene may have beneficial effects on the immune system.

**beta-DNA:** The normal form of DNA found in biological systems, which exists as a right-handed helix.

**biennial:** The kind of plant that produce vegetative growth during the first year of growing season. After a period of storage or over-wintering out of doors, flowers, fruits and seeds are produced during the second year and the plant dies.

**bimitosis:** The simultaneous occurrence of two mitoses in binucleate cells.

**bin:** An enclosed structure used for storage of seeds.

**binary fission:** The method by which bacteria reproduce. The circular DNA molecule is replicated; then the cell splits into two identical cells, each containing an exact copy of the original cell's DNA.

**binding site:** A place on cellular DNA to which a protein (such as a transcription factor) can bind. Typically, binding sites might be found in the vicinity of genes, and would be involved in activating transcription of that gene (promoter elements), in enhancing the transcription of that gene (enhancer elements), or in reducing the transcription of that gene (silencers). Note that whether the protein in fact performs these functions may depend on some condition, such as the presence of a hormone, or the tissue in which the gene is being examined. Binding sites could also be involved in the regulation of chromosome structure or of DNA replication.

**binemic:** Chromosomes that contain two DNA helices per metaphase chromatid.

**binomial nomenclature:** The system of naming organisms using a two-part Latinized (or scientific) name that was devised by the Swedish botanist Carolus Linnaeus (1707-1778); the first part is the generic name (genus), the second is the specific epithet or name (species); the Latin name is usually printed in italics, starting with a capital.

**bin sampler (seed):** The large sized trier, used for drawing samples from bins. These are constructed on the same principles as bag triers but are much larger.

**binucleate:** Cells with two nuclei.

**bioassay:** (i). The use of living organisms to quantitatively estimate the amount of biologically active substances present in a sample. (ii). In cell biology and molecular genetics: determination of the effectiveness of a compound by measuring its effect on plants or animal tissues or organisms in comparison with a standard preparation.

**biobased products:** Fuels, chemicals, building materials, or electric power or heat produced from biological material(s). The term may include any energy, commercial or industrial products, other than food or feed, that utilizes biological products or renewable domestic agricultural (plant, animal and marine), or forestry materials.

**biocatalyst:** A biological substance used to cause a particular chemical or biochemical reaction.

**biochemical genetics:** (i). A branch of genetics dealing with the chemical nature of hereditary determinants. (ii). The study of the relationships between genes and enzymes, specifically the role of genes in controlling the steps in biochemical pathways.

**biochemistry:** The chemistry of life; the branch of chemistry that is concerned with biological processes.

**biochip:** An electronic device that uses organic molecules to form a semiconductor; a microchip that uses tiny strands of DNA to latch onto and quickly recognize thousands of genes at a time; collection of miniaturized test sites (microarrays) arranged on a solid substrate that permits many tests to be performed at the same time in order to achieve higher throughput and speed. A biochip can perform thousands of biological reactions, such as decoding genes, in a few seconds. Biochips can also be used to rapidly detect chemical agents used in biological warfare so that defensive measures can be taken.

**biocide:** A natural or synthetic substance toxic to living organisms.

**biocoenose:** An assemblage of diverse organisms inhabiting a common biotope.

**biocoenosis:** A community or natural assemblage of organisms. The term often is used as an alternative to ecosystem, but strictly it is the fauna/flora association excluding physical aspects of the environment.

**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.

**biodiversity:** The totality of all the species of plants and animals in an area. The existence of a wide variety of species (species diversity), other taxa of plants or other organisms in a natural environment or habitat, or communities within a particular environment (ecological diversity), or of genetic variation within a species (genetic diversity); genetic diversity provides resources for genetic resistance to pests and diseases; in agriculture, biodiversity is a production system characterized by the presence of multiple plant and/or animal species, as contrasted with the genetic specialization of monoculture.

particular their larvae which are active between May and July in the northern hemisphere, are voracious predators of aphids such as greenfly and blackfly, and will also consume mites, scale insects and small caterpillars. Biocontrol methods may be an alternative or complement to chemical and gene-engineered pest control methods.

**biological half-life:** The time required for one-half of the total amount of a particular substance in a biological system to be consumed or broken down by biological processes when the rate of removal is approximately exponential. Toxic chemicals with a long biological half-life will tend to accumulate in the body and are more likely to be harmful. A substance with a short biological half-life may still accumulate if a portion of it becomes tightly bound to bone or other tissues, even if most of it is quickly eliminated from the body.

**biological pesticide (biopesticide):** A chemical which is derived from plants, fungi, bacteria, or other natural synthesis and which can be used for pest control.

**biological safety cabinet:** Enclosure in which one can work with relatively dangerous organisms without risk of acquiring or spreading infection caused by them. These cabinets, also called biosafety hoods, vary in design according to nature of agents to be worked with. The simpler ones maintain a negative pressure within the work area and a laminar air curtain, both of which operate to prevent escape of organisms from interior of hood. Air that is exhausted may be passed through a high-efficiency bacterial filter that will trap all microorganisms that are anticipated or may be passed through a furnace that will incinerate any organisms.

**bioluminescent:** Refers to organisms that emit light under certain conditions.

**biometrical genetics:** Quantitative genetics.

**biometry:** Mathematical statistics applied to biological investigations.

**bionomics:** The life history, habits, breeding, and adaptations of organisms.

**biopiracy:** The collecting and patenting of plants and other biological material formerly held in common and their exploitation for profit.

**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.

**bioseeds:** Seeds produced via genetic engineering of existing plants.

**biostatistics:** The application of statistics to biological data.

**biosynthesis:** The synthesis of the chemical components of the cell from simple precursors.

**biotechnology:** Any technique (e.g., recombinant DNA methods, protein engineering, cell fusion, nucleotide synthesis, biocatalysis, fermentation, cell cultures, cell manipulations etc.) that uses living organisms or parts of them to make or modify products, to improve organisms or to make them available for specific uses; more practically for plant breeding, applications are anther culture for haploid production, embryo/ovule culture after interspecific hybridization, genetic engineering (transformation), *in vitro* selection, *in vitro* germplasm conservation and exchange, micropropagation, cell and organ culture, somaclonal variation, somatic cell hybridization (protoplast fusion), or somatic embryogenesis.

**biotechnology-derived:** The use of molecular biology and/or recombinant DNA technology, or *in vitro* gene transfer, to develop products or to impart specific capabilities in plants or other living organisms.

**biotic/abiotic stresses:** Limitations imposed on development which occur because of biological (biotic) or physical (abiotic) factors.

**biotin(e):** It functions as coenzyme; is a part of the vitamin B complex; it is also called vitamin H; it is present in all living cells, bound to polypeptides or proteins; it is important in fat, protein, and carbohydrate metabolism; it is a common addition to plant tissue culture media.

**biotope:** A portion of a habitat characterized by uniformity in climate and distribution of biotic and abiotic components.

**biotoxin:** Any poisonous or venomous substance produced by any living organism.

**biotrophic pathogen:** A parasitic organism that obtains its nutrient supply only from living host tissue regardless of whether or not it can be artificially cultured.

**biotrophs:** Parasitic fungi that need a living host to complete their life cycles.

**biotrophy:** Biotrophs are typically obligate parasites and get nutrients from the living cells; the term can

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also cover the phase in the infection process where a necrotroph does not destroy the host (hemibiotrophic).

**biotypes:** (i). Individuals or populations of plants or animals that are morphologically alike but physiologically different. (ii). A population of insects capable of surviving on and damaging varieties that are resistant to other populations of the same insect species.

**bisexual:** Reproductive structure with both male and female equivalent parts (stamens and pistil in angiosperms; also called a perfect or complete flower); other terms widely used are hermaphrodite, monoclinous, and synoecious.

**bivalent:** Two homologous chromosomes when they are paired during prophase-metaphase of the first meiotic division.

**bla gene:** Beta-lactamase gene conferring resistance to ampicillin; commonly used as selective marker for plasmid vectors.

**blanch/ blanching:** A method to whiten or prevent from becoming green by excluding light; blanching is applied to the stems or leaves of plants (e.g., celery, lettuce, and endive); it is done either by banking up the soil around the stems, tying the leaves together to keep the inner ones from light, or covering with pots, boxes, etc.

**blast (rice):** A disease caused by the fungus *Pyricularia oryzae*. Leaf lesions are typically spindle-shaped, wide in the center and pointed toward either end. Large lesions usually develop gray centers. The disease can have different forms: leaf blast, node blast, or neck blast. Lesions on panicle neck nodes may result in empty panicles (often called rice blast), “rotten neck” or “neck rot” symptoms.

**blasting (rice):** A plant symptom characterized by shedding of unopened buds; leads to a failure of producing fruits or seeds.

**blastula (pl. blastulas or blastulae):** An early form in the development of an embryo, consisting of a spherical layer of cells filled with fluid; a blastosphere

**blending inheritance:** Inheritance in which the characters of the parents appear to blend into an intermediate level in the offspring with no apparent segregation in later generations.

**blight:** (i). Any agent causing widespread white colouring, yellowing or blackening necrosis of leaves and shoots. (ii). A plant disease symptom characterized by the presence of extensive necrotic areas on plant organs.

**B line:** The fertile counterpart or maintainer line of an A line; does not have fertility restorer genes; used as the pollen parent to maintain the A line; used in hybrid seed production. It is also known as a maintainer line.

**blooming:** In grasses, the period during which florets are open and anthers are extended.

**blossom:** The flower of a plant, especially of one producing an edible fruit; the state of flowering.

**blossom-end-rot (BER):** (i). A physiological and nutritional disorder on fruit creating a black, leathery, sunken appearance on the blossom end of the fruit – often associated with poor watering, root death, and calcium deficiency. (ii). It is a nutrient deficiency disorder affecting several crops, including eggplant, tomato, and peppers. The disease starts as sunken, dry decaying areas start at the blossom end of the fruit, furthest away from the stem. While the outward appearance of the fruit is that it is affected by a disease-causing pathogen, the disorder is actually the result of calcium deficiency. This may be the result of low soil calcium levels, incorrect fertilizer selection, ion competition, or drought stress.

**blot:** The transfer of DNA, RNA, or proteins to an immobilizing binding matrix, such as nitrocellulose, or the autoradiograph produced during certain blotting procedures (Southern blot, Northern blot, Western blot, etc.).

**blotting:** Any one of a number of techniques whereby chromatographically or electrophoretically separated DNA, RNA, or protein molecules can be transferred from the support medium, such as a gel, to another medium such as filter paper or membrane matrix. The transfer can be achieved by capillary action (Southern blotting, Northern blotting, Western blotting) or by electrophoresis (electroblotting).

**blotch:** A disease characterized by large and irregularly shaped spots or blots on leaves, shoots, and stem.

**boll:** The fruit of cotton.

**bolt:** Formation of an elongated stem or seedstalk; in the case of biennial plants, this generally occurs during the second season of growth.

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Ihssen (1911) for detecting seed-borne *Fusarium* infection in cereals; with modifications, the seeds are planted on damp brick grit or in a container of sand covered with 3 cm of damp brick grit, then germinated in darkness at room temperature of a specific time.

**bridge parent:** A parent that is sexually compatible with two reproductively isolated species and can be used to transfer genes between them.

**bridging species:** Species used in a bridging cross in order to bring together the two incompatible species.

**broad-sense heritability:** The ratio of total genetic variance to phenotypic variance; it is used to estimate the degree of genetic control of a trait in a population, and it is useful for predicting response to clonal selection.

**brown spot (rice):** A disease of rice caused by the fungus *Helminthosporium oryzae*, with leaf symptoms consisting of brown and oval spots with gray or whitish centers. The disease is also observed on the grains. The disease is closely associated with abnormal or poor soil and its occurrence serves as an indicator of poor soil conditions for rice production. It is sometimes called “poor man’s disease.”

**bryophyte:** Plants in which the gametophyte generation is the larger, persistent phase; they generally lack conducting tissues. Bryophytes include the Hepaticophyta (liverworts), Anthocerotophyta (hornworts), and Bryophyta (mosses).

**bud:** A short embryonic stem tip bearing leaves or flowers or both. The rudimentary or resting end or branch of a stem; usually referring to the stage in which the growing tips pass the winter or dry season; also applied to undeveloped flowers or flower clusters. Scaly buds are protected by modified leaves or stipules. Naked buds lack such special protection. Usually one bud occurs in each axil or angle above a leaf, but these often branch and collateral buds, standing side by side, are thus produced; in some plants several buds occur one above the other (superposed) in an axil.

**budding:** (i). 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. (ii). Among fungi, budding is characteristic of the brewers yeast *Saccharomyces cerevisiae*. (iii). 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. (iv). It is the formation of a new organism by the protrusion of part of another organism. This is very common in plants and fungi, but may be found in animal organisms, such as the hydra, as well. Usually, the protrusion stays attached to the primary organism for a while, before becoming free. The new organism is naturally genetically identical to the primary one (a clone). When yeast buds, one cell becomes two cells. When a sponge buds, a part of the parent sponge falls off and starts to grow into a new sponge. These are examples of asexual reproduction.

**bulb:** (i). An underground fleshy offspring of a plant that develops roots and shoots. (ii). It is an underground vertical shoot that has modified leaves (or thickened leaf bases) that is used as food storage organs by a dormant plant. A bulb’s leaf bases generally do not support leaves, but contain food reserves to enable the plant to survive adverse conditions. The leaf bases may overlap and surround the centre of the bulb as with lilies, or may completely surround the inner regions of the bulb, as with the onion. A modified stem forms the base of the bulb, and plant growth occurs from this basal plate. Roots emerge from the underside of the base, and new stems and leaves from the upper side.

**bulk breeding method:** The growing of genetically diverse populations of self-pollinated crops in a bulk plot with or without mass selection, followed by single plant selection.

**bulk population selection:** With this method of selection the offspring from a crossing are planted at planting densities equal to commercial planting densities. During this period, which may include a number of generations, the level of homozygosity in the bulk population increases. This method is simple and cheap and involves less work than pedigree selection in the earlier generations. It is necessary to plant large populations to ensure that the best segregates are selected when selection starts. Segregating generations are subjected to another single plant selection step. Fewer records are kept during earlier generations than with pedigree selection. This type of selection is especially carried out with crops which are usually planted at high planting densities, e.g. small grain crops.

**bulk segregant analysis:** Detection strategy used to define molecular regions controlling a certain