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Tree Improvement Glossary

Illustrated glossary of terms used in forest tree improvement

Schmidt, Lars Holger

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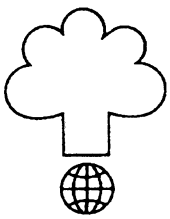
TREE IMPROVEMENT GLOSSARY

Illustrated glossary of terms used in forest tree improvement

compiled by

Lars Schmidt



Danida forest Seed Centre • Krogerupvej 21
DK-3050 Humlebaek • Denmark

PREFACE

In 1972, U.S. Department of Agriculture, Forest Service, published Glossary for Tree Improvement Workers, compiled by E.B. Snyder. In the 25 years that have elapsed since then there has been a marked expansion of research and development in the field of tree improvement. In accordance with that development, several new terms have come into common use. Therefore a new glossary on tree improvement has long been needed. The lack of a concise glossary was met by the compilation of a Tree Breeding Glossary, published as a Field Manual by the UNDP/FAO regional project RAS/91/004, Improved Productivity of Manmade Forest by the Application of Technological Advances in Tree Breeding and Propagation (FORTIP) in 1994. The glossary soon came out of print and a new updated and illustrated version was prepared as a second edition. However, because of fund cuts and later termination of the project the second edition was never published. In agreement with FAO, Danida Forest Seed Centre is now publishing this second edition of the FORTIP glossary, with some corrections and amendments, as a Technical Note.

The Glossary follows basically the outline of Snyder's glossary which was maintained in the first issue. Also, a number of terms are maintained in the definition of Snyder. Other major sources are given under the list of references. All sources which have contributed to the glossary are gratefully acknowledged.

Tree breeding encompasses a number of scientific and technical areas like floral-, reproductive- and micro-biology, genetics, breeding methods and strategies, propagation, data analysis and statistics, each area with a comprehensive terminology. It has not been possible to cover all these terms in a concise glossary. The terms selected for definition here are those most frequently used in tree breeding literature. Clonal propagation is included in the view of the great expansion of that field as a means of mass multiplication of improved material.

Most terms are explained separately rather than grouped with related terms. For example, various mating designs are explained under their particular name (diallel, factorial etc.) rather than under "mating design". However, most illustrations cover several terms and are shown under a selected term, e.g. clone, ramet and ortet under 'vegetative propagation'. Most illustrations are original, others are taken from various textbooks and referrences are found under the illustration. After each term is a list of related terms, which are defined in the glossary. The terms underlined contain an explanatory illustration.

The compiler owes a dept of gratitude to FORTIP tree improvement expert, Palle Havmoller, and Kirsten Olesen from Danida Forest Seed Centre for useful corrections of and suggestions to amendments to the manuscript.

Humlebaek, June 1997

Lars Schmidt

A

Adventitious: Organs that arise in unexpected positions e.g. adventitious roots growing from a stem or a leaf, or adventitious buds (and shoots) growing from a root segment.
See *Cutting, Dormant, Root sucker, Vegetative propagation*.

Aseptic culture: Procedures in tissue culture used to prevent the introduction of fungi, bacteria, vira, mycoplasma or other microorganisms into cell, tissue and organ culture.
See *Micropropagation, Sterile, Tissue culture.*

Acquired character: A modification developed during the lifetime of an organism as the result of environmental influences. Such modifications are not inherited.
See *Character, Inheritance, Phenotype*.

Adaptability: (1) The process of evolutionary (genetic) adjustments fitting individuals or groups to their environment. Also the changed structure or function itself. (2) A tree's performance over a full rotation in a new environment.
See *Adapted, Land race, Evolution, Mutation*.

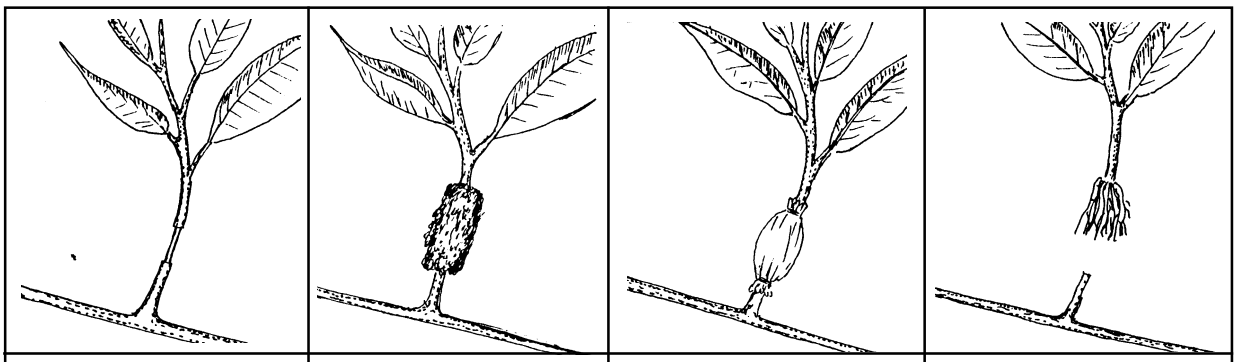
Adapted: Refers to how well trees are physiologically suited for high survival, good growth, and resistance to pests and adverse environments. For exotics it refers to how well the trees will perform in their new environment.
See *Adaptation, Land race.*

Additive genes: Genes conveying effects additively. Additivity is the basis for most quantitative inheritance theory and for most breeding efforts. F.ex., the expectation of hybrid performance is the average of the parental values, i.e., mid-parental.
See *Heritability, Hybrid, Quantitative genetics, Quantitative inheritance*.

Advanced-generation selection: Selection of a tree by genetic test of crosses among parents from previous generation. Some form of family and within-family selection is usually used to choose advanced-generation selections.
See *Juvenile selection, Mating design, Progeny test, Recurrent selection, Selection*.

Ageing (aging): A progression of physiological, cytological and biochemical events which ultimately leads to the death of an organ or an individual.
See *Dormancy, Seed vigor, Viability*

Air layering (=Marcotting): Procedure to develop roots on undetached aerial parts of a plant by girdling or wounding the area where roots are desired and surrounding the area with a rooting medium and possibly applying rooting hormone. See *Cambium, Cutting, Macropropagation, Rooting hormone, Vegetative propagation*.



1. Girding and scraping of cambium	2. Wrapping with e.g. peat moss	3. Covering with polythene sheet and tieing at both ends	4. When roots have developed, separation and planting

Albinism: Complete or nearly complete absence of pigment in a plant or parts of a plant. The affected parts are white or nearly so. An albino plant usually soon dies.
See *Lethal genes.*

Allele: One of an array of genes possible at a certain position (locus) on a given chromosome. Alternative (Mendelian) effects on the same character are produced by different alleles, e.g., as met in green or albino seedlings. If the array contains more than two genes, the genes are called multiple alleles. Multiple alleles arise by repeated mutations of a gene, each with different effects. No more than two alleles can be present in a given diploid organism.
See *Character, Chromosome, Diploid, Dominance, Gene, Heterozygous, Homologous chromosomes, Locus, Multiple alleles, Simple Mendelian inheritance*.

Allopatric: Genetically isolated species or races inhabiting separate geographic areas or adjacent but radically different habitats.
See *Geographical race, Race, Sympatric*.

Allozyme (alloenzyme): An isozyme which differs from other variants of the enzyme as a result of allelic difference, i.e different enzymes coded by the same gene locus.
See *Allele, Enzyme, Fingerprint, Isozyme, Marker.*

Aneuploidy: A condition in which not all the chromosomes are present in equal numbers and hence the total number is not an exact multiple of the haploid set. It occurs when chromosomes fail to separate during meiosis, so a gamete may either lack a chromosome or have an additional copy.
See *Chromosome set, Gamete, Hybrid sterility, Meiosis*.

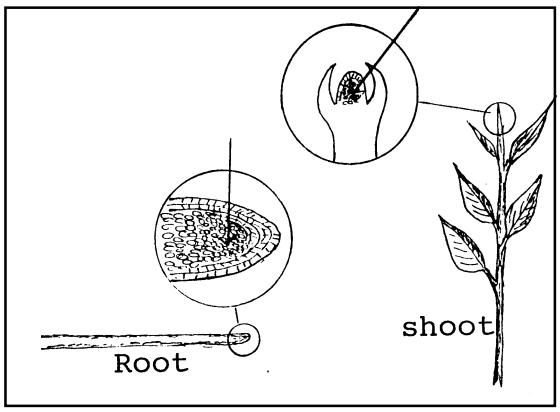
Anther: The pollen-bearing part of the stamen.
See *Anthesis, Dehiscence, Flower, Staminate*.

Anthesis: The period or stage of expansion of a flower; full bloom specified as diurnal, nocturnal, extended, etc. Often anthesis refers to the bursting of the pollen sacs with subsequent release of pollen.
See *Anther, Dehiscence, Phenology, Receptivity, Staminate.*

Apex (pl. apices): Tip, topmost part, pointed end of anything. In shoot and root, the tip containing the apical meristem.
See *Apical meristem.*

Apical: Related to the apex.
See *Apex, Apical meristem.*

Apical meristem: A group of meriste-matic cells at the apex of root or shoot that by cell division produce the precur-sors of the primary tissues of root and shoot; may be vegetative, initiating vegetative tissues and organs, or repro-ductive initiating reproductive tissues and organs.
See *Apex, Apical, Flower initiation, Meristem.*



Apomixis: A general term that includes all forms of asexual reproduction that tend to substitute for sexual regeneration. Often used to mean the production of seeds without fertilization occurring. Depending on the type of apomixis, an apomict usually is genetically identical with its source plant (ortet).
See *Asexual reproduction, Clone, Ortet, Parthenogenesis.*

Artificial pollination: Same as *Controlled pollination.*

Asexual reproduction: Reproduction without fertilization. New individuals may develop from vegetative parts such as tubers, bulbs, or rooted stems, or from sexual parts such as unfertilized eggs or other cells in the ovule.
See *Apomixis, Fertilization, Parthenogenesis, Vegetative cells, Vegetative propagation*.

Auxins: Class of plant hormones with main effect on elongation of shoots and roots. Most common natural occurring auxin is indole 3-acetic acid. Synthetic analogues, e.g. IBA and NAA, are widely used for promoting root formation on cuttings.
See *Cutting, Hormone*.

B

Backcrossing: Crossing an offspring (usually hybrid) to either one of its parental types. Repeated backcrossing is particularly effective in transferring simply inherited characters, e.g., disease resistance, from a donor parent to a deficient but otherwise, valuable recurrent parent.
See *Cross pollination, F_1, Hybrid, Introgression, Simple Mendelian Inheritance*.

Background pollination: Pollination by long distance wind borne pollen. Some tiny pollen grains may be suspended in the air currents and carried hundreds of kilometers. Such background pollination cannot be totally excluded in e.g. seed orchards.
See *Buffer, Isolation, Migration, Pollen dilution zone, Wind pollination.*

Base population (=Selection population): The population of trees from which the tree breeder chooses to make selections for the next generation of breeding. The base population can be a natural stand (first generation) or a genetic test.
See *Breeding population, Genetic test, Breeding strategy, Production population, Wood producing population*.

Biological diversity (= Biodiversity): The variability among living organisms from all sources and the ecological complexes of which they are part; this includes:

- **Ecosystem diversity:** the variety and frequency of different ecosystems

- **Species diversity:** the frequency and diversity of different species
- **Genetic diversity:** the frequency and diversity of different genes and/or genomes. It includes the variation within a population and between populations.

See Ecosystem, Gene centre, Gene conservation, Gene frequency, Population.

Biosphere: The largest, all-encompassing ecosystem that includes soil, water, and the atmosphere.
See Biological diversity, Ecosystem.

Biotechnology: The application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services. Biotechnology comprises any technique that uses living organisms to make or modify a product, to improve plants or animals or to develop microorganisms for specific purposes.
See *Genetic engineering, Micropropagation.*

Bisexual (= Hermaphroditic or Monoclinous): Having functional male and female reproductive organs in the same flower.
See *Dioecious, Flower, Monoecious*.

Block: A subunit of the test area consisting of plots. In field design usually equivalent to a replicate.
See *Experimental design, Plot, Randomized complete block design, Replicate.*

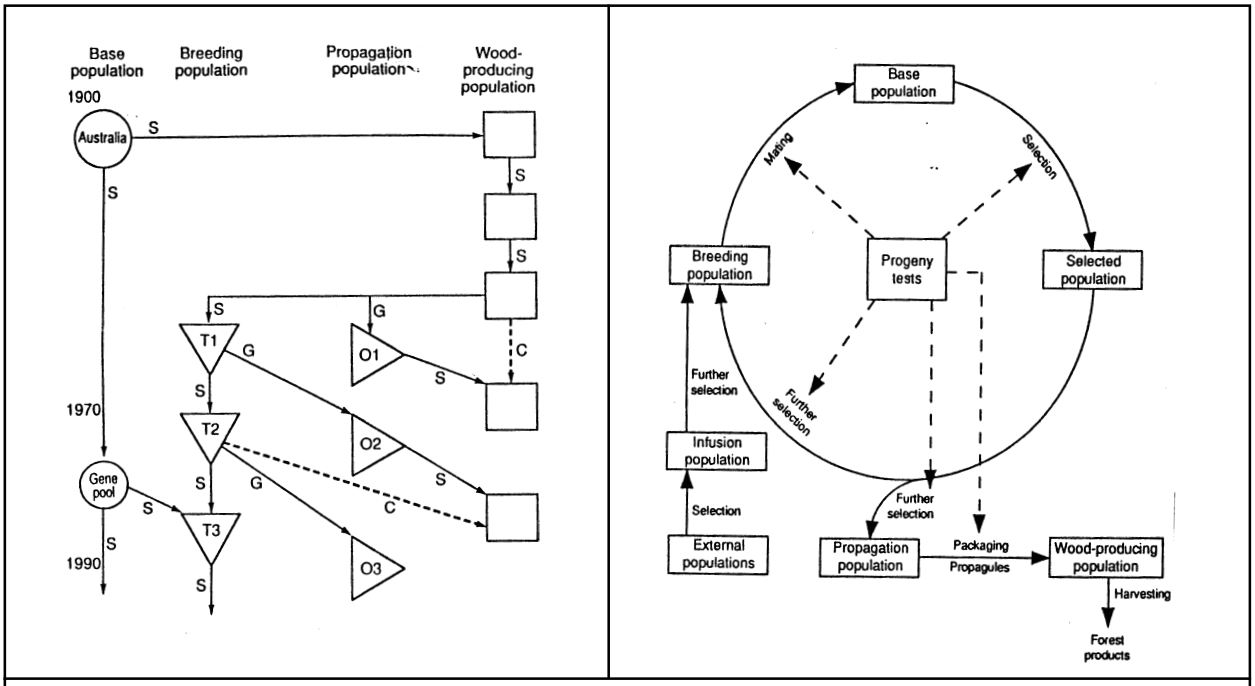
Border effect (= Competition effect): The environmental effect along the borders of an experimental area, block, seed orchard etc. Border effect is caused by difference in competition (of e.g. light or nutrients) between inside and outside the border. In order to reduce the border effect experimental areas or sub-units with a square design may be preferred since such form has a smaller circumference relative to area than rectangular areas. Buffer zones may be established around an area to reduce the border effect.
See *Buffer zone, Experimental design*.

Breeding arboretum: A collection of selected trees or species established for breeding. If the collection is preserved vegetatively, it is sometimes known as a clone bank. Spacing, culture and protection are designed to stimulate early and prolific flowering for controlled pollination and seed harvest.
See *Clone bank, Forest tree breeding, Gene bank, Seed orchard*.

Breeding plan: A detailed schedule of operations to be undertaken in order to implement the breeding strategy.
See *Breeding strategy.*

Breeding population: A subset of individuals from a base population that is selected for their desirable qualities to serve as parents for the next generation of breeding.
See *Base population, Breeding plan, Breeding strategy, Production population, Propagation population, Wood producing population.*

Breeding strategy: An overview of the management of the genetic improvement of a tree species used in man-made forest.
See *Base Population, Breeding population, Breeding plan, Forest Tree Improvement, Infusion population, Plant breeding, Production population, Wood producing population.*



Two examples of illustrating breeding strategies. A) Flow chart for domestication and breeding of eucalypts. S: Seed, G: Grafts, T: Progeny test, O: Orchard. A hypothetical time scale is indicated in the left margin (After Eldridge 1984 in Eldridge et al. 1993). B) The major components in a breeding cycle. The 'infusion' and 'external' populations are the base populations of fig A. The 'selected', 'breeding', and 'base' populations are the breeding populations of fig. A. Progeny tests provide information (dashed lines) used at several stages of the breeding cycle (After White 1987 in Eldridge et al. 1993).

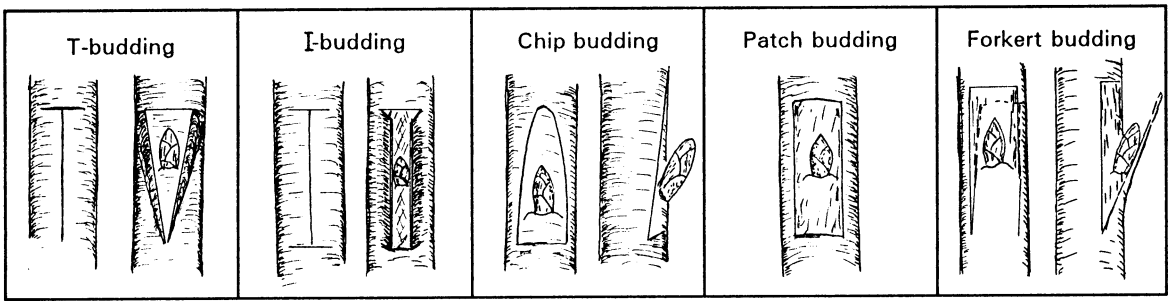
Breeding system: See *Mating system*.

Breeding value: The value of a parent judged by the performance of its progeny from several crosses. The breeding value of an individual is defined as twice its general combining ability (GCA). See *Combining ability, General combining ability, Genetic gain, Progeny test, Specific combining ability*.

Breeding zone: A subdivision of a species' geographical distribution in which individuals inter-breed. Delineation of breeding zones may be done by means of climatic or edaphic data.
See *Migration, Provenance, Seed collection zone*.

Breed true: A population of homozygous individuals derived by inbreeding which produce a new generation of homozygous individuals when intermating.
See *Homozygous, Inbred line, Inbreeding, Pure line.*

Budding (graft budding): Grafting by inserting a bud, with a small amount of tissue, into a slit or hole made in the bark of a stock plant. After a union has formed, the portion of the stock plant above the bud is removed. A number of budding methods exist, the figure illustrates the most common ones.
See *Grafting, Macropropagation, Root stock.*



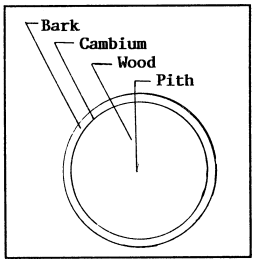
Buffer area (zone): A zone surrounding a seed production area in a plantation in order to limit contamination by external pollen sources. The buffer is composed of the same species as the SPA and therefore contributes pollen to, or cross pollinate with the stand. The buffer zone is rogued according to the same criteria as the SPA but no flower/fruit promoting operation is undertaken since seeds are not collected in the buffer zone.
See *Flower induction, Pollen dilution zone, Rogueing, Seed production area, Wind pollination.*

Buttress: See *Fluting*.

C

Callus: 1) The mass of parenchyma cells that develops from and around wounded plant tissues in order to diminish evaporation from the wound and initiate healing. In grafting it occurs at the junction of a graft union, arriving from living cells of both scion and stock. The production and interlocking of these parenchyma (or callus) cells constitute one of the important steps in the healing process of a successful graft. 2) In micropropagation used to describe an undifferentiated mass of cells.
See *Grafting, Grafting wax, Graft union, Micropropagation, Tissue culture.*

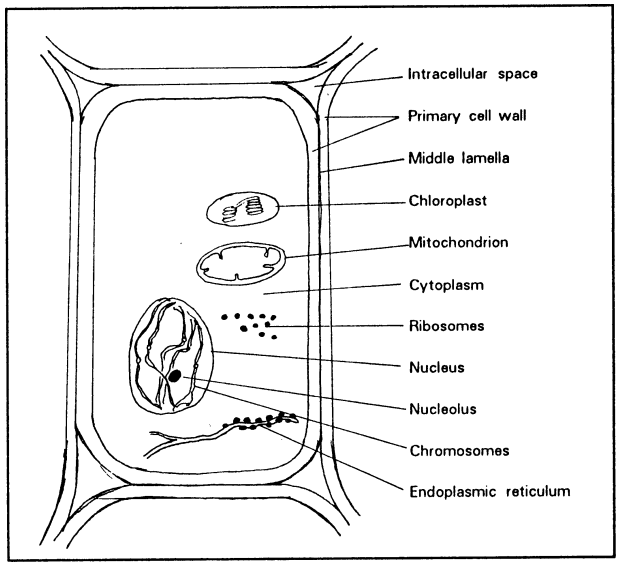
Cambium: A thin tissue of the plant located between the bark and the wood. Its cells are meristematic, i.e. they are capable of dividing and forming new cells.
See *Grafting, Meristem.*



Candidate tree: A tree that has been selected for grading because of its desirable phenotypic qualities but has not yet been graded or tested.
See *Advanced-generation selection, Comparison or check trees, Elite tree, Select, superior or plus tree*.

Catkin: Pendulous inflorescence modified for wind pollination. It is a spike of usually unisexual and reduced flowers, as in *Betula* and *Populus*. The term should not be applied to the male or staminate strobilus of conifers.
See *Flower, Strobilus.*

Cell: The fundamental unit of a living organism and the basis of its structure and physiology. A plant cell consists of a cell wall and protoplast (cytoplasm, nucleus, cell membranes and organelles (e.g. cloroplasts and mitochondrion).
See *Meiosis, Mitosis, Protein synthesis.*



Census number: The actual number of trees in the population studied.
See *Effective population size.*

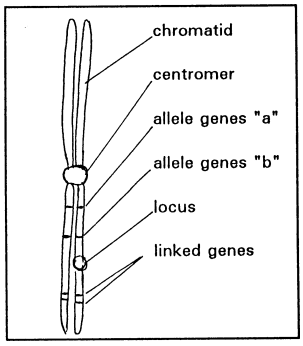
Certified tree seed: Seed collected from trees of proven genetic superiority, as defined by a certifying agency, and produced under conditions thaht assure genetic identity. These could come from trees in a seed orchard, or from superior ('plus') trees in natural stands with controlled pollination.
See *Improved, Phytosanitary Certificate, Seed orchard, Seed production area, Selected tree seed, Source-identified tree seed.*

Character (trait): A distinctive but not necessarily invariable feature exhibited by all individuals of a group and capable of being described or measured; e.g., size, straightness, form, and performance. A character of a given individual will have a certain phenotype (state) as determined by the individual's genotype and environment. Selection is based on characters. Desired characters for wood producing species can be fast growth and straightness, while un-desired characters may be crookedness, low branching and susceptibility to deseases.
See *Genotype, Genetic test, Phenotype, Population, Selection.*

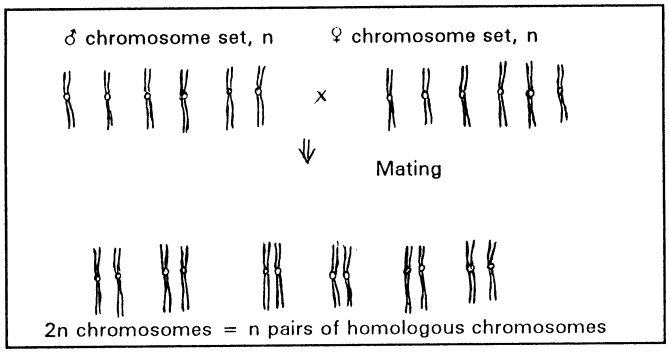
Chiasma: The points of the chromatide segments where crossing over takes place.
See *Crossing over*.

Chimera (Chimaera): Plants composed of two or more genetically different tissues growing separately but adjacent to each other in one plant. Chimeras may be sexually reproduced if they are in the lineage of reproductive cells.
See *Grafting, Budding, Inheritance.*

Chromosome: A microscopic, usually rod-like body carrying the genes. Number, size, and form of chromosomes are usually constant for individual species. The chromosome consists of chromatide which is made up of DNA, packaged with protein and coiled.
See *Allele, Cell, Chromosome number, Chromosome set, Crossing over, DNA, Gene, Locus, Meiosis, Mitosis, Nucleus.*



Chromosome number: The number of chromosomes characteristic of a species. The number of chromosome sets associated with this number must also be specified; thus in *Pinus* the chromosome number may be expressed as *n* = 12 or as 2*n* = 24, depending on whether reference is to sex cells or normal diploid vegetative cells.
See *Chromosome set, Diploid, Gametes, Haploid, Polyploid, Vegetative cells.*



Chromosome set: The *n* number of chromosomes inherited as a set from one parent. Normal sex cells carry only one set, which includes one of each chromosome characteristic of the species.
See *Chromosome, Chromosome number, Diploid, Haploid, Homologous chromosomes, Meiosis, Polyploid.*

Cladode: A modified stem or branch performing the function of a leaf. Occurs e.g. in casuarinas.
See *Cutting, Morphology.*

Cline: A geographical gradient of phenotype or genotype within the species' range. Determining whether a cline is genetic requires a test in a single environment. Usually clinal variation results from an environmental gradient. Parts of populations exhibiting such continuous (clinal) change from one area to another should not be designated as ecotypes, races, or taxa.
See *Ecotype, Ecotypic differentiation, Genotype, Phenotype, Race, Taxon.*

Clonal archive: Same as *Clone bank.*

Clonal garden: A collection of selected clones from which vegetative propagation material, e.g. cuttings, are harvested. The clones are often kept in their juvenile stage by hedging.
See *Breeding arboretum, Clone, Clone bank, Coppice shoots, Hedging, Juvenile.*

Clonal plantation: A plantation (*wood producing population*) established from vegetative propagated materials, e.g. cuttings or tissue cultured plants. The clonal plantation can be composed of several clones.
See *Clone, Clone bank, Clonal garden, Vegetative propagation, Wood producing population.*

Clonal propagation: Same as *Vegetative propagation.*

Clonal seed orchard: See *Seed orchard.*

Clonal test: Comparison and evaluation of a number of clones in replicated tests. Such tests provide estimates of respective genotypes, but do not necessarily provide information on breeding behaviour.
See *Clone, Experimental design, Genetic test, Heritability, Vegetative propagation.*

Clone: A population of genetically identical cells or individuals. Such a population is obtained by mitotic division or by asexual reproduction.
See *Apomixis, Asexual reproduction, Micropropagation, Mitosis, Tissue culture, Vegetative propagation.*

Clone (or clonal) bank: A collection of selected trees or species established for breeding. The collection is established and preserved by vegetative propagation.
See *Breeding arboretum, Clone, Clonal garden, Gene conservation.*

Co-dominance: The condition in heterozygotes where both members of an allelic pair are expressed and contribute to the phenotype, which is then a mixture of the phenotypic characters produced in either homozygous condition. A hypothetic allele pair producing red and white flowers respectively in homozygotes would in a co-dominance situation produce both red and white flowers. In incomplete dominance the flowers would be pink. Compare *Incomplete dominance*.
See *Allele, Dominance, Locus, Recessive, Simple Mendelian inheritance.*

Combining ability: A statistical value indicating the capacity of a parent, in crosses with other parents, to transmit genes for a certain degree of character expression. Good *general combining ability* (GCA) of a parent signifies high average performance of its progenies in various crosses, as compared to progenies of other parents in the same test. The '*breeding value*' of a parent is twice its GCA. Good *specific combining ability* (SCA) refers to two parents which, when crossed together, produce progeny better than expected on the basis of the parental GCA values.
See *Breeding value, Controlled pollination, Cross-pollination, General combining ability, Heterosis, Heterozygous, Mating design, Progeny test, Specific combining ability.*

Example of calculation of GCA and SCA in a cross of 5x5 parents (Factorial design) is shown below.

		Male parent							
		A	B	C	D	E	$\overline{X}$	GCA	
Female parent	F	6	2	4	6	6	4.8	0.9	GCA = $\overline{X}$ - $\overline{X}_{pop}$ Ex: GCA_A = 4.6 -3.9 = 0.7 Breeding value A = 2 x 0.7 = 1.4
	G	5	3	5	5	4	4.4	0.5	
	H	4	3	3	4	4	3.4	-0.5	SCA = $\overline{X}_{cross}$ - GCA_{male} - GCA_{female} - $\overline{X}_{pop}$
	I	5	2	1	5	3	3.2	-0.7	Ex: SCA for cross A x I = 5 - 0.7 - (-0.7) - 3.9 = 1.1
	J	3	2	4	5	4	3.6	-0.3	
	$\overline{X}$	4.6	2.4	3.4	5.0	4.0	3.9		**Overall mean**
	GCA	0.7	-1.5	-0.5	1.1	0.1			

Comparison or check tree: Trees that are located in the same stand, are of nearly the same age, are growing on the same or better site as the select tree and against which the select tree is graded. Trees chosen as comparison trees are the best in the stand, with characteristics similar to "crop" trees that would be chosen in a silvicultural operation.
See *Advanced-generation selection, Candidate tree, Elite tree, Select, superior or plus tree.*

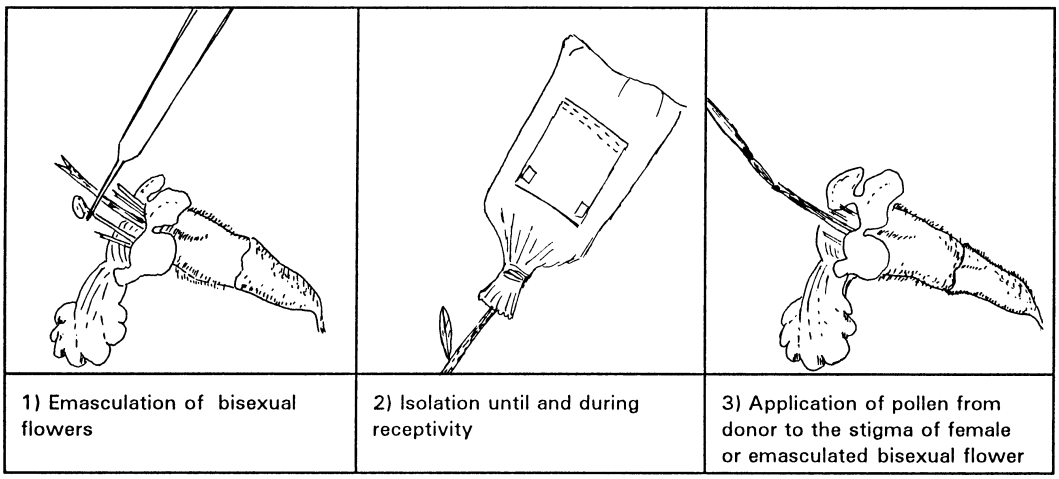
Complete diallel: See *Diallel cross*.

Completely random design (CRD): Test design in which each family or seedlot to be tested are distributed at random throughout the test area.
See *Block, Experimental design, Plot, Randomized complete block design, Replication.*

Complete pedigree design: Mating design in which both parents are known to the breeder, e.g. *Diallel, Factorial design, Nested design, Single pair mating*, *Topcross design*.
See also: *Mating design*, *Incomplete pedigree design*.

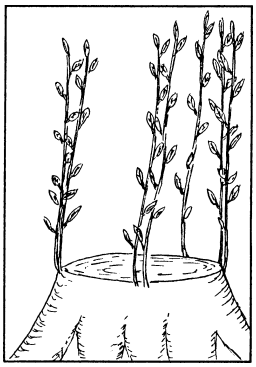
Conelet: An immature cone. The term is applied to the young cone from the time of female 'flower' scale closure after pollination until the initiation of rapid development of the cone a few months before maturity.
See *Flower, Strobilus.*

Controlled pollination: Transfer or permitted transfer of pollen from a known source to receptive flower parts of known seed parents. All other pollen, including own, are excluded (e.g. by covering flowers with isolation bags, and/or emasculation prior to pollination).
See *Emasculation, Flower, Dioecious, Isolation, Mating design, Wind pollination*.



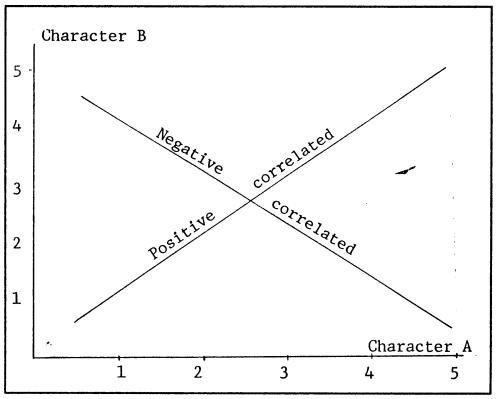
1) Emasculation of bisexual flowers | 2) Isolation until and during receptivity | 3) Application of pollen from donor to the stigma of female or emasculated bisexual flower

Coppice shoots: Shoots appearing from the stump after the tree has been cut. For some species coppice shoots can also be induced by girdling. Coppice shoots are often used as scions or cuttings in vegetative propagation as they are juvenile and usually have an orthotropic growth.
See *Cutting, Epicormic shoot, Girdling, Juvenile, Orthotropic growth, Rejuvenation, Vegetative propagation*.



Correlated response: For correlated characters, the change in one character when selecting for another.
See *Correlation, Genetic correlation, Genetic response*.

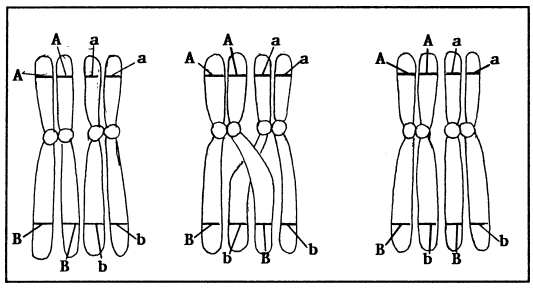
Correlation: Tendency for two variables to vary in a similar fashion. In positive correlation the two variables either increase or decrease at the same time. In negative or inversely correlation the two variables vary in opposite fashion. The correlation coefficient is the mathematical ex-pression of the degree of correlation.
See *Correlated response, Genetic correlation, Linkage, Juvenile-mature correlation.*



Cross: Same as *Hybrid*. Also an abbreviation of *Cross-pollinate*.
See *Controlled pollination, Cross-pollination, Hybrid.*

Crossability: Relative success in obtaining viable offspring from cross-pollinations, especially interspecific ones.
See *Cross-pollination, Incompatibility, Species hybrid, Sterility.*

Crossing over: Exchange of cromatide segments between homologous chromosomes during meiosis, resulting in gene recombination.
See *Allele, Chromosome, Linkage, Meiosis, Recombination.*



Cross-pollination: Pollination by a genetically different plant. An *outcross* is a cross to an unrelated individual.
See *Controlled pollination, Hybrid, Open pollination, Outbreeding, Self-pollination.*

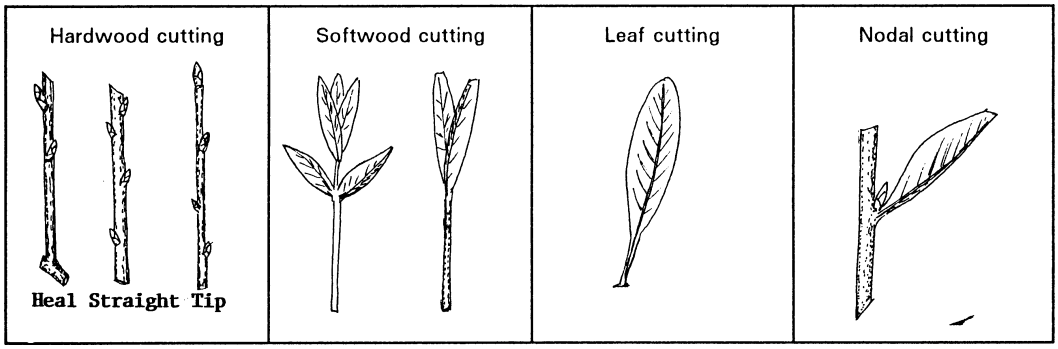
Cryopreservation: Maintaining tissues or seeds for the purpose of long-term storage at ultralow temperatures, typically between -150°C and -190°C.
See *Gene conservation*

Culling: See *Rogueing.*

Cultivar: Cultivated variety or strain.
See *Land race, Variety, Stock.*

Cutting : Detached portion of stem or other plant part which when rooted, produces a whole plant.
See *Air layering, Budding, Grafting, Nodal cutting, Vegetative propagation.*

Some examples of cutting types



Cyclophysis: The process of maturation of the apical meristem on a vegetative propagule. See *Apical meristem, Juvenile, Mature, Periphysis, Topophysis.*

Cytogenetics: Cytological aspects of genetics; i.e., chromosome behaviour as related to sterility, or chromosome damage as related to mutations following irradiation.
See *Chromosome, Cytology, Meiosis, Mutation, Sterility.*

Cytology: The study of the cell, i.e. its structure, function, development, and reproduction in relation to growth, differentiation, and heredity.
See *Cell, Chromosome, Meiosis, Mitosis, Nucleus.*

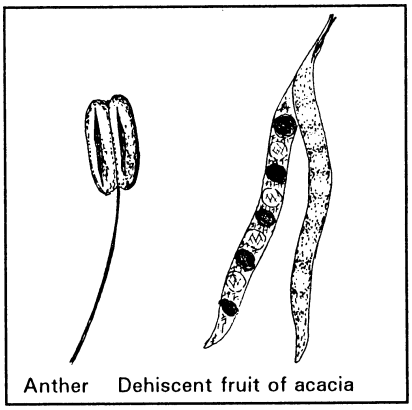
Cytoplasm: The living matter (protoplasm) within a cell, excluding the nucleus.
See *Cell, Cytoplasmic inheritance, Gene, Nucleus.*

Cytoplasmic inheritance (extrachromosomal inheritance): The determination of a charac-teristic by genes in the cytoplasm (plasmagenes) rather than in the chromosomes. They are normally transmitted through the female gamete, which contributes most of the cytoplasm to the zygote. Genes inherited in this manner are found on DNA present in small quantities in the chloroplasts, mitochondria and sometimes in the cytosol itself.
See *Chromosome, Cytoplasm, Inheritance, DNA, Reciprocal cross.*

Cytosol: The soluble part of the cytoplasm when all the cell organelles and other particles have been removed by centrifugation.
See *Cell, Cytology, Cytoplasm.*

D

Dehiscence: The splitting open of an anther or fruiting structure. Dehiscent fruits are fruit types that open or disintegrate while still attached to the tree e.g. folicles, capsules and cones. Ant. Indehiscence.
See *Anther, Anthesis*.



Design: See *Experimental design, Mating design.*

Diallel cross: Complete pedigree design in which each parent is crossed to all others.
Complete (Full): A mating design and subsequent progeny test resulting from the crossing of *n* parents in all possible n^2 combinations including selfs and reciprocals.
Half: Same as Complete except that reciprocals and, usually, selfs are not made.
Incomplete (partial): A diallel where any individual, family, or type of family may be omitted. In either type of cross, identities of both seed and pollen parents are maintained for each family.
See *Complete pedigree design, Mating design, Progeny test, Reciprocal cross.*

Complete diallel

Female parent \ Male parent	1	2	3	4	5	6	7	8
1	X	X	X	X	X	X	X	X
2	X	X	X	X	X	X	X	X
3	X	X	X	X	X	X	X	X
4	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X
6	X	X	X	X	X	X	X	X
7	X	X	X	X	X	X	X	X
8	X	X	X	X	X	X	X	X

Half diallel

Female parent \ Male parent	1	2	3	4	5	6	7	8
1								
2	X							
3	X	X						
4	X	X	X					
5	X	X	X	X				
6	X	X	X	X	X			
7	X	X	X	X	X	X		
8	X	X	X	X	X	X	X	

Partial diallel

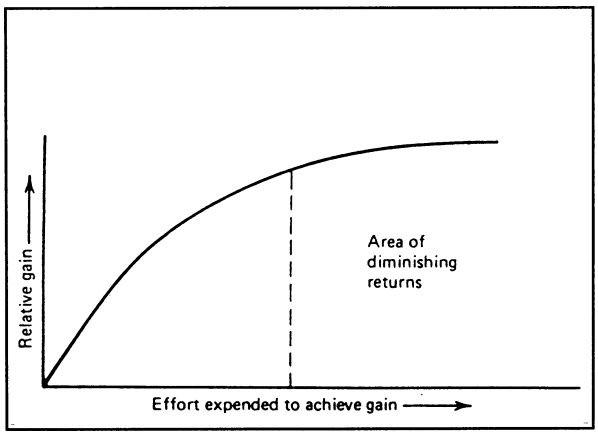
Female parent \ Male parent	1	2	3	4	5	6	7	8
1		X	X	X				
2			X	X				
3				X				
4								
5						X	X	X
6							X	X
7								X
8								

Dichogamy: The maturation of male and female organs on the same plant at separate periods, so that pollen presentation and pollen receptance do not coincide. Dichogamy fosters natural cross-pollination.
See *Cross-pollination, Flower, Monoecious, Phenology, Protandry, Protogyny.*

Diffuse flowering: Flowering throughout the year or flowering outside the main flowering season. Ant. Gregarious flowering.
See *Gregarious flowering, Masting, Periodicity, Phenology.*

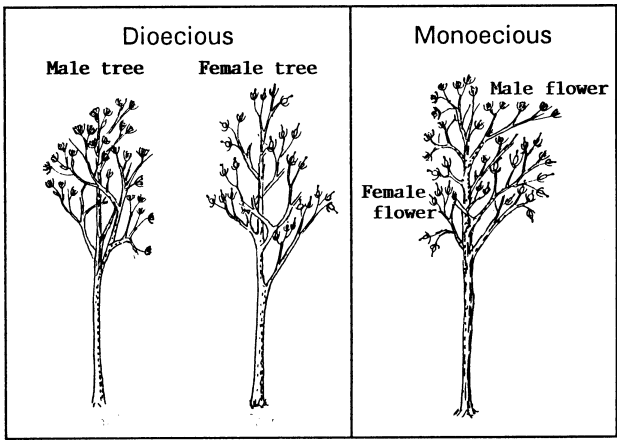
Dilution zone: See *Buffer, Isolation, Pollen dilution zone.*

Diminishing return (law of -): The doctrine stating that the further a tree improvement programme advances for a given species, the smaller the gain relative to cost. Implicit from the statement is that the relatively cheap initial tree improvement at species and provenance level yields a high relative gain, while advanced single tree breeding yields a smaller relative gain.
See *Breeding strategy*.



Dimorphism: Existence of two distinct forms of a structure, for instance sun leaves - shade leaves, juvenile leaves - adult leaves, males - females etc.
See *Dioecious, Gametes, Periphysis.*

Dioecious: A species or other taxon in which individuals are unisexual (male or female), e.g. rattan and some casuarinas. Ant. *Monoecious.*
See *Bisexual, Monoecious*.

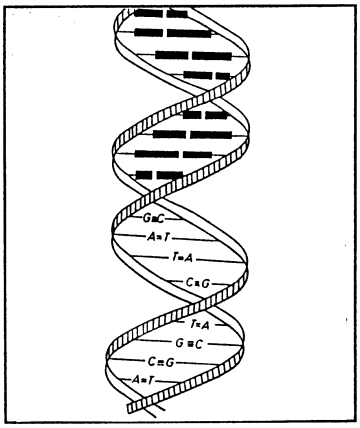


Diploid: A cell is diploid when it contains two sets of chromosomes (*2n*), one set from each parent. Most higher organisms are diploid except for their sex cells and associated tissue.
See *Chromosome number, Chromosome set, Gametes, Haploid, Homologous chromosomes, Polyploid, Zygote.*

Distal: The distal end of either the root or the shoot is that furthest from the stem-root junction of the plant and nearest to the tip of the root or the shoot. Ant. Proximal.
See *Polarity, Proximal.*

Diversity: The condition of being different, showing differences. In a tree breeding context diversity refers to the variation of genotypes in the population.
See *Gene resources, Gene conservation, Genetic base.*

DNA (Deoxy-ribo-Nucleic Acid): A doubled-stranded organic molecule consisting of sugars and bases which carries the genetic information or 'code'. On the figure G,C,A and T indicate the 4 bases Guanine, Cytocine, Adenine and Thymine. See *Allele, Chromosome, Gene, Protein synthesis, RNA.*



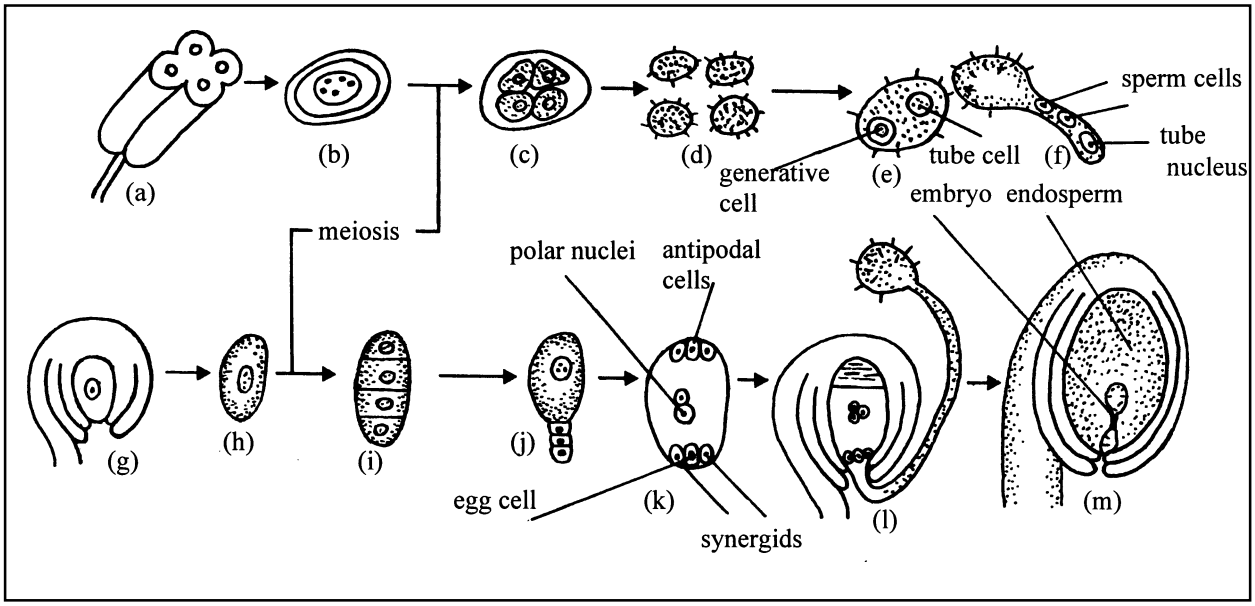
DNA Marker: A distinctive segment of DNA.
See *Marker, DNA, Fingerprint, Isoenzyme*.

Domestication: To bring under human control; wild trees brought into cultivation in plantations become genetically altered over generations of selections.
See *Forest tree breeding, Land race, Naturalization, Selection.*

Dominance: The masking of the action of one allele by that of its alternate allele. Thus, where a completely dominant allele for red color appears with a recessive one for white, the phenotype will be red; when this dominance is partial, the colour may tend toward deep pink; where there is no dominance, the colour will be intermediate.
See *Allele, Codominance, Epistasis, Heterozygous, Incomplete dominance, Phenotype, Recessive, Simple Mendelian inheritance.*

Dormancy: 1) Seed dormancy: Viable seeds which fail to germinate though exposed to conditions normally appropriate for germination. Seed dormancy may be classified as innate, enforced or induced. Dormancy can be due to e.g. physical constraints to water absorption, chemical or hormonal influence etc. In order to make a dormant seed germinating, dormancy has to be broken by pretreatment. 2) Bud dormancy: Buds, on the stem or branches, which fail to develop into shoots unless the dormancy is broken.
See *Epicormic shoots, Rejuvenation*.

Double fertilization: The process, unique to the angiosperms, in which one of the two sperm nuclei from the pollen tube units with the egg nucleus to form the diploid zygote and the other sperm nucleus unites with two of the nuclei of the embryo sac to form the triploid endosperm.
See *Diploid, Endosperm, Fertilization, Gametes, Megaspores, Microspores, Nucleus, Pollen tube, Polyploid, Seed, Xenia, Zygote.*



Double fertilization, summary of the reproductive processes in angiosperms. The microspore mother cell (b) in the anther tissue (a) undergoes a meiotic division to form four haploid microspores (c) that develop into pollen grains (d). The pollen grains contain two cells, a tube cell and a generative cell (e). At pollination the pollen are deposited on the stigma of the ovule, where they germinate and develop pollen tubes that grow through the stylar tissue and into the embryo sac. During the growth of the pollen tube the generative cell undergoes a division to form two sperm nuclei (f). The megaspore mother cell (h) within the ovule (g) undergoes a meiotic division, giving rise to four megaspores (i), each containing a haploid (n) chromosome set. Usually only one of the megaspores survives to give rise to an embryo sac whereas the others abort (j). The nucleus within the embryo sac undergoes three successive divisions to form 8 nuclei: an egg nucleus, 2 synergid nuclei, 3 antipodal nuclei and 2 polar nuclei (k). After penetration of the embryo sac (l), one of the sperm nuclei unites with the egg nucleus to form a zygote whereas the other fuses with the two polar nuclei in the embryo sac to form a triploid (3n) nucleus that undergoes division to give rise to the endosperm (m). Further development of the zygote leads to the formation of the embryo.

Drift: See *Genetic drift.*

Dysgenic selection: An undeliberate and undesirable 'selection' occurring when the best trees in a stand are removed, leaving the inferior ones to produce seeds for the next generation. Detrimental to the genetic qualities of future generations. The term applies especially to man-made deterioration, such as losses resulting from removal of superior trees from a forest stand. Ant. *Eugenic.* See *Diversity, Eugenic, Selection.*

E

Ecological niche: A localized environment that favours the permanent survival of some particular populations. Such habitat may be discontinuous or may be part of a gradient. Unique niches may favour hybrids or mutants that are at a disadvantage in other environments.
See *Ecotype, Evolution, Hybrid, Introgression, Mutation, Population.*

Ecosystem: A dynamic complex of plant, animal and micro-organism communities and their non-living environmental interaction as a functional unit.
See *Ecotype, Evolution, Hybrid, Introgression, Mutation, Population.*

Ecotype: A race genetically adapted to the selective action of a particular environment. Most differences among ecotypes show up only when different ecotypes are tested in a uniform environment. Ecotypes are described, e.g., as climatic or edaphic.
See *Adaptation, Cline, Land race, Physiological character, Race.*

Ecotyic differentiation: The process of producing distinct individuals within a species, subspecies, or variety in a given environment that are different morphologically and physiologically from others of the same species in another environment.
See *Ecotype, Land race, Population structure, Species.*

Edaphic: Related to soil type or soil conditions.
See *Adapted, Ecotype, Land race.*

Effective population size: The size of an ideal population that would have the same rate of increase in inbreeding or decrease in genetic diversity by genetic drift as the population studied. The effective population size of a true population is usually much less than its real size. Expressed in mathematical equations as N_e.
See *Genetic drift, Population, Representative, Sampling*.

Electrophoresis: The process by which charged particles move, typically through a gel in response to an electrical field. Due to different speed of movement in the field the particles, e.g. proteins, are separated by the process. Similar particles tend to move with a similar speed. Hence it is possible to verify a biochemical relationship by comparing the electrophoresis pattern and to identify particles by plotting them against a known reference.
See *Allozyme, Genetic marker, Fingerprint, Isozyme*.

Elite tree: A tree verified by appropriate testing as highly superior or desirable for a specified environment and breeding program. The superiority of crossbred parents is determined by progeny tests, and that of clones by clonal tests.
See *Certified, Clonal test, Plus, Progeny test, Seed Orchard, Select, superior or plus tree.*

Emasculation: Removal of immature anthers to prevent self-pollination or unwanted cross-pollination of surrounding plants.
See *Bisexual, Controlled pollination, Cross-pollination, Flower, Self-pollination.*

Embryo: The young plant individual after fertilization (or parthenogenesis). The embryo is usually differentiated in the seed into radicle (root), hypocotyl (stem) and cotyledons (leaves).
See *Polyembyrony, Seed*.

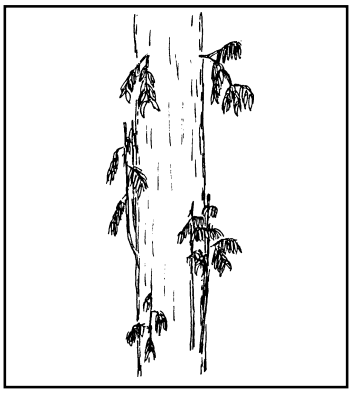
Endogamy: Crossing of related individuals with loss of heterozygosity.
See *Heterozygous, Homozygous, Inbreeding, Inbred line, Selfing.*

Endosperm: Typically triploid tissue in the seeds of many angiosperms, furnishing food for the embryo. Its hereditary characters may be determined independently from those of the embryo. The so-called endosperm of conifers is haploid female tissue.
See *Double fertilization, Gametes, Haploid, Polyploid, Seed, Triploid, Xenia.*

Environmental variation: Variation in trials or performance of individuals caused by environmental differences at the growth site e.g. soil condition and exposure.
See *Genotype - environment interaction, Genotype, Phenotype, Variation*.

Enzyme: Proteins that promote chemical processes in living organisms without themselves being changed.
See *Allozyme, Isozyme, Hormone.*

Epicormic shoots: Shoots which develop from dormant buds on the stem of a tree after neighbouring trees have been removed, i.e. as a result of exposure to light. Epicormic shoots deriving from the lower part of the stem tend to show an orthotropic growth habit and can be used as material for vegetative propagation.
See *Coppice shoots, Dormancy, Orthotropic growth, Reiteration, Rejuvenation, Ramicorn, Vegetative propagation*.



Epistasis: The masking of phenotypic effect of either or both alleles by a gene of a different locus.
See *Allele, Dominance, Multiple alleles, Recessive.*

Escape: An apparently pest-resistant individual that appears so because it was never attacked. Also, an introduced tree found wild.
See *Exotic, Naturalization, Resistance.*

Eugenic: Tending to improve the genetic qualities of future generations. Applied especially to man-made practices such as reserving the best phenotypes for seed trees. Ant. *Dysgenic*.
See *Mass selection, Phenotype, Rogueing, Seed production area.*

Evolution: The stepwise development (or extinction) of biological groups, as a result of natural selection and increase of hereditary variants in the population. A small proportion of individuals with a particular non-favourable genetic make up may survive in a large population. Through successive generations, change in the environment or a new environment to which the organisms have migrated may favour the survival and reproduction of the aberrant individuals with a consequent increase of their genes in the population. The causative processes include mutation, recombination, drift, isolation, and natural selection.
See *Adaptation, Drift, Genetic drift, Mutation, Recombination, Natural selection.*

Exotic (= non-native): A plant grown outside its natural range of distribution, e.g. teak in Africa. Ant. *Indigenous*.
See also *Land race, Naturalization.*

Experimental design: The layout of a test or trial, e.g. provenance or progeny test. The test area is divided into a number of blocks or replications, which are further subdivided into plots. Examples of experimental designs of field trials are *Completely random design, Randomized complete block design, Latin square design, lattice design or split block design.*
See also *Block, Genetic test, Mating design, Plot, Progeny test, Provenance trial, Replication, Species trial.*

Completely randomized design (CRD)								
5	18	21	9	18	20	8	19	11
12	7	17	11	2	16	4	15	13
1	10	5	4	14	7	17	6	20
21	16	3	12	1	10	21	12	8
14	9	20	6	8	3	13	18	19
6	11	2	13	15	14	9	2	15
3	17	19	1	7	5	16	10	4

Randomized complete block design (RCBD)								
1	16	11	4	6	19	9	6	2
15	12	20	14	1	13	10	8	18
4	2	7	5	10	7	15	3	21
21	17	19	15	3	21	12	17	11
10	5	13	8	17	9	5	1	20
3	14	18	12	2	20	14	16	13
8	9	6	11	16	18	4	19	7

Two examples of experimental design of a field trial. The experiment contains 21 seedlots, which are sown in plots with 3 replications. In CRD the plots are distributed at random throughout the test area, each plot number occurring 3 times. In RCBD the test area is divided into 3 blocks/replications; each block contains each seedlot once. In both designs the plots may contain one or several trees.

Explants: The basic plant part removed from the mother plant when used for micro-propagation/ tissue culture. Corresponds to cutting, air-layer or scion in macropropagation.
See *Micropropagation, Macropropagation, Tissue culture, Vegetative propagation.*

Ex-situ: Material moved from its place of origin to another place. Ant. *In-situ*.
See also *Gene conservation.*

Ex-situ conservation: See G*ene conservation*

Extensive seedling seed orchard (ESSO): See *Seed orchard.*

Extrachromosomal inheritance: See *Cytoplasmic inheritance.*

F

Factorial design (tester design): Complete pedigree mating (breeding) design in which members of one sex (in case of monoecious species, sex is designated) are crossed in all cobinations with several members of the other sex.
See *Complete pedigree design, Controlled pollination, Cross, mating design, Nested design, Single pair mating*.

Parent	A	B	C	D
E	X	X	X	X
F	X	X	X	X
G	X	X	X	X
H	X	X	X	X
I	X	X	X	X
J	X	X	X	X

Family: 1). The sexually produced individuals raised from a single tree. 2). The taxonomic 'family' is a group of species with similarities in morphology, anatomy etc. which suggest a common origin i.e. phylo-genetically related. In the taxonomic hierarchy 'family' ranks subordinate to order but above the category 'genus'.
See *Race, Phylogeny, Taxon, Taxonomic hierarchy, Variety*.

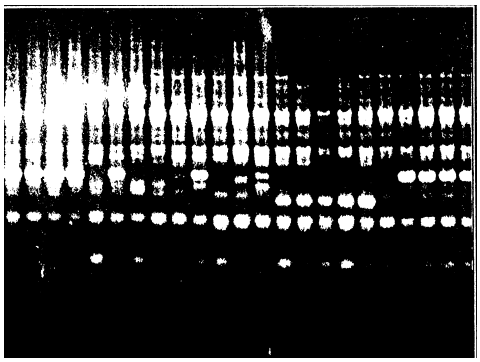
Family selection: The selection of progeny families on their mean performance. In addition, the best individuals are usually selected in the best families.
See *Individual selection, Selection differential.*

F_1: The first (filial) generation of a cross. If each parent is true-breeding (homozygous), the F_1 individuals resemble each other.
See *Cross-pollination, F_2, Heterozygous, Homozygous.*

F_2: The second generation, produced by intercrossing or selfing the F_1 individuals. Characteristically the individuals within an F_2 generation vary greatly.
See *Cross-pollination, Heterozygous, Hybrid, Self-pollination.*

Fertilization: Union of nucleus and other cellular constituents of a male gamete (sperm) with those of a female gamete (egg) to form a zygote. In some species, fertilization may occur months after pollination.
See *Double fertilization, Gametes, Pollination, Zygote*.

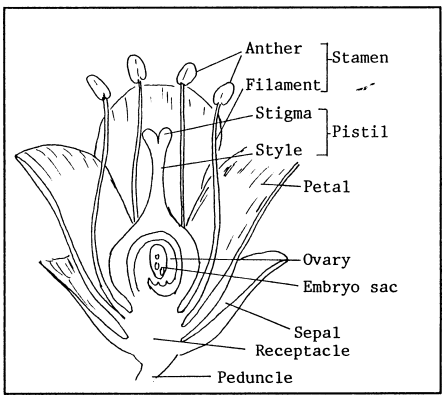
Fingerprint (genetic): The use of genetic markers to unambiguously characterize a phenotype. The pattern of markers on the electrophoretic gel (figure) is characteristic for a particular genotype.
See *Allozyme, DNA marker, Electro-phoresis, Phenotype, Genotype, Iso-zyme, Marker*.



Fitness: The relative contribution that an individual makes to the gene pool of the next generation.
See *Gene frequency, Gene pool.*

Fixation indix: A measure of the departure of genotype frequencies from those predicted under Hardy-Weinberg conditions.
See *Gene frequency, Hardy-Weinberg law.*

Flower: Angiosperm reproductive structure bearing pistils, stamens, or both, and usually also sepals and petals. So-called flowers of conifers are the male and female strobili before and during pollination.
See *Bisexual, Monoecious, Dioecious, Strobilus*.

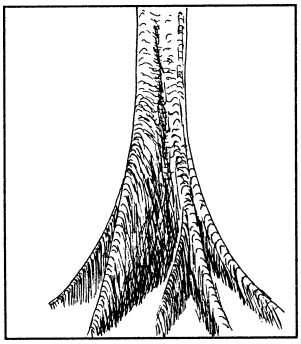


Flower induction: Stimulation of the onset of flowering or the number of flowers, for instance by applying hormones or by imposing stress.
See *Flower, Flower initiation, Girdling, Hormone, Strangulation.*

Flowering period: The phenological period from the appearance of flowers to fruit set. Flowering may be prolonged (diffuse) or short (gregarious).
See *Anthesis, Diffuse flowering, Gregarious, Masting, Phenology*.

Flower initiation: Earliest stages of flower or cone development.
See *Apical meristem*, *Flower, Flower induction, Phenology.*

Fluting: Non-circular cross-section of the stem often caused by buttress roots, i.e. large planklike upgrowth of the upper side of the roots, providing support for the tree. Buttressing and fluting is heritable to varying degree. It is normally a non-desired character in forest tree breeding.
See *Character, Selection.*

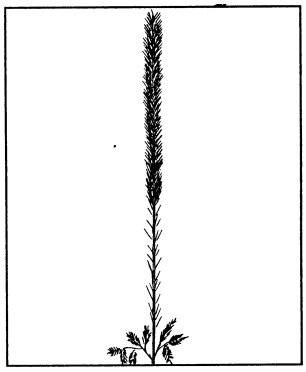


Forest reproductive material: Seed, cones and parts of plants intended for the production of plants; also young plants raised from seed or vegetatively.
See *Certified tree seeds, Germplasm, Selected reproductive material.*

Forest tree breeding: Practices applying knowledge of genetics to develop improved trees. Conventional tree breeding is based on selection of individuals for certain desired characters and mating these individuals to produce an improved popupation. Forest tree breeding may connote breeding systems varying from harvesting seed from only the best sources (mass selection) to sophisticated multi-phase, multigeneration programmes or controlled pollination.
See *Breeding strategy, Controlled pollination, Forest tree improvement, Genetics, Mass selection, Plant breeding.*

Forest tree improvement: Usually synonymous with forest tree breeding, but may refer to tree breeding in combination with silvicultural practices.
See *Forest tree breeding, Genetics, Plant breeding.*

Foxtail: A genetically determined growth habit of certain pines showing an extremely long branch-free internode. The character is usually correlated with reduced wind-firmness and hence an undesired character in tree breeding. See *Correlation, Node*.



Full diallel (= Complete diallel): See *Diallel cross*.

G

Gametes: Mature sex cells, either sperm or eggs.
See *Chromosome set, Fertilization, Haploid, Meiosis, Microspores, Pollen, Zygote.*

Gene: The smallest transmissible unit of genetic material consistently associated with a single primary genetic effect. The genes are ultra-microscopic and act as if linearly arranged at fixed places (loci) on a chromosome. The gene consists of a segment of DNA chain with a definite nucleotide sequence that contains the instruction for a complete protein. Each gene, by interacting with other genes on the same or other chromosomes and the environment, governs a certain physiological effect in the cell and is expressed as one or more characters.
See *Allele, Character, Chromosome, Codominance, DNA, Dominance, Genetic code, Genetics, Genome, Germplasm, Mutation, Protein synthesis.*

Gene bank: A collection of superior and sometimes special trees maintained for present and future use in research and tree breeding.
See *Breeding arboretum, Clonal bank, Gene centre, Gene conservation.*

Gene centre: Centre of diversity. A geographical area that shows considerable genetic diversity of certain plants.
See *Biological diversity, Gene conservation, Gene frequency, Genetic base, Genetic erosion, Gene flow, Gene pool.*

Gene conservation: Protecting and maintaining the genetic variety of a species in order to keep a genetic resource for future research and improvement.

- **In situ gene conservation:** Protection of a species and its genetic variation at its native site, e.g. by establishing forest reserves.
- **Ex situ gene conservation:** Protection of a species and its genetic variation outside its native site i.e. established plantations.

See *Breeding arboretum, Clone bank, Cryopreservation, Diversity, Gene centre, Gene pool, Genetic erosion, Genetic resource, Sustainable use*.

Gene expression: The process of turning the genetic code into visible or identifiable traits through protein synthesis.
See *Dominant, Genotype, Phenotype, Protein synthesis, Recessive, Simple Mendelian inheritance*.

Gene flow: Passage of genes from one population to another (also called gene migration).
See *Gene frequency, Migration.*

Gene frequency: The proportion of an allele in a population compared with other alleles of that gene. Thus if a gene A has two alleles, a and A, and the frequency of a=0.2 (20%), then the frequency of A must be 0.8 (80%) since A+a=1 (100%).
See *Diversity, Fitness, Gene flow, Gene pool, Hardy-Weinberg law, Heritability, Population genetics, Quantitative inheritance.*

Gene pool: The total sum of all the genes and their alleles present in a breeding population or species at one time.
See *Base population, Diversity, Fitness, Gene bank, Gene flow, Gene frequency, Gene resource, Genetic base, Genetic erosion*.

General combining ability (GCA): The average performance of the progeny of an individual when it is mated to a number of other individuals in the population.
See *Breeding value, Combining ability, Specific combining ability.*

Genetic base: The total amount of genetic diversity within a population.
See *Base population, Diversity, Gene conservation, Gene pool.*

Genetic code: The exact sequence of amino acids laid down in a protein, determined by the sequence of nucleotides in messenger RNA which in turn depends on the sequence of the nucleotides in the DNA.
See *DNA, Gene, Genome, Protein synthesis.*

Genetic correlation: A measure of degree of genetic relationship between two characters, e.g., the correlation between general combining ability values. Not to be confused with the correlation between phenotypes.
See *Character, Combining ability, Correlation, Juvenile-mature correlation, Linkage, Phenotype.*

Genetic drift: Random change in allele frequencies in a population from one generation to the next because of small population size (also called random drift).
See *Gene frequency, Population.*

Genetic engineering (recombinant DNA technology): The isolation of useful genes from a donor organism or tissue and their incorporation into an organism that does not normally possess them.
See *Biotechnology, DNA, Gene.*

Genetic erosion: The loss of genetic variation and the consequent narrowing of the genetic base of cultivated plants through the introduction of improved varieties that can be grown over wide areas.
See *Gene centre, Gene conservation, Gene frequency, Gene pool.*

Genetic fingerprint: See *Fingerprint.*

Genetic gain: Average improvement in a progeny over the mean of the parents. Gain is achieved by selection in the parental generation; the amount depends on selection intensity, parental variation, and heritability.
See *Heritability, Selection, Selection intensity.*

Genetic makeup: Total genetic content of an individual or species (also called genome).
See *Gene pool, Genotype.*

Genetic marker: Any allele used as an experimental probe to mark a nucleus, chromosome or a gene. Genetic markers can be classified as Biochemical markers (e.g. isozymes) and Molecular markers (e.g. DNA markers).
See *DNA marker, Electrophoresis, Fingerprint, Isozyme, Marker.*

Genetic recombination: See *Recombination*.

Genetic response: The change in genotype frequency following selection. After one generation of selection the genetic response, R, is expressed by $R = h^2 \times D$, where h^2 is the heritability of the character under consideration, and D is the selection differential.
See *Genotype, Hardy-Weinberg law, Heritability, Selection differential.*

Genetic resource: A unit of heritable variability of actual or potential value.
See *Gene conservation, Gene pool, Genetic base, Breeding strategy.*

Genetics: Genetics is the basic science dealing with causes of resemblances and dif-ferences among organisms related by descent. It takes into account the effects of genes and the environment. When the basic knowledge of genetics is applied to breeding trees, the effort is preferably referred to as forest tree breeding or forest tree improvement.
See *Forest tree breeding, Forest tree improvement, Quantitative genetics, Simple Mendelian inheritance.*

Genome: See *Genetic makeup.*

Genotype: (1) An individual's hereditary constitution, with or without phenotypic expression of the one or more characters it underlies. Also the gene classification of this constitution expressed in a formula. The genotype is determined chiefly from performance of progeny and other relatives. It interacts with the environment to produce the phenotype. **(2)** Individual(s) characterized by a certain genetic constitution.
See *Genetic makeup, Genotype - environment interaction, Phenotype*.

Genotype - environment interaction: When a number of genotypes are established in a number of different environments, the genotypic effect may vary according to the environment. One genotype may perform well at one site and poorly at another in comparison to other genotypes. The expression of a character, phenotype (P), can be ascribed to genotype (G) and the environment (E), and the interaction of the two (I). The relation is expressed as $P = G + E + I$.
See *Character, Clonal test, Experimental design, Genotype, Heritability, Inheritance, Major genes, Phenotype, Phenotypic plasticity, Progeny test.*

Geographic race: A race native to a geographic area.
See *Ecotype, Land race, Local seed source, Provenance, Race, Seed source.*

Geographic variation: The phenotypic differences among native trees growing in different parts of a species' range. If the differences are largely genetic rather than environmental, the variation is usually specified as racial, ecotypic, or clinal.
See *Allopatric, Cline, Ecotype, Genotype, Geographic race, Phenotype, Sympatric.*

Germination: The physiological processes in the first stages of growth of seed and pollen grain. Pollen germination may be restricted by *Incompatibility*, seed germination by *Dormancy*.
See also *Ageing, Double fertilization, Germination test, Pollen, Vigour.*

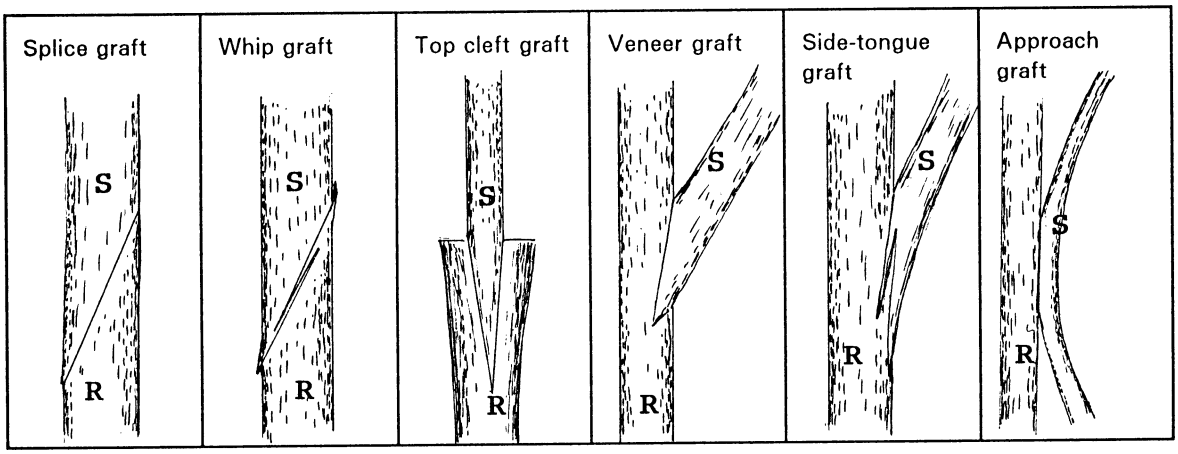
Germination test (viability test): Standard test carried out to determine the quality of a seed lot, i.e. the percentage of viable seeds. The germination test is carried out under prescribed standard conditions under the, for the particular species, optimal germination conditions of temperature, humidity and light. Dormant seeds must be pretreated in order to break dormancy before the germination test.
See *Ageing, Dormancy, Germination, Seed lot.*

Germplasm: (1) Within an individual or group, the collective hereditary material that is the physical basis for inheritance; i.e. the genotype, with particular reference to its transmission to the next generation.
See *Genotype, Forest reproductive material, Gene, Genetic code, Heritability.*

Girdling: Removal of a piece of bark of the tree in its full or partial circumference. Girdling impedes normal passage of water and nutrients. Sometimes used as an imposed stress factor to promote flowering or for rejuvenation in connection with harvesting of cuttings or scions.
See *Coppice shoots, Dormancy, Flower induction, Rejuvenation, Strangulation.*

Grading system: System of assessment of characters / traits of select trees in a stand. The system may contain objective measures or subjective assessments as compared to comparison/ check trees.
See *Character, Comparison or check tree, Independent culling, Selection index, Select superior or plus tree*.

Grafting: Uniting parts of separate individuals by matching their tissue so that union and growth can occur. Commonly, an aerial portion (scion) is joined with a rootstock. Both the site of the union and the composite individual are termed grafts. Because the scion retains its original genetic constitution, grafting is valuable for preserving, testing, and propagating.
See *Air layering, Budding, Clone, Graft incompatibility, Graft union, Macropropagation, Scion, Seed orchard, Stock, Vegetative propagation.*



Some types of grafting. S=Scion, R=Root stock

Graft incompatibility: Inability of the stock and scion to form or maintain a union that will result in the desired plant growth.
See *Graft union, Incompatibility, Scion, Stock*.

Grafting wax: Substance applied on the graft union in order to minimize desiccation and exclude water access.
See *Callus, Grafting, Graft union.*

Graft union: The point of the grafted plant where the scion and the stock are joined and unite.
See *Graft incompatibility, Grafting, Scion, Stock.*

Gregarious flowering: Profuse flowering during a short period of time. Ant. Diffuse flowering.
See *Diffuse flowering, Flowering, Masting, Phenology, Seed year*.

Growth substance: See *Hormone.*

H

Habitat: The place or type of site where an organism or population naturally occurs.
See *Community, Ecosystem.*

Half diallel: See *Diallel cross*.

Haploid: Having one complete set of chromosomes per cell. These are the *n* chromosomes normal in sex cells as compared to the *2n* in vegetative cells.
See *Chromosome, Chromosome number, Chromosome set, Diploid, Gametes, Meiosis, Polyploid.*

Hardwood cutting: See *Cutting.*

Hardy-Weinberg law: The law stating that provided certain conditions are met, the geno-type frequency in a population of organisms will remain constant and distributed as p^2, 2pq and q^2 for the genotypes A_1A_1, A_1A_2 and A_2A_2 respectively, where p= the frequency of the allele A_1 and q = the frequency of the allele A_2 such that p+q=1.
See *Fitness, Fixation index, Gene frequency, Gene pool, Simple Mendelian inheritance, Quantitative inheritance, Wahlund's effect.*

Heal: A small part of mature tissue retained at the base of a tender shoot.
See *Cutting.*

Health Certificate: See *Phytosanitary Certificate.*

Hedging (Stool): Trimming trees or plants and keeping them low in order to overcome poor rooting and often poor form of cuttings taken from old trees. Cuttings from hedged plants tend to be of young physiological age.
See *Clonal garden, Coppice shoot, Juvenile, Mature, Orthotopic growth, Plagiotropic growth, Topophysis.*

Heritability: Degree to which a character is influenced by heredity as compared to environment. *Narrow-sense heritability* is the fraction of total variation that contributed by additive effects of genes; i.e., it is the ratio of additive genotypic variance to phenotypic variance. *Broad-sense heritability*, applicable to vegetatively propagated species, includes also non-additive effects. High heritability indicates that individual phenotypes are indicative of their genotypes. If calculated from parent-progeny data, it estimates the degree of resemblance between parent and progeny.
See *Additive genes, Genetic gain, Genotype, Genotype - environment interaction, Inheritance, Variation.*

Hermaphroditic: See *Bisexual.*

Heterogeneous: Exhibiting dissimilarity among members of a group. Not to be confused with *heterozygous*. Ant. Homogeneous.
See also *Variation.*

Heterosis: Hybrid vigour exhibited when mean F_1 hybrid phenotype falls outside the range of the parents, e.g. more vigorous growth, greater yield or increased disease resistance. Statistically: An increase over the mean of the parents. Usually applied to traits such as size or general thriftiness.
See *F_1*, *Heterozygous, Hybrid, Inbreeding, Transgressive segregation.*

Heterozygous: Having one or more sets of unlike alleles, e.g. the dominant with the recessive gene. Thus, an A*a* cell or plant is heterozygous whereas the AA's and aa's are homozygous. Refers also to differences in the arrangement of genes on the chromo-somes. A heterozygous organism (heterozygote) does not generally breed true and is known as a hybrid with respect to the genes in question.

See *Allele, Dominance, Gene, Homozygous, Recessive, Simple Mendelian Inheritance.*

Homogeneous: Exhibiting similarity among members of a group; not to be confused with homozygous. Ant. *Heterogeneous*.

Homologous chromosomes: A pair of similar chromosomes, one of maternal, and one of paternal origin, present in diploid cells. The members of each pair are similar in size, shape, genic content, and arrangement. They pair physically at meiosis.
See *Allele, Chromosome, Chromosome number, Chromosome set, Diploid, Fertilization, Gametes, Meiosis.*

Homozygous: Having one or more sets of similar alleles, e.g., both dominant (AA), or both recessive (aa). The homozygote breeds true when mated with the same genotype.
See *Allele, Breed true, Dominance, Genotype, Heterozygous, Inbred line, Simple Mendelian inheritance.*

Hormone (= growth substance): Substance that has a marked and specific effect on plant growth and that produces this effect when present in very low concentrations. Certain hormones stimulate plant growth by promoting cell division or cell elongation while others inhibit certain developmental processes. The term covers substances produced within the plant as well as artificial, often structurally related, chemicals that have similar effect. Examples of hormones are auxin, gibberellin and acetylene. Synthetic analogous of auxins are widely used as rooting hormone. Others are used for instance for flower induction.
See *Air layering, Auxin, Cutting, Enzyme, Flower induction, Rejuvenation, Rooting hormone.*

Hybrid: The offspring of genetically distinctly different parents. The term is applied to the progeny from matings within species (intraspecific) as well as to those between species (interspecific).
See *Allele, Cross, Genotype, Heterosis, Heterozygous, Hybrid sterility, Hybridization, Hybrid swarm, Species hybrid.*

Hybridization: The formation of a hybrid. In the context of DNA technology the formation of a double stranded molecule by complementary base pairing between two single stranded molecules.
See *Biotechnology, DNA, Genetic code, Hybrid, Hybrid sterility, Protein synthesis.*

Hybrid sterility: The reduced ability of some hybrids to produce viable gametes. This is caused by the absence of homologous pairs of chromosomes, so that bivalents cannot form during meiosis. The resulting gametes are thus aneuploid.
See *Aneuploid, Hybrid, Homologous chromosomes, Incompatibility, Sterility.*

Hybrid swarm: A population consisting of hybrids and various types of backcrosses between two or more intercrossing sympatric species. The population may include one or more of the parent species, or these may be replaced by the backcrosses.
See *Backcrossing, Ecological niche, F_1, Heterosis, Introgression, Sympatric.*

Hybrid vigour: See *Heterosis.*

I

Improved: A non-technical term often referring to open-pollinated seed from selected trees.
See *Certified, Forest tree breeding, Forest tree improvement, Open pollination.*

Inbred line: A population derived by inbreeding. It is relatively pure genetically (homozygous) and hence true-breeding. The approach to homozygosis is often expedited by recurrent selfing accompanied by selection.

See *Breed true, Heterosis, Homozygous, Inbreeding, Pure line, Selection, Self-pollination.*

Inbreeding: Production of relatively homozygous offspring by mating closely related organisms, usually by selfing. This procedure, especially if carried out for a number of generations, exposes undesirable recessive characters and is used with selection to fix desirable ones, i.e, to render them true-breeding. Inbreeding of normally crossbred organisms frequently results in an 'inbreeding depression' of vigour or fertility, but the vigour can usually be restored and may even be increased by crossbreeding again, cf. heterosis. Inbreeding is mathematically expressed by the inbreeding coefficient F, which ranges from 0 (no inbreeding) to 1.
See *Breed true, Endogamy, Heterosis, Homozygous, Inbred line, Minimum viable population, Pure line, Self-pollination.*

Incompatibility: The failure of gametes from genetically similar material to fuse due to physiological or morphological mechanisms. For example, pollen tube growth may be deficient even though the egg and sperm cells are potentially functional. Also used synonymous with graft incompatibility.
See *Graft incompatibility, Self incompatibility, Sterility.*

Incomplete block design: See *Lattice design.*

Incomplete diallel: See *Diallel cross.*

Incomplete dominance: The partial expression of both alleles in a heterozygote so that the phenotype is intermediate between those two homozygote.
See *Co-dominance, Dominance, Heterozygote, Homozygote*, *Recessive.*

Incomplete pedigree design: Mating design in which only one parent is known for any given progeny, e.g. *Open pollinated mating*, *Pollycross design* and sometimes *Topcross* (see these). Ant. *Complete pedigree design*.
See also: *Mating design.*

Independent culling: Multitrait selection that involves setting of minimum values for each trait of interest. Individuals must meet these minimum criteria if they are to be maintained.
See *Candidate tree, Comparison or check tree, Selection index, Select, superior or plus tree, Tandem selection*.

Index selection: See *Selection index.*

Indigenous (indigenous species): Species native to the country or area. Ant. non-native or exotic.
See *In-situ, Land race, Naturalization, Provenance.*

Indirect selection: Choosing individuals or populations on the basis of a trait (usually of no economic importance in itself) believed to be associated with a desired trait of economic importance, rather than on the basis of the desired trait.
See *Correlation, Linkage, Selection criteria.*

Individual selection: From a family or population single plants are selected on their own merit as parents or ortets. Sometimes called phenotypic selection.
See *Family selection, Mass selection, Phenotype, Progeny test, Recurrent selection.*

Infusion population: Selected trees from an external population infused into the breeding population in order to introduce new desirable genes and maintain a broad genetic base.
See *Base population, Breeding population, Breeding strategy, Propagation population.*

Inheritance: The acquisition of characters or qualities by transition from parent to offspring.

See Acquired character, Genotype - environment interaction, Gene, Heritability, Meiosis, Simple Mendelian inheritance.

In-situ: At its native place. Ant. *Ex-situ*.
See *Gene conservation*

In-situ conditions: Conditions where genetic resources exist within ecosystems and natural habitats, and in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.
See *Adapted, Land race, Gene conservation.*

In-situ conservation: See *Gene conservation.*

Inter-fertile: The ability of individuals to breed with each other.
See *Hybrid, Crossability, Self fertile, Species.*

Internode: The part of a plant stem between two nodes. In conifer referring to the stem separating two distinct whorls of branches.
See *Cutting, Fox-tail, Nodal cutting, Node.*

Interspecific hybrid: See *Species hybrid.*

Intraspecific hybrid: See *Hybrid.*

Introgression (introgressive hybridization): The natural spread of the gene(s) from one species or population to another through hybridization and successive backcrossing of the hybrids. A hybrid swarm may be a stage in the process. The outcome may vary from minor gene infiltration to coalescence of the species. Introgression is principally similar to migration but occurs between species.
See *Backcrossing, Ecological niche, Gene flow, Hybrid, Hybrid swarm, Migration, Species hybrid.*

In-vitro: Describing experiments on biological processes that are carried out in laboratory apparatus. Ant. *In-vivo.*
See *Tissue culture.*

In-vivo: Describing experiments investigating biological processes that are carried out in living organisms. Ant. *In-vitro*.

Isoenzyme: See *Isozyme.*

Isolation: A condition that prevents or limits breeding among populations, e.g., phenological difference in flowering time, chromosome difference, and distance. A knowledge of effective pollination distance is important to the relative isolation of seed orchards. For wind pollinated species background tree pollen in the air usually cannot be eliminated, but contamination is often minimized by dilution zones of border trees. The term also refers to the condition of isolating flowers during controlled pollination.
See *Allopatric, Controlled pollination, Incompatibility, Migration, Pollen dilution zone, Seed orchard, Sterility.*

Isozyme (=Isoenzyme): Different forms of the same enzyme may be formed by different loci or different alleles at the same locus. In the latter case they can be called allozymes. Detectable generally in terms of molecular size, shape and charge.
See *Allozyme, Allele, Electrophoresis, Enzyme, Fingerprint, Genetic marker, Linkage, Locus, Marker.*

J

Juvenile: Young or non-mature stage of a tree, a population or propagation material. Ant. mature. The juvenile stage of trees often refers to the stage prior to flowering. Also used in morphological context e.g. juvenile leaves.
See *Cyclophysis, Hedging, Juvenile selection, Juvenile-mature correlation, Mature, Orthotopic growth, Rejuvenation, Plagiotropic growth, Topophysis.*

Juvenile-mature correlation: The genetic or phenotypic correlation of characters assessed at the juvenile stage with those expressed at the mature age. Expressed as correlation coefficients between pairs of data sets measured at different age
See *Character, Correlation, Correlated response, Genetic correlation, Juvenile, Mature*.

Juvenile selection: Selection from non-mature stands in order to reduce generation interval. Juvenile selection can only be implied if there is a high juvenile-mature correlation.
See *Advanced generation selection, Juvenile, Juvenile-mature correlation, Regression system.*

L

Land race: A population of individuals that have become adapted to a specific environment in which it has been planted.
See *Acquired character, Adaptability, Exotic, Indigenous, Naturalization.*

Latin square design: Experimental design in which the test area is divided into rows and columns, one plot of each seedlot is planted in each row and each column.
See *Completely Random design, Experimental design, Lattice design, Randomized complete block design, Split block design.*

7	2	4	8	3	5	1	6
5	8	3	6	1	4	7	2
1	6	2	4	7	3	8	5
2	7	5	1	6	8	4	3
6	3	7	2	4	1	5	8
4	1	6	5	8	2	3	7
8	5	1	3	2	7	6	4
3	4	8	7	5	6	2	1

Lattice design (= balanced incomplete block design): Experimental design in which blocks of equal size are established but each block con-tains fewer than the total number of seedlots involved in the test.
See *Completely Random design, Experimental design, Latin square design, Randomized complete block design, Split block design.*

3	12	2	10	7	3
1	11	6	4	9	5
5	7	10	1	8	11
10	12	9	4	1	6
5	2	6	7	11	2
4	8	3	12	9	8

Lethal gene: A gene which, when expressed, is mortal, e.g. Albinism.
See *Albinism, Dominance, Recessive, Mutation*.

Line: A population of seed-propagated plants in which genetic variability is controlled and the uniformity is maintained to a standard appropriate for the cultivar. E.g. inbred lines, composite or synthetic lines, hybrid lines.
See *Homozygote, Inbreeding, Inbred line, Pure line, Self-pollination.*

Linkage: The association of inherited characters because their genes are in proximity on the same chromosome. There are as many linkage groups as chromosome pairs. Linkage is rarely complete, i.e., new combinations of linked characters can occur due to crossing over between chromatids of homologous chromosomes during meiosis.
See *Chromosome, Correlation, Crossing over, Genetic correlation, Homologous chromosome, Locus, Meiosis, Recombination.*

Local seed source: Source native to the locality in which the seedlings are to be grown, i.e. belonging to the indigenous geographic race. Its seed-collection zone is usually defined experimentally as being within a certain distance or elevation of the planting site.
See *Geographic race, Provenance, Race, Seed collection zone, Seed source.*

Locus (pl.loci): The position occupied by a gene on a chromosome. Alleles of a gene occupy the same locus on homologous chromosomes.
See *Allele, Chromosome, Gene.*

M

Macropropagation: Vegetative propagation from cuttings, air-layering, grafting or other large plant part, distinguished from micropropagation or tissue culture.
See *Micropropagation, Tissue culture, Vegetative propagation.*

Major} genes: Genes that make a large contribution to the expressed character, relative to environmental and other modifying influences.
See *Gene, Gene frequency, Genotype - environment interaction.*

Marcotting: See *Air layering.*

Marker: A character or gene which by virtue of linkage can be used to indicate the presence of another gene.
See *Fingerprint, DNA marker, Genetic marker, Isozymes, Linkage*.

Mass propagation: Large scale multiplication of improved material (breeding population) to be used for plantation (wood producing population). Mass propagation of clonal material is usually carried out by cuttings.
See *Breeding strategy, Breeding plan, Forest tree improvement, Tissue culture, Vegetative propagation.*

Mass selection: Use of seed from individuals chosen for a certain common phenotype from a larger population, and then bulked. The larger population provides the male parentage, and selections are not intermated prior to seed use. Thus, seed may be collected from selected trees of a wild stand and used in a commercial planting or for establishing a seedling seed orchard. The process may be repeated through successive generations. Note, however, that collecting seed from a rogued orchard is recurrent selection.
See *Family selection, Individual selection, Recurrent selection, Rogueing, Seed orchard*.

Masting: Ecological term used to describe the strategy of some plant species to produce large crops of seeds at long interval, e.g. dipterocarps.
See *Flowering, Gregarious flowering, Phenology, Seed year.*

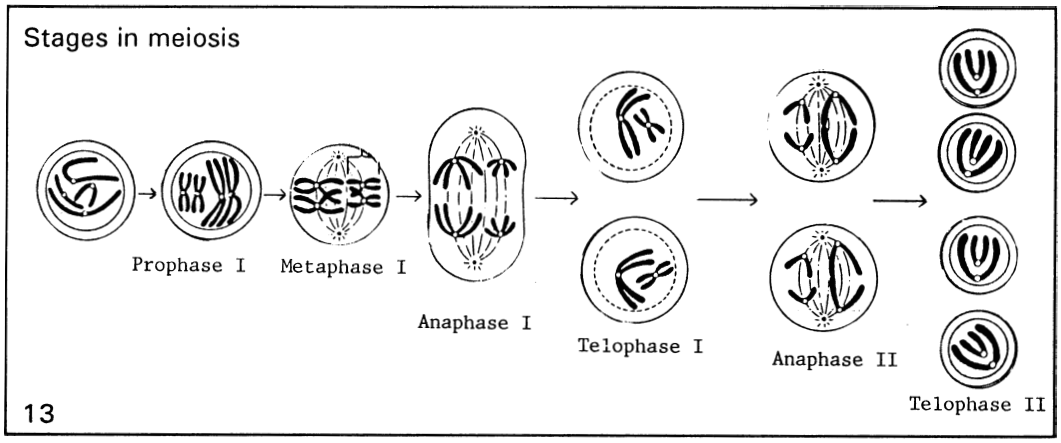
Mating: Same as *Fertilization.*
See also *Controlled pollination, Cross, Mating design.*

Mating design: The pattern of pollinations set up between individuals. It is described, e.g. as random, systematic, diallel, or according to parental similarities. It can be grouped into *Complete pedigree design* in which both parents are known or *Incomplete pedigree design* in which only the mother plant is known.
See *Controlled pollination, Diallel cross, Experimental design, Factorial design, Forest tree breeding, Nested design, Polycross, Single pair mating.*

Mature: Individual tree which has reached an advanced age, e.g. often referring to reproductive age, but also size and anatomical or morphological structures. Ant. *Juvenile*.
See also *Juvenile selection, Juvenile-mature correlation, Orthotropic growth, Plagiotropic growth, Rejuvenation, Topophysis.*

Megaspores (macrospores): The female cells produced by sexual cell divisions (meiosis), to give rise to the embryo sac.
See *Double fertilization, Gametes, Haploid, Meiosis.*

Meiosis: The process by which diploid cells divide to form haploid cells. The process consists of two consecutive specialized nuclear divisions ultimately leading to the formation of eggs or sperm.
See *Chromosome set, Crossing over, Diploid, Double fertilization, Gametes, Haploid, Homologous chromosomes, Mitosis.*



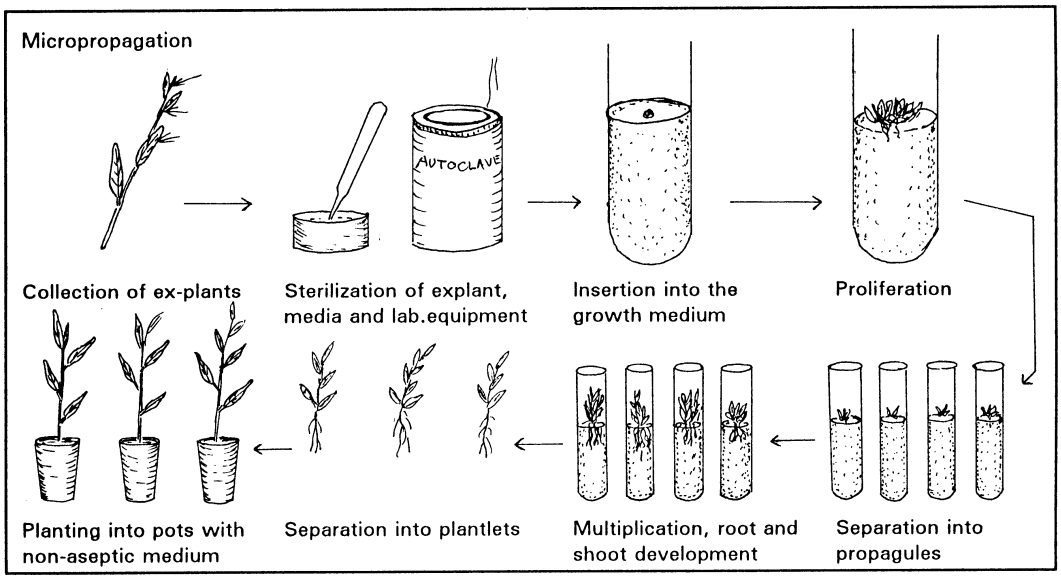
Mendel's principles: Hereditary differences have particular bases called genes. Genes are present in pairs, each of which is an allele. One allele may dominate the other. During meiosis paired alleles separate. During fertilization alleles from male and female part unite. The resulting offspring exhibit segregation ratios for various character combinations according to laws of probability, because each segregating allele is distributed randomly to one gamete and independently of other genes (provided the genes are not linked), and because eggs and sperm unit randomly.
See *Allele, Chromosome, Dominance, Fertilization, Gametes, Gene, Genotype, Phenotype, Simple Mendelian inheritance, Recessive.*

Meristem: Tissue primarily concerned with formation of new cells by division, e.g. apical meristem and cambium.
See *Apical meristem, Cambium, Mitosis.*

Meristem culture: The culture of excised meristem on suitable nutrient media under aseptic conditions.
See *Aseptic culture, Explant, Meristem, Micropropagation, Tissue culture, Vegetative propagation*.

Metaxenia: See *Xenia.*

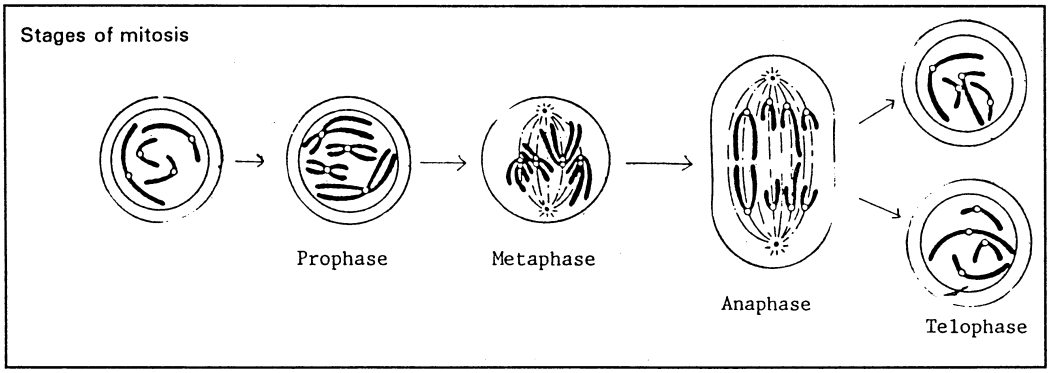
Micropropagation: Production of plants from very small plant parts, tissues, or cells grown aseptically in a test tube or other container where the environment and nutrition can be rigidly controlled. The term often used synonymous with *tissue culture.*
See *Aseptic culture, Explant, Macropropagation, Plantlet, Tissue culture, Vegetative propagation.*



Microspores: The male cells produced by sexual cell divisions (meiosis) and maturing to pollen grains.
See *Double fertilization, Gametes, Haploid, Meiosis, Pollen.*

Migration: Movement of genes by pollen, seeds or plants from one population (emigra-tion) into another population (immigration) of the same species. Migration contribute to altering the gene frequencies of the offspring compared to the parent generation.
See *Evolution, Gene flow, Gene frequency, Introgression, Isolation, Pollen dilution zone.*
Minimum viable population (MV=): The size of a population below which it cannot remain stable or increase in number, but will decline and disappear due to either insufficient reproduction or genetic consequences of inbreeding.
See *Inbreeding, Population.*

Mitosis: Normal division of a nucleus into two identical daughter nuclei by a process of duplication and separation of chromosomes.
See *Meiosis, Nucleus, Vegetative cells.*



Molecular marker: See *Genetic marker*.

Monoecious: Of a population or species having functional male and female organs in separate places on the same plant.
See *Bisexual, Dioecious.*

Monoclinous: See *Bisexual.*

Morphology: The external and internal form and structure of whole plants, organs, tissues, or cells; also the study of such form and structure, including life cycles of organisms. Internal morphology is often known as anatomy. Functional aspects of structure are an aspect of physiology rather than morphology.
See *Phenotype, Physiological character, Taxon.*

Multiple alleles: A series of alleles of a particular gene.
See *Additive genes, Allele, Locus, Epistasis, Gene.*

Mutagen: Any agent that causes an increased frequency of mutation. Mutagens are typically short-wave electromagnetic radiations (e.g. ultraviolet irradiation, x-rays and cosmic rays) ionizing radiations (e.g. alpha or beta particles) and chemicals (e.g. nitrous acid and proflavine) that react with nucleotides.
See *Evolution, Mutation, Recessive.*

Mutation: A heritable change in the genetic constitution, often recognized as a sudden deviation from the ancestral phenotype. If a chromosome changes, the type of the mutation is preferably specified as a change in structure (aberration) or number. Although mutations are infrequent, and usually recessive and harmful, they are the material of evolution and sometimes breeding. A changed individual or part is also known as a mutation or mutant. Because the spontaneous mutation rate is low, external mutagens, such as X-rays or chemicals, have been used to induce mutations.
See *Chromosome, Evolution, Gene, Genotype, Linkage, Mendel's principles, Mutagen, Polyploid, Recombination.*

N

Native: See *Indigenous*

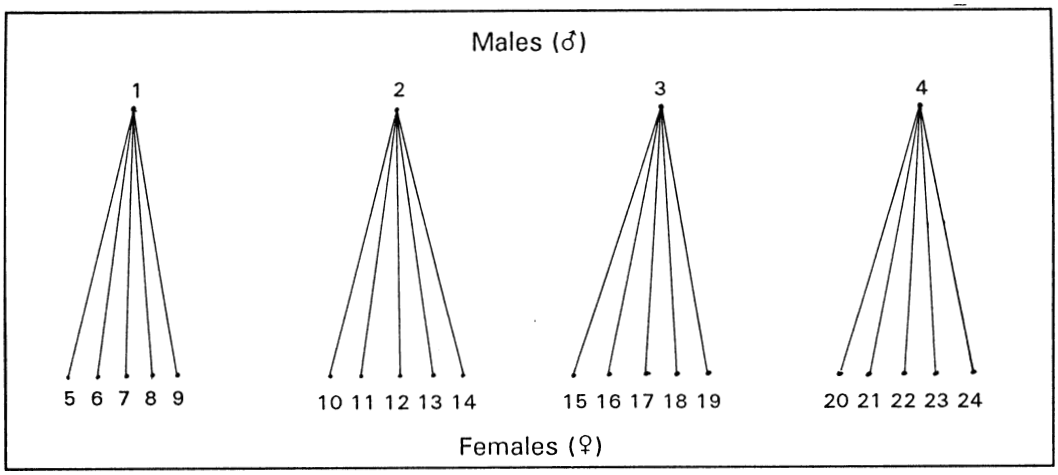
Naturalization: Introduced and cultivated plants that have spread from the cultivated areas into the wild where they spread and multiply by natural regeneration. Ant. *Domestication*.
See also *Exotic, Indigenous, Land race, Provenance.*

Natural selection: The force that causes some individuals in a population to contribute more descendants (and genes) than others to subsequent generations and so, over a period of time, leads to changes in the genetic composition of populations.
See *Evolution, fitness, Genetic drift.*

Negative correlation: See *Correlation.*

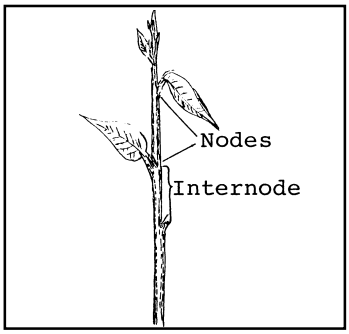
Neighbourhood: A sub-division of a geographic population containing individuals that i) are able to mate randomly, or ii) may be related to each other.
See *Inbreeding, Sub-population*.

Nested design (hierarchical mating design): Complete pedigree mating (breeding) design in which groups of parents of one sex (in case of monoecious species, sex is "designated") are mated to members of the other sex. Therefore the progeny are composed of full-sib families that have both parents in common, and half sib families that have one parent in common.
See *Complete pedigree design, Controlled pollination, Diallel cross, Factorial design, Incomplete pedigree design, Mating design, Single-pair mating*.



Nodal cutting: Cutting consisting of a small piece of stem with a single leaf and an axillary bud attached, i.e. a single node.
See *Cutting, Node, Internode.*

Node: A point of the stem from which one or more leaves arise. In the mature stem the nodes are usually well separated by internodes which elongate during growth. In conifers node refers to the branch whorls.
See *Cutting, Fox-tail, Internode, Nodal cutting.*



Non-native : See *Exotic*.

Nucleus: The cell part that contains the genetic material. The nucleus consists of chromosomes, nucleolus and nucleoplasm. It is separated from the cytoplasm by the nuclear membrane.
See *Cell, Chromosome, Cytoplasm, Double fertilization, Mitosis.*

Nucleic acid: Two types viz. DNA and RNA. They are made up of long chains of molecules called *nucleotides*.
See also *DNA, Protein synthesis*.

Nucleotide: The building blocks of DNA and RNA. Each nucleotide is composed of phosphate, sugar and one of the four bases, Adenine, Cystine, Guanine and Thymine (Urasil in RNA). The sequense of the bases is the basis of the genetic code, i.e the formation of proteins.
See *Cell, DNA, Genetic code, Nucleic acid, Protein synthesis, RNA*.

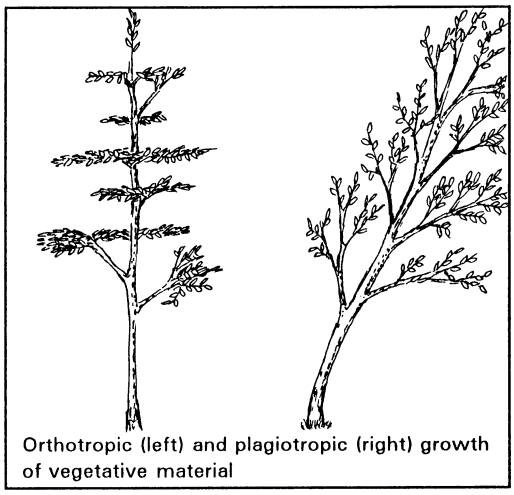
O

Open pollinated mating: Incomplete pedigree mating design in which seeds are collected from mother trees with no information of the pollen source. As a progeny-test method, it may provide information on general combining ability of the seed parents.
See *Combining ability, Cross-pollination, Mating design, Progeny test, Random mating, Wind pollination.*

Origin: For an indigenous stand, the origin is the place in which the trees are growing (=provenance). For a non-indigenous stand, the origin is the place from which the seed or plants were originally introduced.
See *Indigenous, Provenance, Seed Source, Source identified seeds.*

Ortet: The original plant from which a clone derives.
See *Clone, Ramet, Vegetative propagation.*

Orthotropic growth: The situation where the vegetative propagule assumes an up-right or normal tree form. Ant. plagio-tropic growth.
See *Coppice shoots, Hedging, Juvenile, Mature, Plagiotropic growth, Reiteration, Vegetative propagation.*


Orthotropic (left) and plagiotropic (right) growth of vegetative material

Outbreeding (= outcrossing): The production of offspring by the fusion of distantly related gametes. Ant. *Inbreeding*.
See *Incompatibility, Dioecious, Dichogamy, Self incompatibility.*

Outcross: See *Outbreeding.*

Ovulate: Having seed-bearing organs only. May apply to individual flowers, or strobili, or to female plants of dioecious species in conifers and other gymnosperms.
See *Dioecious, Flower, Pistillate, Staminate.*

P

Panmixis: See *Outbreeding.*

Parameter: An arbitrary variable or constant used to describe a condition mathematically. Changing value of the variable would alter the condition.
See *Character, Variation*.

Partial diallel: See *Diallel cross.*

Parthenocarpy: Development of fruit without viable seed. May be induced artificially as by foreign pollen or hormones.
See *Fertilization, Incompatibility, Pollination, Sterility.*

Parthenogenesis: Reproduction from an unfertilized egg; a type of apomixis. The resultant embryo may be either haploid or diploid.
See *Apomixis, Diploid, Fertilization, Haploid*.

Pedigree: Record of ancestry, i.e. genetic history of an individual.
See *Complete pedigree design, Incomplete pedigree design.*

Periodicity: The interval (in years) between good seed or cone crops.
See *Flowering period, Masting, Phenology, Seed year.*

Periphysis: Variation of growth habit of vegetative propagules due to their origin from different environments on the plant, such as shade and sun leaves on an individual tree.
See *Cyclophysis, Hedging, Plagiotropic growth, Topophysis, Vegetative propagation*.

Phenology: The study of relations between plant development and seasonal climatic changes, such as in temperature or day length, especially as such changes affect periodic phenomena like leafing, flowering, and dormancy.
See *Flowering period, Flower initiation, Periodicity.*

Phenotype: The plant or character as we see it; state, description, or degree of expression of a character; the product of the interaction of the genes of an organism (genotype) with the environment. When the total character expressions of an individual are considered, the phenotype describes the individual. Similar phenotypes do not necessarily breed alike.
See *Character, Genotype, Genotype - environment interaction, Heritability, Morphology.*

Phenotypic plasticity: The degree to which the sensitivity to environmental changes differ among genotypes.
See *Genotype - environment interaction.*

Physiological character: A character related to the life processes of an organism; a function in contrast to form or structure. Often it is not discernible except by performance, e.g. rate of growth or resistance to certain pests.
See *Character, Morphology, Selection criteria.*

Phytosanitary Certificate (= Health Certificate): Certificate issued as a result of a test carried out to ascertain that seed or plants are free from general or specific diseases or organisms not endemic in or not desired to be introduced into another country. May only be issued after quarantine or disinfection.
See *Certified, Forest reproductive material.*

Pistillate: Having female organs only. May apply to individual flowers or inflorescences, or to plants of a dioecious species in angiosperms. Collectively the pistils are called the gynoecium.
See *Monoecious, Dioecious, Flower, Ovulate, Staminate*.

Plagiotropic growth: The situation where the vegetative propagule does not assume a normal tree form, but continues to grow like a branch. Ant. *orthotropic growth.*
See *Hedging, Juvenile, Mature, Orthotopic growth, Topophysis, Vegetative propagation.*

Plant breeding: The improvement of a plant production through selection and controlled propagation, e.g. crossing.
See *Genetic gain, Forest tree breeding, Forest tree improvement, Mating design*.

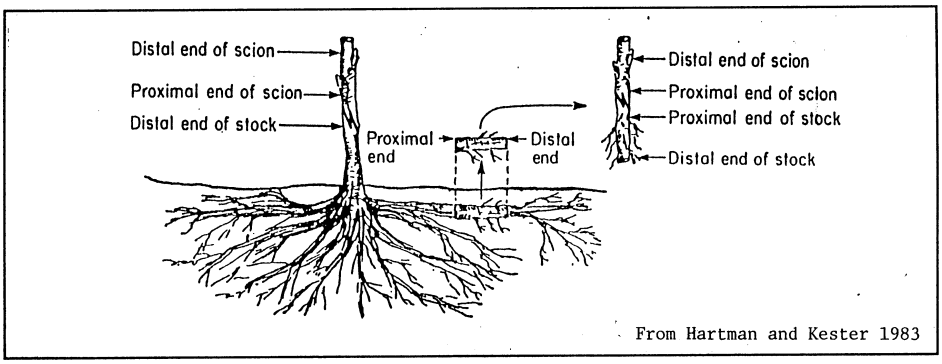
Plantlet: Small plant originating from micropropagation/tissue culture.
See *Micropropagation, Tissue culture, Vegetative propagation.*

Plot: A group of trees of a single family, provenance or species that vary in size from one (single-tree plot) to several hundred (multiple-tree plot) trees that are treated as a unit in a field trial.
See *Block, Experimental design, Mating design, Replicate.*

Plus: Appearing distinctly superior to the average. The term is used for describing phenotypes of both stands (plus stands) and single trees (plus trees). The superior character(s) should be specified, i.e. plus for volume, quality, pest-resistance, or combination of characters.
See *Comparison or check tree, Elite tree, Phenotype, Select superior or plus tree, Superior*.

Plus stand: A stand containing a preponderance of good phenotypes, not necessarily plus trees.
See *Plus, Seed production area, Select, superior or plus tree.*

Polarity: The condition that plant parts maintain their spatial orientation when separated from the mother plant. The phenomenon is important in cuttings and grafting.
See *Distal, Proximal.*



Pollen: The microspores of seed plants, produced in vast numbers in the male part of the flower (anther).
See *Anther, Double fertilization, Fertilization, Flower, Microspores, Pollen vector, Pollination.*

Pollen dilution zone: A zone surrounding seed orchards and seed stands where trees of the species occurring in the seed orchard or stand and possibly hybridizing species have been cut in order to protect the stand from contamination by outside pollen.
See *Background pollination, Buffer area, Isolation, Mating design, Migration, Open pollinated mating, Seed production area, Seed orchard, Wind pollination.*

Pollen tube: An outgrowth of a germinating pollen grain through the stigma, through which the sperm passes to fertilize the egg.
See *Double fertilization, Fertilization*.

Pollen vector: The carrier, such as wind, insects or birds, carrying pollen from one plant to another.
See *Pollination, Wind pollination.*

Pollination: Deposition of pollen on the receptive part of the female flower. In angiosperms this is the stigmatic surface, in gymnosperms the ovule tip.
See *Controlled pollination, Double fertilization, Fertilization, Pistillate, Pollen vector, Receptivity*.

Polycross (pollen mix) design: Incomplete pedigree mating (breeding) design in which each female is crossed with a mix of pollen from a number of male parents. Identities can be maintained only for the mother plants. Generally a considerable number of pollens are included in the mix to ensure that the female parents are pollinated by a representative sample of other parents. The pollen mix can be artificially applied to each seed parent, or the selections may naturally and randomly open-pollinate themselves in isolation blocks (orchards). Via the test it is possible to assess general combining ability from crosses among selected parents.
See *Combining ability, Controlled pollination, Mating design, Open pollinated mating, Polycross test, Progeny test, Topcross test.*

Polyembryony: The formation of more than one embryo in an ovule.
See *Double fertilization, Fertilization, Flower, Seed.*

Polygenes: Several non-allelic genes all affecting the same character and approximately additive in their effect (polymeric systems).
See *Additive genes, Epistasis, Multiple alleles*.

Polymeric systems: See *Polygenes.*

Polyploid: Having more than twice the basic number *n* of chromosomes of the ancestral species in its vegetative cells. A cell, tissue, or organism having three sets (3n) is called triploid, and four sets (4n) tetraploid.
See *Chromosome number, Diploid, Haploid*.

Population: Genetically, a group of similar individuals related by descent and so delimited in range by environmental or endogenous factors as to be considered a unit. In cross-bred organisms the population is often defined as the interbreeding group.
See *Cline, Ecosystem, Ecotype, Population structure, Stand, Variety.*

Population genetics: The study of the number, variety and distribution of genes in a population or species, and the factors that influence these.
See *Gene frequency, Gene pool, Hardy-Weinberg law, Quantitative genetics.*

Population structure: The arrangement of genetic variation within and among populations.
See *Gene frequency, Population genetics.*

Positive correlation: See *Correlation.*

Production population: See propagation population.

Progeny: Offspring, descendants.
See *F_1, F_2, Progeny test.*

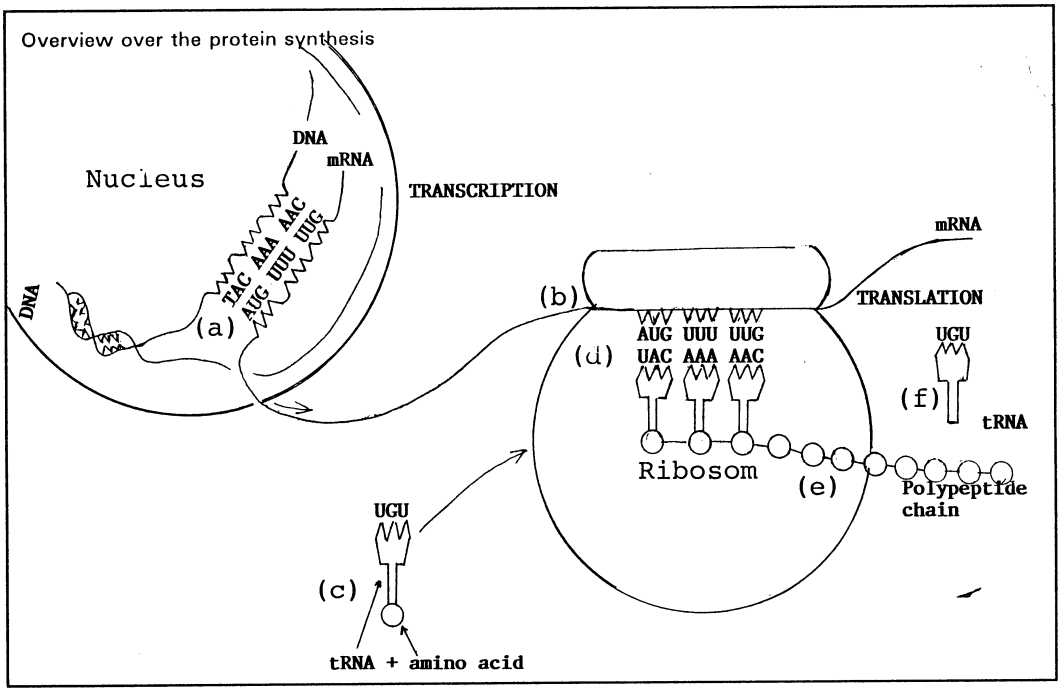
Progeny test (trial): Evaluation of parents by comparing the performance of their offspring. Accuracy is usually gained because several to many offspring per parent are evaluated under more controlled conditions than exist for the parent. Preferably established on two or more environments to study family x environment interaction.
See *Clonal test, Combining ability, Genetic test, Progeny, Experimental design, Provenance trial.*

Propagation population (= Production population): Population used strictly to produce seeds or vegetative propagules for operational reforestation programs.
See *Base population, Breeding population, Breeding strategy, Wood producing population, Seed orchard*.

Propagule: A plant part, such as a bud, tuber, root, or shoot, used to propagate an individual vegetatively.
See *Asexual reproduction, Forest reproductive material, Germplasm, Vegetative propagation*.

Protandry: Termination of the shedding of pollen of a plant or flower prior to receptivity on the same plant or flower.
See *Dichogamy, Monoecious, Protogyny, Receptivity.*

Protein synthesis: The biochemical process by which the genetic material of the cells is expressed as the amino acid sequence of a protein. The proteins consist of polypeptid chains which are built up from 20 different amino acids. The number, sequence and type are unique for a particular protein. The sequence of amino acids is determined by the sequence of bases of the DNA via the process illustrated below: (a) The base sequence is transcripted to a complementary base sequence of the mRNA; (b) the mRNA moves to the ribosomes where the synthesis occurs; (c) the tRNA binds specific amino acids at one end and a triplet of bases (anticodon) at the other; (d) the anticodon binds to a triplet (codon) of the mRNA; (e) the individual amino acids bind together in a polypeptide chain; (f) the tRNA is released to bind to another free amino acid. The matching of codons and anticodons and the attachment of amino acids to the polypeptide chain is called translation.
See *Cell, DNA, Gene, Genetic code.*



Protogyny: Termination of receptivity prior to the maturation of pollen on the same plant or flower.
See *Dichogamy, Monoecious, Protandry, Receptivity.*

Provenance: 1) The original geographic source of seed, pollen, or propagules. In forest tree breeding the term usually refers to the original native source of a population. When a population is removed from its sources and has grown elsewhere for a number of generations, it is referred to as a 'land race'. 2) The place in which any stand of trees are growing. The stand may be indigenous or non-indigenous, cf 1).
See *Geographic race, Land race, Local seed source, Origin, Provenance trials.*

Provenance resource stand: A forest plantation of known provenance and broad genetic base the boundaries of which are marked in the field and recorded on official maps, and which may be used for plus tree selection, seed collection, provenance conservation etc.
See *Breeding arboretum, Clonal bank, Gene conservation, Provenance, Seed production area.*

Provenance trial (test): A well-designed comparison of population samples from a range (preferably the whole range) of a species. Should be established in two or more environments to enable assessment of provenance x environment interaction.
See *Experimental design, Progeny test, Provenance, Species test, Sampling.*

Proximal: The proximal end of either the root or the shoot is that nearest to the stem-root junction of the plant and farthest from the tip of the root or the shoot. Ant. *Distal*.
See also *Distal, Polarity.*

Pure line (pure strain): A succession of generations recognized by their ability to produce genotypical identical offspring when selfed or crossed between themselves. The members of a pure line are said to be 'breed true'. By inference such individuals are deemed to be homozygous.
See *Breed true, Homozygote, Inbreeding, Inbred line, Line, Self pollination*.

Q

Qualitative inheritance: See *Simple Mendelian inheritance.*

Quantitative genetics: The part of genetic science which deals with the hereditary transmission of differences among individuals that are quantitative, e.g. growth rate, wood density etc. Most of these characters are determined by additive genes.
See *Additive genes, Gene frequency, Hardy-Weinberg law, Population genetics, Quantitative inheritance, Simple Mendelian inheritance.*

Quantitative inheritance: Inheritance of characters, such as size and form, which vary continuously (quantitatively). From one to hundreds of genes may control such characters. These genes (multiple factors or polygenes) act cumulatively and cannot be detected by their individual effect. Quantitative characters are usually subject to considerable modification by the environment and hence require refined statistical techniques in their study.
See *Additive genes, Allele, Dominance, Heritability, Quantitative genetics, Simple Mendelian inheritance*.

R

Race: A population within a species that exhibits general genetic characteristics discontinuous and distinct from those of other populations. It is usually an interbreeding unit. When distinguishing characteristics of a race are adaptive, the term is synonymous with ecotype, and the race is described similarly, e.g. climatic or edaphic race.
See *Cline, Genetic drift, Ecotype, Geographic race, Land race, Local seed source, Population, Seed source, Taxonomic hierarchy, Variety*.

Ramet: An individual member of a clone.
See *Clone, Ortet, Vegetative propagation.*

Ramicorn: Upright/vertical branch. Often occurring in conifers as a branch outside the normal branch whorl. Ramicorns do not dehisce easily and tend to leave large knots in the wood. They are heritable and character often de-selected for in the breeding programme.
See *Character, Epicormic branches, Selection*.

Random drift: See *Genetic drift.*

Random mating (= Panmixis): The occurrence of sexual reproduction among individual members of a population in which the probability of any two individuals mating is equal.
See *Completely random design, Open pollination, Seed production area, Wind pollination*.

Randomized complete block design (RCB): Test design in which each family or seedlot is represented by a single plot within the subunit called a replication or block. For each test several replications are established with the plots randomly distributed within each replication.
See *Block, Completely random design, Experimental design, Latin square design, Lattice design, Plot, Split block design.*

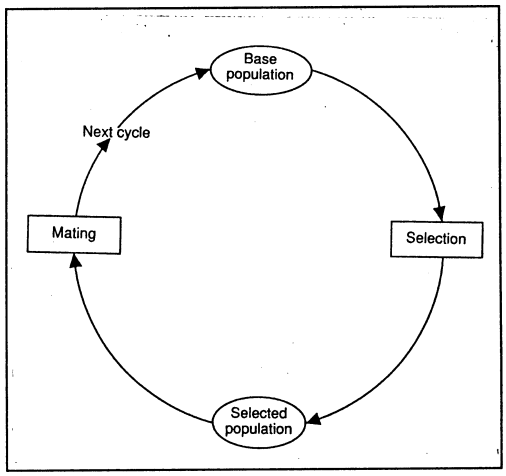
Receptivity: Condition of the female flower that permits effective pollination.
See *Anthesis, Dichogamy, Fertilization, Pollination*.

Recessive (allele): Describing an allele that is only expressed when homozygous. They are in most cases considered to be the mutant form of dominant alleles. Recessive alleles are in crossings referred to with small letters, dominant alleles with capitals.
See *Allele, Dominance, Gene, Hardy-Weinberg law, Locus, Mendel's principles, Simple Mendelian inheritance*.

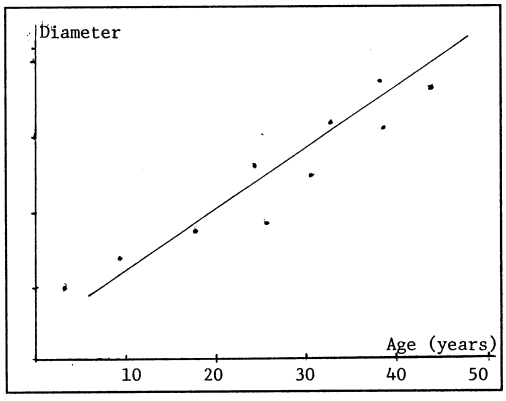
Reciprocal cross: The repetition of a cross where the sexual function of the parents is reversed, i.e. female B x male A is the reciprocal of female A x male B. Used in full diallel cross.
See *Bisexual, Cross-pollination, Diallel cross, Mating design.*

Recombination: (1) Formation in the progeny of new combinations of linked genes not present in either parent. The new combinations are due to crossing over during meiosis. (2) New combinations in absence of linkage.
See *Allele*, *Crossing over, Linkage, Locus, Gene, Meiosis, Mendel's principles.*

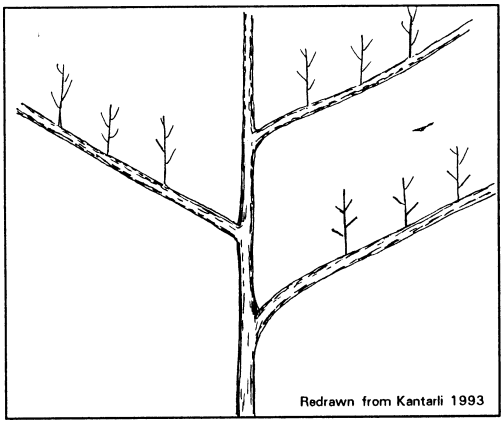
Recurrent selection: Selecting individuals or families and intermating them or allowing them to interpollinate to produce the next generation, e.g. a seed-production area or a clonal seed orchard. The new generations are generally used as breeding populations in which to start repeated cycles of selection and breeding.
See *Breeding population, Breeding strategy, Mass selection, Selection.*



Regression system: A grading system relating characters of interest in a tree improvement program with age. The value of the character of interest is plotted against age. The acquired regression line serves as a baseline for subsequent grading of uneven-aged or mixed-species-type stands.
See *Juvenile-mature correlation, Juvenile selection.*



Reiteration: Orthotropic shoots arising on the upper side of the branches of the crown of e.g. dipterocarp species. Used for cutting propagation.
See *Coppice shoots, Cutting, Epicormic shoots, Hedging, Orthotropic shoots, Rejuvenation.*



Rejuvenation: 1) Apparent rejuvenation: Production of for example coppice shoots, which readily root, from growth of already juvenile dormant buds, e.g. by girdling. Reversal of physiological maturation is not involved. **2) True rejuvenation:** Reversal of the adult maturation state through tissue culture or grafting, so that the material will root.
See *Coppice shoots, Dormancy, Epicormic shoots, Girdling, Hedging, Juvenile, Mature, Orthotropic growth, Tissue culture.*

Replicate (replication): 1) Part of the test (site) with the same experimental design. In field trials often synonymous with block. 2) Duplication of chromosomal or extra-chromosomal DNA prior to cell division.
See *Block, DNA, Experimental design, Mating design, Meiosis, Mitosis, Plot.*

Representative: A small unit covering approximately the total variation of the larger unit it represents. Test sites may be representative of the total geographical distribution of a species if they cover the total ecological amplitude e.g. altitude and rainfall regime. A sample or a conservation stand is representative if it covers the genetic variation of the population it represents.
See *Gene conservation, Genetic base, Provenance resource stand, Sampling*.

Reproductive age: The age at which the tree produces its first fruit crop, i.e. the demarkation from juvenile to mature in respect of reproduction.
See *Flower, Flower initiation, Juvenile, Mature.*

Residual: See *Variation*.

Resistance: Relative ability to endure pests or other damaging influences. It may vary in degree from immunity, in which the attack or influence is completely without effect, to absolute susceptibility, which may result in death.
See *Escape, Plus.*

RNA: Ribo-Nucleic-Acid. A single stranded organic molecule consisting of sugars and bases which acts during the protein synthesis by translating and transcribing the genetic code. There are three types of RNA viz. messenger RNA (mRNA), transport RNA (tRNA), and ribosomal RNA (rRNA)
See *DNA, Protein synthesis, Transcription, Translation.*

Rogueing (=Culling): Systematic removal of individuals not desired for the perpetuation of a population.
See *Buffer area, Mass selection, Seed production area*.

Rooting hormone: Hormone (growth substance) which specifically promotes root formation and root growth. The active compound is usually β-indole-butyric acid (IBA) or α-napthalene-acetic acid (NAA). Sold under various trade names e.g. RooTone or Seradix.
See *Air-layering, Auxin, Cutting, Hormone, Vegetative propagation.*

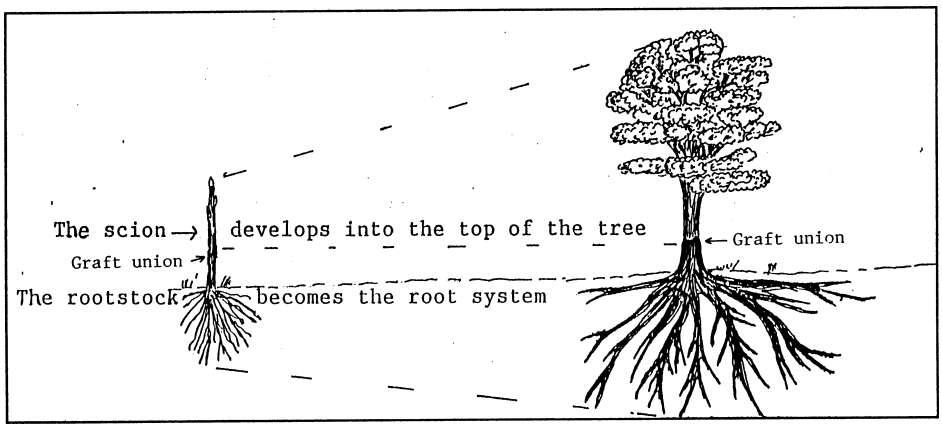
Rootstock (=Stock): The root-bearing plant or plant part, usually stem or root, onto which another plant is grafted.
See *Budding, Grafting, Scion.*

Root suckers: Shoots appearing from adventitious buds on superficial lateral roots. Roots suckers are genetically identical to the mother plant and used in vegetative propagation.
See *Air layering, Clone, Coppice shoots, Cutting, Vegetative propagation*.

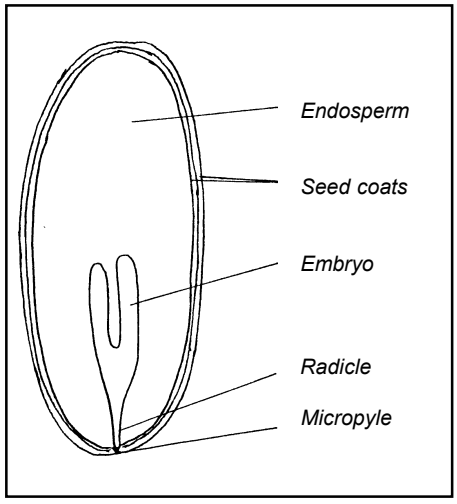
S

Sampling: In the context of genetic resources, the use of the principles and theory of population genetics and other related disciplines to ascertain what and how much collecting is needed to obtain the genetic diversity available in a population
See *Diversity, Gene conservation, Genetic resource, Representative, Variation.*

Scion: An aerial plant part, often a branchlet, that is grafted onto the root-bearing part (stock, rootstock) of another plant.
See *Grafting, Macropropagation, Root stock, Vegetative propagation.*



Seed: Morphologically the structure developed from the fertilized ovule in seed plants. It contains the embryo, which develops into the new plant, and usually endosperm, which forms the food supply. The seed is surrounded by a protective seed coat or testa. In a broad sense 'seed' often refers to the whole dispersal unit, e.g. in certain indehiscent fruits to the seed plus the whole or part of the fruit which continues to enclose the seed during collection and handling. In drubes, for example, seed usually refers to the seed plus enclosing endocarp. Such 'seeds' may contain one or more morphological seeds which are then called kernels.
See *Double fertilization, Endosperm, Pretreatment, Germination, Zygote.*



Seed collection area: An area with defined boundaries and altitude limits in which soil and climate are sufficient uniform to indicate high probability of reproducing a single ecotype.
See *Ecotype, Origin, Provenance, Seed collection zone, Seed orchard, Seed production area, Source-identified seed.*

Seed (collection) zone: Zone of trees with relatively uniform genetic (racial) composition as determined by progeny-testing various seed sources. The encompassed area usually has definite geographic bounds, climate, and growing conditions. A single geographic race may be divided into several zones.
See *Geographic race, Provenance, Seed collection area, Seed deployment zone, Seed source*.

Seed deployment zone: The zone in which seed from a particular seed zone can be used.
See *Seed collection zone.*

Seedling seed orchard: See *Seed orchard*.

Seed lot: A quantity of seeds of the same species, provenance, date of collection and handling history, and which is identified by a single number.
See *Certified tree seed, Experimental design, Germination test, Origin, Provenance, Forest reproductive material.*

Seed orchard (SO): A plantation consisting of clones or seedlings from selected trees usually of proven genetic quality. The plantation is isolated to reduce pollination from outside sources, rogued of undesirable trees, and managed for early and abundant seed production.

- **Seedling seed orchard (SSO):** Seed orchard raised from seedlings produced from selected parents through natural or controlled pollination.
- **Clonal seed orchard (CSO):** Seed orchard raised from selected clones propagated by grafting, budding, air-layering or rooting of cuttings.
- **Extensive seedling seed orchard (ESSO):** Stands established with special stock from a balanced mixture of seeds from at least 60 good parents (preferably of proven superior combining ability) and gradually culled. The family identity is not retained in the field.

See *Breeding arboretum, Certified tree seeds, Clone, Isolation, Pollen dilution zone, Seed production area, Selected tree seeds*.

Seed production area (SPA): Same as *Seed Stand.* A plus stand that is generally upgraded and opened by removal of undesirable trees and then managed for early and abundant seed production.
See *Buffer area, Provenance, Recurrent selection, Rogueing, Seed orchard, Seed collection area, Source-identified tree seeds.*

Seed source: The locality where a seed lot was collected; also the seed itself.
See *Geographic race, Local seed source, Provenance, Seed collection area, Source-identified tree seed.*

Seed stand: The stand of trees growing in a seed production area.
See *Seed production area, Stand.*

Seed year: In respect of any species, particular trees of irregular or infrequent seed production, a year in which it produces, either as an individual or a crop, an adequate amount of seed. Many periodic seeders produce heavy (‘bumper’) seed crops during their seed years.
See *Gregarious flowering, Masting, Periodicity.*

Seed zone: See *Seed collection zone.*

Selected reproductive material: Forest reproductive material derived from basic material approved for registration under the Forest Reproductive Material (FRM) regulations.

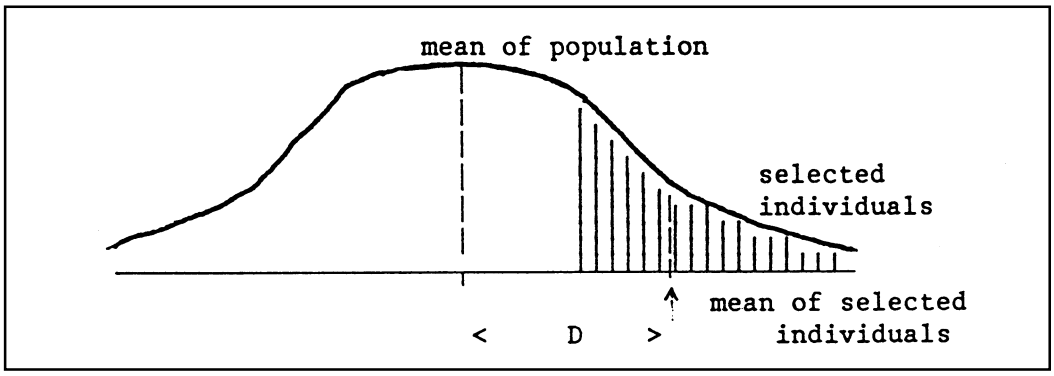
See *Certified tree seed, Forest reproductive material, Selected tree seeds.*

Selected tree seeds: Seeds collected from trees that have been rigidly selected for promising phenotypic characters or properties, but have not been progeny tested. The source and elevation must be stated.
See *Certified tree seeds, Provenance, Seed production area, Seed orchard, Selected reproductive material, Select, superior or plus tree, Source identified tree seed.*

Selection: Often synonymous with artificial selection, which is the choice by the breeder of individuals for propagation from a larger population. Artificial selection may be for one or more desired characters or properties. It may be based on the tree itself (phenotypic), or on the progeny of the tree or its other relatives (genotypic).
See *Character, Dysgenic selection, Eugenic, Evolution, Genotype, Phenotype, Progeny test, Select, superior or plus tree.*

Selection criteria: Type and priority of characters for which trees are selected for breeding. For forest trees, fast growth and straightness are often the main selection criteria.
See *Character, Grading, Selection, Select, superior or plus tree, Selection index*.

Selection differential: For individual traits, the difference between the mean of the whole population and the mean of the selected group.
See *Genetic response, Regression system, Selection, Selection intensity, Selection index*.



Selection index (=index selection): A form of multitrait selection that combines information on all traits of interest into a single index. This enables the breeder to assign a simple score to each individual based on heritability and economic importance. The selection index "I" is calculated as:

$$I = a \times X + b \times Y + c \times Z \text{ etc.},$$

where X,Y,Z etc. are the assessed or measured values of the individual traits (volume, straightness etc.), and a,b,c etc. are multiplication constants calculated on the basis of heritability and economic importance.
See *Character, Heritability, Independent culling, Regression system, Selection differential, Tandem selection.*

Selection intensity: The proportion of individuals in the population that are selected for breeding.
See *Genetic gain, Selection differential.*

Select, superior or plus tree: A tree that has been graded and recommended for use in production or breeding orchards. It has a superior phenotype for growth, form, wood quality, or other desired characteristics and appears adaptable. It may not yet have been tested for its genetic value, but the chances of it having a good genotype are high for characteristics with a high heritability.
See *Candidate tree, Comparison or check tree, Elite tree, Plus, Progeny test, Selection, Selection index*.

Self incompatibility (self sterility): The failure of gametes from the same plant to form a viable embryo.
See *Dioecious, Inbreeding, Incompatibility, Protandry, Protogyny, Self pollination*, *Sterility.*

Selfing: See *Self pollination.*

Self-pollination: Pollination of a flower with pollen from the same tree or clone. The offspring may be termed 'self'. Ant. *Cross pollination*.
See also *Inbred line, Inbreeding*.

Self pruning ability: The ability of a tree to shed its lower limpbs. The character is heritable and selected for in some species.
See *Character, Selection criteria.*

Sexual reproduction: The formation of new individuals of a species by the fusion of two normally haploid gametes to form a diploid zygote. Ant. asexual or vegetative reproduction.
See *Double fertilization, Fertilization, Meiosis, Zygote.*

Siblings (sibs): A group of individuals within a family. Full-sibs have both parents in common; half-sibs, only one.
See *Family, Pedigree*.

Simple Mendelian inheritance: Inheritance of genes for discrete characters, as for instance the presence or absence of pigments. Such inheritance is controlled by one or a few major genes; their effects are discontinuous and pronounced enough to be individually detected.

The figure illustrates mating of two parents heterozygous for the gene "A": A=Dominant, a=recessive. The sex cells con-tain either A or a. Mating results in genotypes as shown: 25% homozygous AA, 50% heterozygous Aa and 25% homozygous aa, i.e.
Genotypic distribution AA:Aa:aa=1:2:1,
Phenotypic distribution A:a=3:1

Gametes	A	a
A	AA	Aa
a	Aa	aa

If two independent heterozygous genes are involved e.g. "A" and "B" the heterozygous is AaBb. Mating results in the genotypic distribution AABB:AABb:AAbb:AaBB:AaBb: Aabb:aaBB:aaBb:aabb= 1:2:1:2:4:2:1:2:1;
Phenotypic distribution: AB:Ab:aB:ab= 9:3:3:1
See *Allele, Mendel's principles, Quantitative inheritance*.

Single-pair mating: Complete pedigree mating (breeding) design in which each parent is mated to one other member of the population. This creates the maximum number of unrelated families in each generation with a minimum number of crosses.
See *Complete pedigree design, Controlled pollination, Diallel, Factorial design, Incom-plete pedigree design, Mating design, Nested design.*

	Male parent									
Female parent	1	2	3	4	5	6	7	8	9	10
1		X								
2										
3				X						
4										
5						X				
6										
7								X		
8										
9										X
10										

Smear (squash): A quick preparation and staining procedure for studying chromosomes by spreading apart tissues by pressure. Smears are often made with pollen mother cells at meiosis (PMC smears), and with pollen grains, root tips, and other growing tissue at miosis.
See *Chromosome, Chromosome number, Meiosis, Mitosis.*

Somatic cells (= vegetative cells): Any other cell of the body than spores, gametes and their precursors. Ant. reproductive cells.
See *Somatic embryogenesis, Somatic mutation.*

Somatic embryogenesis: Development of embryos from diploid somatic cells in suspension culture.
See *Somatic cells, Tissue culture, Totipotency, Vegetative propagation*.

Somatic mutation: Genetic changes occurring in somatic (vegetative) cells. It can result in abnormalities of growth. They are not inherited unless the mutant tissue gives rise to a reproductive shoot.
See *Mutation, Mutagen, Somatic cells.*

Source identified tree seeds: Seeds collected from natural stands where geographical origin (source and elevation) is known and specified or from seed orchards or plantations of known provenance, specified by seed-certifying agencies.
See *Certified tree seeds, Forest reproductive material, Origin, Provenance, Seed collection area, Seed orchard, Seed production area, Selected tree seeds.*

Species: A population of organisms that are able to interbreed freely under natural conditions. A species represents a group of organisms which has evolved distinct inheritable features and occupies unique geographical area. Species do not usually interbreed freely with other species.
See *Ecotypic differentiation, Hybrid, Species hybrid, Species test, Taxonomic hierarchy.*

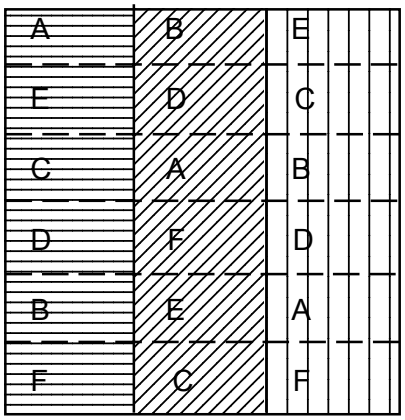
Species elimination trial (test): See *Species test.*

Species hybrid (interspecific hybrid): The offspring produced by crossing two species. See *Cross-pollination, Hybrid, Hybridization, Sympatric*.

Species test (trial): A well designed comparison of selected species preferably established on two or more environments to study which species are the best suited for a particular planting site. Used prior to introduction of new species into an area and prior to or combined with provenance trials.
See *Exotic, Experimental design, Provenance test, Progeny test.*

Specific combining ability (SCA): The average performance of the progeny of a cross between two specific parents that are different from what would be expected on the basis of their general combining abilities alone. It can be either negative or positive.
See *Combining ability, General combining ability, Heterosis, Hybrid*.

Split block design: Experimental design in which more than one factor is being tested, e.g. fertilizer and families. The test area is divided into (few) blocks which are further subdivided into sub-blocks composed of plots. The plots are randomly distributed within the sub-blocks and the sub-blocks randomly distributed within the blocks. In the figure there are 3 blocks each with 6 sub-blocks.
See *Completely randomized design, Experimental design, Randomized complete block design.*



Staminate: Having pollen-bearing organs (stamens) only. May apply to individual male plants of a dioecious species or to flowers, inflorescences, and strobili.
See *Dichogamy, Dioecious, Flower, Ovulate, Protandry, Pistillate, Strobilus*.

Stand: A population of trees possessing sufficient uniformity in composition, constitution, and arrangement to be distinguished from adjacent populations.
See *Population, Seed production area.*

Sterility: (1) Absence or defectiveness of pollen, eggs, embryo, or endosperm, which prevents sexual reproduction. 2) The exclusion of contaminating microorganisms in laboratory work for example micropropagation. Sterility can be achieved by killing possible organisms by e.g. heating.
See *Aseptic culture, Hybrid, Incompatibility, Micropropagation, Self-incompatibility*.

Stock (strain): 1) A group of plants of common lineage which, although not taxonomically distinct from others of the species or variety, are distinguishable on the basis of productivity, vigour, resistance to disease, or other ecological or physiological characters. **2)** Same as *rootstock*.
See *Line, Rootstock, Stand, Variety.*

Stool (plants): Same as hedged plants.
See *Hedging*.

Strangulation: Blockage of water and nutrient passage in the cambium by physically constriction of the bark. Strangulation may be imposed as a stress factor in order to induce flowering.
See *Flower induction, Girdling.*

Strobilus (pl. strobili): The cone of conifers and certain other plants. The strobili contain the reproductive organs of one or both sexes. Before and during pollination time, they are often called flowers and, for a period thereafter, conelets.
See *Conelet, Flower.*

Subculture: The process of micropropagation in which plant tissue is divided and transferred into fresh culture medium.
See *Micropropagation, Tissue culture*.

Sublining: Use of multiple breeding populations in order to avoid inbreeding in production seed orchards.
See *Breeding strategy, Inbreeding, Mating design, Seed orchard, Self pollination.*

Sub-population: Sub-division of the breeding population in order to avoid inbreeding in future plantations or seed orchards.
See *Breeding strategy, Population, Sublining.*

Sucker: See *Root sucker*.

Superior: A non-technical term referring to selections which appear or have been proved to be outstanding. Superior tree often used synonymously with plus or select tree.
See *Elite, Plus, Selection, Select, superior or plus tree.*

Sustainable use: The use of components of biological diversity in a way and at a rate that does not lead to long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.
See *Biological diversity, Gene conservation.*

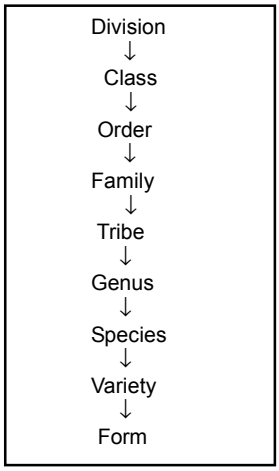
Sympatric: Describing two or more populations inhabiting the same or overlapping areas, and which could inbreed but do not usually do so because of various differences, e.g. time of flowering or type of pollinator.
See *Allopatric, Geographical race, Land race, Race*.

T

Tandem selection: Breeding and selection for one trait at a time until the desired level of improvement is reached for that trait. Used in e.g. breeding for disease resistance and cold hardiness, but rarely used in forestry due to the slow succession of generations.
See *Elite, Independent culling, Mating design, Selection, Selection index.*

Taxon (pl. taxa): Any formal taxonomic category, e.g. family, genus, variety.
See *Family, Phylogeny, Taxonomic hierarchy, Taxonomy*.

Taxonomic hierarchy: Ranking of living (or extinct) organism according to taxon. The taxonomic hierarchy appears from the figure. Some levels are often divided into sub-levels, e.g. sub-division, sub-class and sub-species. '*Race*' is sometimes included in the hierarchy between subspecies and variety. The non-taxonomic categories *Provenance, Land race* and *Cultivar* are often used in tree breeding terminology (see these).
See *Morphology, Phylogeny, Taxonomy*



Taxonomy: Classification of organisms, including identification of nomenclature, according to a natural (chiefly morphological) system that seems to depict evolution.
See *Morphology, Phylogeny, Taxon, Taxonomic hierarchy.*

Test design: See *Experimental design, Genetic test, Mating design.*

Tester design: See *Factorial design.*

Tetraploid: Having 4n chromosomes.
See *Chromosome set, Diploid, Haploid, Polyploid.*

Tissue culture: The growth of isolated plant cells or small pieces of tissue under controlled conditions in a sterile growth medium. The medium is designed to meet the requirement of the tissue involved, e.g. by application of hormones and nutrients.
See *Micropropagation, Somatic embryogenesis, Totipotency, Vegetative propagation*

Topcross test: Progeny test derived by crossing each parent with the same tester (topcross) pollen. The pollen may be a single lot or a mixture from a number of tester trees, but should not mask the contribution of the tested parents. The selections to be compared are sometimes placed in an isolation block where the tester is the only source of pollen.
See *Cross-pollination, Diallel cross, Mating design, Polycross test, Progeny test*.

Topophysis (Plagiotrophy): The phenomenon that occurs when scions, buddings, and rooted cuttings maintain for some time the branchlike growth habit they had as shoots on the ortet.
See *Cyclophysis, Hedging, Juvenile, Mature, Orthotropic growth, Plagiotropic growth, Periphysis.*

Totipotency: The capacity, exhibited by certain types of differentiated plant cells, to regenerate whole plants. To realize this potential the cell must be removed from the inhibiting influence of the rest of the plant body and given the appropriate stimuli, namely the correct balance of nutrients and growth substances.
See *Meristem culture, Somatic embryogenesis, Tissue culture, Vegetative propagation.*

Trait: See *Character*.

Transcription: The process by which a messenger RNA is formed as a "mirror image" of the parent DNA during protein synthesis, and such encompasses the genetic code.
See *DNA, Genetic code, Protein synthesis, RNA, Translation.*

Transgressive segregation: Appearance in the F_2, or other segregating generations, of individuals where expression of some character (usually discrete) is more extreme than in either the parental or the F_1 generation.
See *F_1*, *F_2*, *Heterosis, Hybrid.*

Translation: The process in the protein synthesis in which the genetic code of the DNA is expressed in amino-acid sequence (polypeptide chain) by the intermediate agent of the mRNA.
See *DNA, Protein synthesis, RNA, Transcription.*

Treatment: In experimental and statistical terminology any variable factor being tested. In silviculture, treatments may typically be thinning, fertilizing etc., i.e. the literal meaning of the word. In experimental design on tree improvement treatment may be different provenances and seedlots to be tested.
See *Experimental design, Seed lot, Variation*.

Tree breeding: See *Forest tree breeding, Forest tree improvement, Plant breeding*

Tree improvement: See *Forest tree improvement*.

Trial: Same as test. See e.g. *Provenance trial*.

Triploid. Containing 3n chromosomes.
See *Double fertilization, Endosperm, Hybrid sterility, Polyploid.*

V

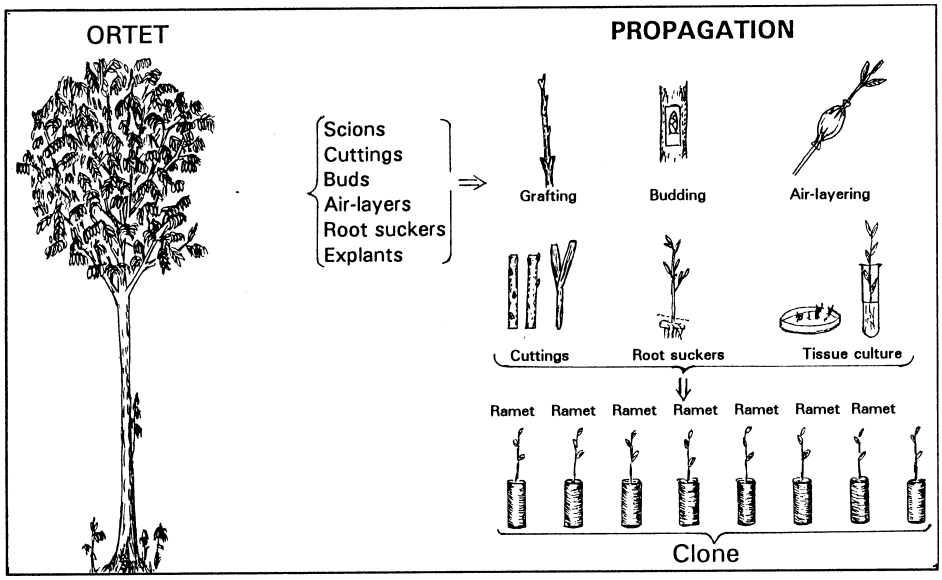
Variance: A statistical concept denoting the numeric measure of variability. It is defined as the sum of the squared deviation of each observation from the arithmetrical mean divided by one less than the total number of observations.
See *Variation, Genotype - environment interaction.*

Variation: Difference in performance and characters of individuals due to internal and external factors. In a natural population the phenotypic variation is the product of developmental, environmental and genetic variation. In trials, sampling variation and experimental error make up the residual variation
See *Diversity, Genotype - environment interaction, Genotype, Phenotype, Variance*.

Variety: (1) A taxonomic subdivision of a species based on minor characteristics and often an exclusive geographic range. Variety ranges subordinate to species but above the category "form" in the taxonomic hierarchy. (2) An assemblage of cultivated individuals distinguished by any useful, reproducible character(s). In this second sense, taxonomists prefer to use the word *cultivar* rather than *variety* of *strain*.
See *Family, Race, Taxon, Taxonomic hierarchy*.

Vegetative cells: See *Somatic cells*.

Vegetative propagation: Propagation of a plant by asexual means, as in budding, dividing, grafting, rooting of cuttings, and air-layering. Hereditary characteristics of the resulting clone (ramets) are identical with those of the original plant (ortet).
See *Air-layering, Apomixis, Asexual reproduction, Budding, Clone, Grafting, Macropropagation, Micropropagation, Ortet, Ramet, Root sucker, Vegetative cells.*



Vigour: Healthy, profuse and rapid growth.
See *Ageing, Heterosis*.

W

Wahlund's effect: The result of pooling individuals from genetically distinct sub-populatons into a single sample. The proportion of heterozygotes is lower than expected from the mean allele frequencies.
See *Hardy-Weinberg law, Gene frequency, Sub-population.*

Wind pollination: Pollination by wind-borne pollen.
See *Background pollination, Buffer area, Controlled pollination, Open pollination, Pollen dilution zone.*

Wood producing population: Operational plantations in the afforestation programme.
See *Base population, Breeding population, Breeding strategy, Production population.*

X

Xenia: An observable effect of pollen on the endosperm or embryo, especially effects resulting from the dominance relationships and other types of gene action in the triploid endosperm. Because of Xenia, hybrid characteristics may be manifested in form, colour, etc. of the derived seed.
See *Allele, Dominance, Double fertilization, Endosperm*.

Z

Zygote: The fertilized egg; sometimes also the individual developing from it. The zygotic chromosome number is normally diploid (2*n*).
See *Chromosome number, Diploid, Double fertilization, Fertilization*.

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