

## DEFINITIONS OF COMMON GENETICS TERMS

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Articles posted on this website and elsewhere often contain terms that are specific to plant breeding and genetics. The below definitions should aid in the understanding of the content of these articles and articles that are linked in them.

### **Agrobacterium mediated transformation.**

Utilization of the tumor-inducing plasmid of bacterium species *Rhizobium radiobacter* to transfer a heritable piece of DNA to plant callus tissue.

**Allele.** Any of several forms of a gene that are responsible for hereditary variation. An allele is an alternative form of a gene (one member of a pair) that is located at a specific position on a specific chromosome. These DNA codings determine distinct traits that can be passed on from parents to offspring.

Organisms have two alleles for each trait. When the alleles of a pair are heterozygous (different), one is dominant and the other is recessive. The dominant allele is expressed and the recessive allele is masked.

**Amino acids.** A group of 20 naturally occurring molecules that are combined to make proteins. Their presence or absence and their proportion in plants is generally a measure of the quality of the protein that is produced by a particular plant species such as soybean.

**Base.** A single nucleotide; adenine (A), thymine (T), guanine (G), and cytosine (C).

**Base pair.** The bonded structure between two complementary nucleotides; e.g. A-T or C-G.

**Bioinformatics.** Use of computer programs for searching and analyzing electronic databases of DNA and protein sequences. This branch of science is an important component of molecular biology and

genetics.

**Biolistics.** The process of introducing DNA into plant cells by shooting DNA-coated pellets into the cell using a compressed air delivery system known as a **gene gun**.

**Biotechnology.** Generally implies manipulating a plant's genome to improve its function in the environment or to enhance its usefulness for improved food material for animal and human nutrition.

**Callus.** Undifferentiated plant cells that are multiplied under tissue culture.

**Chromosome.** A complex DNA chain that contains genetic information. Chromosomes occur as paired sets throughout the genome.

**CRISPR-Cas9.** A genomic editing system that contains a DNA targeting component (CRISPR = clustered regularly interspaced short palindromic repeats) and a nuclease or enzyme (Cas9 = CRISPR associated protein 9) that cuts the targeted DNA segment.

**DNA.** Deoxyribonucleic acid, the hereditary material in living organisms. It is composed of nucleotides that are made up of the sugar deoxyribose, a phosphate group, and an organic base. The four primary bases are adenine (A), thymine (T), guanine (G), and cytosine (C). Their order or sequence determines the information for building and maintaining an organism.

DNA usually consists of a double strand of nucleotides referred to as a "double helix". RNA primers and DNA polymerase are involved in the formation of new DNA strands.

**DNA marker.** A DNA sequence that exists in two or



more forms that can be used to genotype individual organisms.

**DNA sequencing.** The process of determining the order of DNA bases (adenine, cytosine, guanine, thymine) along a DNA strand. The sequence or the order of the bases is what determines the phenotype and behavior of an organism.

**Dominant gene.** A gene whose phenotype is expressed when the allele is present as either one or two copies of the pair (e.g. AA or Aa).

**Epigenetics.** Any process that alters gene activity without changing the DNA sequence or genetic code; these modifications can affect gene function and/or expression. Such changes help determine whether genes are turned on or off. Chemical compounds that are added to single genes (e.g. DNA methylation) and environmental stimuli can regulate or alter their activity. These biological- and environmental-induced changes can influence the production of proteins in certain cells. An important trait of epigenetics is that its effects are reversible.

**Event.** The individual plant that is the product of genetic transformation. Every transformed plant constitutes a new event. For commercialization of biotech crops, one particular event must be approved through regulatory authority.

**Gene.** The basic, functional heredity unit consisting of a DNA sequence. They are specific sequences of bases that provide instructions on how to make important proteins, which are the molecules that trigger the various biological actions of an organism.

**Gene discovery.** A process whereby the individual base nucleotides in an organism's DNA are identified in order to learn more about the genome of the organism, and to learn about or identify specific areas of interest on chromosomes. This process allows for the identification of specific genes that code for a particular trait or traits.

**Gene editing.** A genetic engineering technique that is used to precisely modify DNA **within an organism**.

The process involves making cuts at specific DNA sequences with enzymes called engineered nucleases, which are made up of two parts—a nuclease or enzyme that cuts the DNA, and a DNA-targeting component that is designed to guide the nuclease to a specific DNA sequence in an organism. This process can be used to insert a new section of DNA, or to replace an existing section of DNA with an altered version to effect a point mutation within a gene. In effect, gene editing can direct and effect a mutation at a specific site in an organism's genome. **No outside DNA is introduced into the organism's DNA in this process.**

**Genetics.** The study or science of genes and heredity.

**Genetic engineering.** Altering the genetic structure of an organism by adding foreign genes or altering or removing native genes through biotechnology.

**Genetic (genomic) map.** A chart giving relative distance and position of one gene or genetic marker in relation to others in a genome.

**Genetic marker.** A gene or DNA sequence at a known location on a chromosome that can be used to identify individuals or species. A genetic marker may be a short or long DNA sequence. Some common types of genetic markers are [RFLPs](#) (Restriction Fragment Length Polymorphism), [SSLPs](#) (Simple Sequence Length Polymorphism), [SNPs](#) (Single Nucleotide Polymorphism), and [SSRs](#) (Simple Sequence Repeat DNA marker). Genetic markers play a role in genetic engineering because they allow breeders to locate and utilize genes of interest for genetic gains.

**Genetically modified organism (GMO).** A plant or animal whose genetic material (DNA) has been altered through genetic engineering/biotechnology techniques (insertion/deletion of genes) to produce a genotype that possesses a modified trait that is not found in naturally occurring plants of that species. When genes are inserted, they usually come from a different species. The principle of producing a GMO is to add new genetic material into an organism's genome.



In agriculture, genetically modified crops are developed to 1) contain desirable traits such as resistance to pests, herbicides, and/or environmental stresses, and 2) improve storage life and nutritional value.

**Genetic polymorphism.** Differences between DNA sequences.

**Genome.** The complete genetic makeup or the collection of all genes of an organism.

**Genomics.** The discipline of genetics that encompasses gene mapping, gene sequencing, and determining gene function.

**Genome mapping.** Determining a set of landmarks or genetic markers—genes or short DNA sequences—in the genome that will enable researchers to find new genes. A genome map is one-dimensional—a straight line with landmarks that stand for genes or DNA sequences. They guide a researcher toward a gene that is suspected to be involved in some process that is of interest.

**Genome sequencing.** Determining the order of every DNA base in the genome. More detailed than a genome map and usually done on short segments of the genome. Done to establish the distinctive order of genes of an organism.

**Genotype.** The genetic composition of an individual.

**Germplasm.** The genetic material that carries the inheritance traits of an organism. Specifically, a collection of diverse genetic resources (e.g. the [National Plant Germplasm System](#)) that is available to be used in the development of improved breeding lines and varieties.

**Heterozygous.** Having two different alleles (e.g. Aa) governing a single phenotypic trait. A hybrid corn plant, for example, is heterozygous at every locus (e.g. Aa Bb Cc Dd...).

**Intellectual property.** All patent applications, patents, [plant variety protection \(PVP\) certificates](#), or

trade secrets that make up proprietary information.

**Marker-assisted selection (MAS).** Use of genetic/DNA markers to guide in choosing specific plants or lines with targeted traits for new variety development.

**Molecular breeding.** Plant breeding assisted by using DNA markers or protein markers.

**Molecular genetics.** The study of genes, the base components of heredity. Genes are made up of DNA, whose bases are placed in a unique order that determines the hereditary traits in living organisms.

**Mutation.** A natural or induced alteration in DNA structure or sequence.

**Nucleic acid.** DNA or RNA molecules that are composed of nucleotides.

**Nucleotides.** The basic structure of DNA and RNA that consists of an organic base (A, T, C, G), phosphoric acid, and a sugar.

**Phenotype.** The observable or measurable characteristics of an individual.

**Plant introduction (PI).** Germplasm brought to the United States from other parts of the world to provide new genes for potential improvement of crop productivity.

**Plasmid.** A heritable piece of DNA that is not part of a chromosome.

**Polymerase chain reaction (PCR).** A process that reproduces a specific stretch of DNA, going from very few copies to millions of DNA copies.

**Polymorphism.** Differences between DNA sequences.

**Qualitative trait.** Traits that are easily classified into distinct phenotypic categories. These phenotypes are under the genetic control of only one or a few genes with little or no environmental modification to



obscure the genetic effects.

**Quantitative trait.** Refers to phenotypes or characteristics of an organism that vary in degree and can be attributed to multi-gene effects (as opposed to single or a few genes) and their environment. These traits do not fit into discrete phenotypic classes, but instead form a continuum of phenotypes that blend to form a continuous variability.

**Quantitative trait loci (QTL).** Stretches of DNA containing closely linked genes that are responsible for phenotypes associated with quantitative traits. Mapping genomic regions that contain genes involved in expressing a quantitative trait is done using molecular tags.

**Recessive gene.** A gene whose phenotype is expressed only when it is present as two copies of both alleles (e.g. aa).

**Regeneration.** The embryonic development of shoots and roots from callus tissue, producing a plantlet.

**RNA.** Ribonucleic acid.

**Stacked traits.** Term used to describe seed products or GMO's with more than one biotechnology trait. These GMO's have had more than one gene from another organism or organisms transferred into their genome, thus creating a GMO with stacked "biotech" traits.

**Transformation.** The change in the genetic structure of an organism by the incorporation of new or foreign DNA.

**Transgene.** A modified native gene or a gene from another species that is inserted into plants to bring about a desired change or introduce a trait not native to the natural genome of that species.

**Transgenics.** The alteration of plant DNA by adding a gene from another species.

**Vector.** A plasmid used for carrying cloned DNA.

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