

## PLANT BIOTECHNOLOGY: THE BASICS

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Biotechnology refers to the use and manipulation of living organisms, or their products, for specific human purposes. Humans have been using other organisms for their benefit for a long time. However, modern-day biotechnology generally refers to the manipulation of organismal DNA for specific purposes. Often, this involves the identification and isolation of genes for valuable traits in one species and their insertion into another. Biotechnology, based on DNA manipulation, is possible because genes are multipartite consisting of regulatory and coding regions, DNA of all organisms is chemically identical, and the same genetic code is used in all organisms. Thus, genes and gene parts can be interchanged among organisms. The manipulation and exchange of DNA among organisms forms the basis of plant biotechnology, or recombinant DNA technology, today.

Recombinant DNA technology uses specialized techniques to transfer a gene or DNA segment from one organism to another, i.e. to “recombine” DNA from two different organisms. These techniques can be divided into four basic steps: gene splicing, gene cloning, plant transformation, and plant regeneration. Gene splicing consists of the construction of recombinant DNA molecules using restriction enzymes that cut DNA and other enzymes, called DNA ligases, that rejoin, or ligate, DNA fragments from different sources. The resulting recombinant DNA molecules include the novel desired gene that is to be transferred. During gene cloning, millions of copies of the desired gene are produced. This step is normally accomplished with the help of a “vector”, which introduces the desired gene into host bacterial cells that reproduce and, at the same time, produce multiple copies of the desired gene. The most common vectors are plasmids, which are small, circular DNA molecules found in bacteria.

During plant transformation, the new gene is introduced into a plant chromosome. Two methods are commonly used, *Agrobacterium*-mediated gene transfer or the “gene gun” method. In many plant species, one or a few genes can be introduced via the naturally occurring pathogenic soil bacterium, *Agrobacterium tumefaciens*. For other species, a microprojectile gun shoots DNA, coated onto microscopic beads, at high speed into plant cells directly. Some beads carry the DNA into the cell, where it is incorporated into a plant’s chromosomes. Once the desired gene is incorporated into the chromosomes of at least some living plant cells and these cells are identified and separated from untransformed cells, whole plants are regenerated from the transformed cells. All cells of the regenerated plants will contain the gene of interest.

Recombinant DNA techniques have dramatically increased the possibilities for crop improvement. Whereas traditional breeding is limited to the traits and genes that are present in a crop species or its close relatives, recombinant DNA technology can potentially introduce novel traits and genes from any source, including other organisms.