

Genetic modification: an overview for non-scientists

What is genetic modification?

For centuries farmers have used selective breeding to improve both crops and stock by breeding from the plants or animals that had the qualities they wanted to bring out and strengthen. This was the only way they had to develop animals and crops that were more productive and resistant to disease, and could cope better with extremes of climate.

Today, scientists can find individual genes that control particular characteristics, separate them out, change them, and transfer them directly into the cells of an animal, plant, bacterium or virus. Because the DNA code is known and is common to all life, it is also possible to produce synthetic genes. This technology is called genetic modification or genetic engineering.

There are three major differences between selective breeding and genetic modification:

- In genetic modification, scientists take individual genes from one plant or animal and put them into the DNA of the cells of another. They may also make changes to (modify) an existing gene.
- Genetic modification provides a way of giving a plant or animal new, inheritable qualities that is much faster than traditional breeding methods; these qualities may themselves be entirely new.
- Genes can be transferred in ways that are not found in nature, between different species and even between animals and plants.

History

The knowledge on which the techniques of genetic modification are based dates from the 1950s, when James Watson, Francis Crick and Maurice Wilkin discovered the structure of DNA, the now-familiar double helix of nucleotides that forms the blueprint of life. This new understanding opened up the possibility that the genetic coding of organisms could be altered to give them new characteristics in ways that natural evolution or selective breeding could not produce.

When in the 1970s it became possible to isolate individual genes, refashion them and copy them in cells, huge commercial possibilities opened up. Ways of applying this new technology to medicine were developed quite rapidly. Applying these methods successfully to plants took longer; the first genetically altered whole food, Flav'r Sav'r tomatoes, came on the market in 1994. Since then the growth in the number and range of genetically modified products has been explosive. As the general public has become more aware of the impact of these discoveries, concerns over the use and safety of genetic modification have also been raised. As always, new technology brings with it new possibilities and new questions.

How genetic modification works

Cells that contain a gene to be isolated are broken open and the strands of DNA are extracted. Then proteins called restriction enzymes are added to break the DNA at particular points, until the short lengths that are individual genes are obtained.

The wanted gene is added to plasmids, small molecules in bacterial cells that contain DNA that is not part of the chromosomes of the cell. It is the discovery that plasmids can move between cells, taking their DNA with them, that has made this technology possible. The plasmids to which the wanted gene has been added are put in with the cells (usually bacteria) where the wanted gene is to go. The plasmids get inside the bacteria and add their genes to the genes of the bacteria. This means the bacteria now have the wanted gene as well as their own. These bacteria are then used to transfer the new genes into plant or animal cells. This process of gene splicing creates recombinant DNA.

The ability to separate out single genes and study them is a vital part of biological and medical research.

Another way to create genetically modified products is to use the bacteria themselves as factories for the introduced genes, producing such things as enzymes used in food production (eg, chymosin for cheese making) and vitamins for use in making processed foods, or hormones for use in medicine and animal husbandry.

The future

Genetic modification means that for the first time humans can make living things to our own design, without relying on nature. The implications are vast. Although any new technology may have its risks, this one has special features. They need to be addressed with wisdom and discernment.