What is Genetic Engineering?

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Genetic engineering has been much in the news lately. Some see it as an opportunity and some as a threat. What is it? Over the last twenty years, we have learned how to isolate any gene from any living organism, introduce the new gene into another organism, and get it to work there.

The process is straightforward and can be applied to any living organism. The DNA is isolated and treated with a special class of enzymes called restriction enzymes which break the DNA down into large fragments about the size of a gene or bigger. This mixture of fragments is then forced into special strains of bacteria or viruses so that, on average, each bacterium or virus contains one piece of DNA. Growth of the mixture amplifies every piece present, and the bacteria or viruses are then grown up from single colonies. Each colony is then screened for the presence of the gene in question.

The result is a bacterium or virus containing the gene-sometimes incomplete and sometimes with other adjacent genes as well. Growing up that bacterial clone then gives milligram amounts of the gene, which can be sequenced, trimmed and special DNA signals added to it called promoters, before it is inserted into the DNA of a bacterium, plant or animal. Because the genetic code is universal, the gene will work in the new host provided the right signals have been attached. The old species barriers have gone.

In this way we can make insulin, growth hormone or interferon, and many other substances, in bacteria for medical uses. These are now in routine clinical use, and are, in every case, as good as or better than the 'natural' product, and crucially they can be made in gram amounts, whereas before genetic engineering this was impossible. There has been little or no user concern over these medical products.

The technology can also be used to modify enzymes - naturally occurring biological catalysts - for use in the food industry, mainly to make new or modified enzymes for food processing. In this way, the gene for the enzyme chymosin was made synthetically by joining the DNA nucleotides together in the correct order. The gene was then used to produce the active enzyme in bacteria, and since it does not come from an animal source, is used to make vegetarian cheese, carrying the V label, whereas the previous product came from calves' stomachs and was not acceptable to vegetarians. Indeed, the enzyme can sometimes be 'improved' for a particular process by 'protein engineering' in which the code for the enzyme is modified at the DNA level, and then used to produce a slightly modified enzyme that may, for example be more stable at higher temperatures.

We can also modify plants and animals, leading to many new crop products; for example: modification of the genetic material of plants to extend their shelf life, e.g. the tomato, or to produce novel parental lines for the production of new hybrids, e.g.

rape, or to introduce resistance to herbicides or pests, e.g. soya, potatoes, cotton and corn.

There are many other new crop products to come over the next few years, some, like rice, for major crops for the developing world. It is also possible to modify animals so that cows for example could produce milk that is much closer in its composition to human milk, or animals with less body fat. However this sort of work worries many people, and it will be years before such products come to market.

Before such new foods can be sold we must be sure that they are safe, and that they will not damage the environment. In both the UK and the US there are highly developed regulatory processes to ensure this, but not everyone trusts them, and particularly in Europe; trust has been eroded by the BSE outbreak. So a number of changes are being made to rebuild trust and in particular to make the process more transparent.