

Genetic engineering

Revision notes · What genetic engineering is, the main stages using restriction enzymes, ligase and vectors, and GM crops such as Bt crops.

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

Genetic engineering **Spec 4.10–4.12B**

What is genetic engineering? **Spec 4.10**

Genetic engineering is a process which involves modifying the **genome** of an organism to introduce desirable characteristics.

Usually a gene for the characteristic is taken from one organism and inserted into another organism of a different species. The organism produced is called a genetically modified (GM) organism. It can now make the protein coded for by the new gene.

Examples of genetic engineering

Organism	Gene inserted	Desirable characteristic
Bacteria	Human gene for insulin	Bacteria make human insulin, to treat diabetes
Crop plants	Gene for resistance to insect pests	Plants are not damaged by the pest

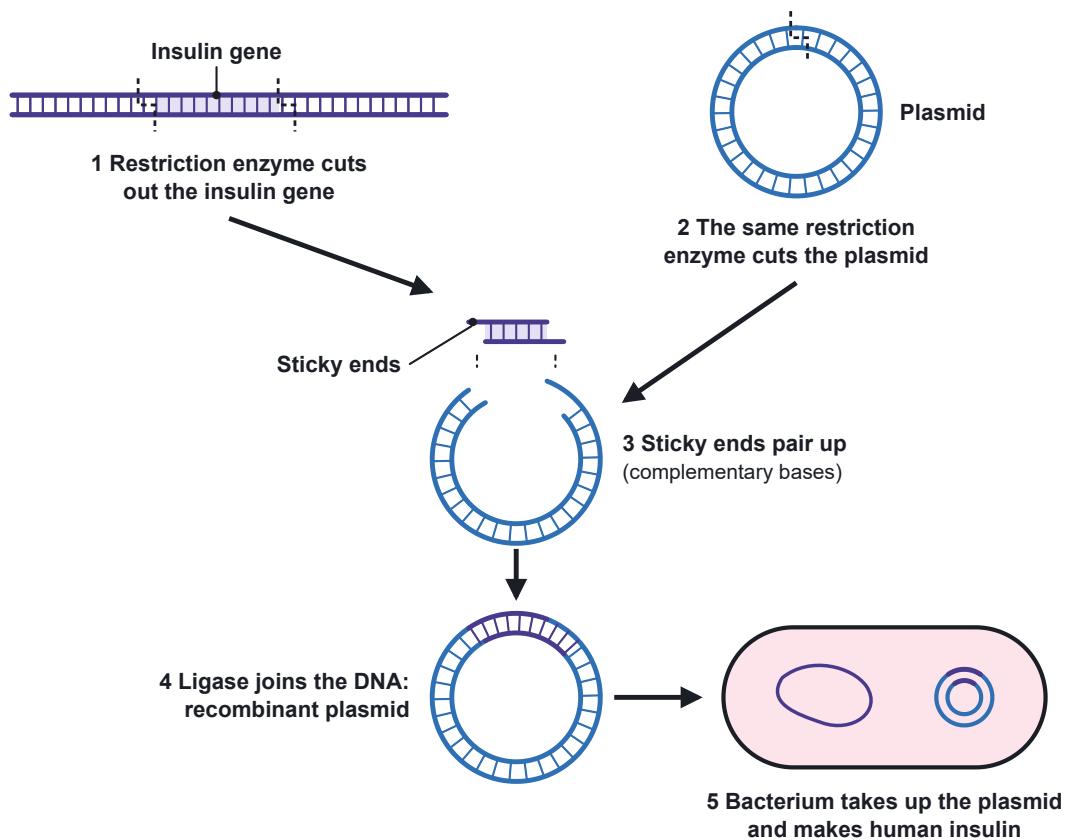
Common mistake: Genetic engineering is not the same as selective breeding. Selective breeding uses the genes already in a species; genetic engineering changes the genome directly.

The main stages of genetic engineering **Spec 4.11** **Higher tier**

1. The gene for the desired characteristic is cut out of the chromosome of the donor organism using a **restriction enzyme**. Each restriction enzyme cuts DNA at a specific sequence of bases.
2. The cut leaves short, unpaired strands of DNA at each end. These are called **sticky ends**.
3. The **vector** is cut open using the same restriction enzyme, so it has matching sticky ends. A vector is something used to carry the gene into the new cell, such as a bacterial plasmid or a virus.
4. The gene and the vector are mixed. The sticky ends join by complementary base pairing, and the enzyme **ligase** joins the DNA strands together permanently. This makes recombinant DNA, for example a recombinant plasmid.
5. The vector is used to insert the gene into the cells of the target organism (for example a bacterium, or a plant or animal at an early stage of development). The organism's cells now make the protein.

Restriction enzyme	An enzyme that cuts DNA at a specific base sequence.
Sticky ends	Short, unpaired strands of DNA left at the ends of a cut, which can join with complementary sticky ends.
Ligase	An enzyme that joins pieces of DNA together.
Vector	A carrier, such as a plasmid or virus, used to insert a gene into another organism's cells.

Exam tip: Use the same enzyme to cut both the gene and the vector. That gives matching sticky ends. Ligase then does the joining.



Same **restriction enzyme** gives matching **sticky ends**; **ligase** joins them to make a recombinant plasmid.

GM organisms and crop plants Spec 4.12B Triple only

A well-known example is the introduction of a gene from the bacterium *Bacillus thuringiensis* (Bt) into crop plants. The gene codes for a **toxin** that kills many insect pests. Plants with the gene make the toxin themselves and so have **insect resistance**.

Advantages and disadvantages of GM crops	
Advantages	Disadvantages
Less crop is lost to pests, so yields are higher	Possible risk to human health, which some people worry about
Less insecticide needs to be sprayed, which saves money and reduces damage to other organisms	Genes may spread to wild plants, and the toxin might harm other insects
Crops can be given extra characteristics, such as greater nutritional value or resistance to disease	GM seeds can be expensive, and farmers may have to buy new seeds each year
More food can be produced for a growing population	Concerns that it is wrong or unnatural to change organisms' genes
Crops with a gene for herbicide resistance can be sprayed to kill weeds without harming the crop	Insect pests may evolve resistance to the Bt toxin by natural selection

Exam tip: Structure 'advantages and disadvantages' answers as a balanced argument, then add a conclusion. Link each point to the crop, the farmer, people or the environment.

Quick check

- 1 . What is genetic engineering?
- 2 . What does a GM organism contain that a normal organism does not?
- 3 . Give one example of a desirable characteristic introduced by genetic engineering.

Quick check answers

Genetic engineering

1. Modifying the genome of an organism to introduce desirable characteristics.
2. A gene transferred from another organism.
3. For example, bacteria making human insulin, or crop plants resistant to insects.