

Genetic modification

Revision notes · Genetic modification: what it is, examples, how bacteria are modified to make a human protein, and GM crops.

For Cambridge IGCSE Biology 0610 (and 0970, which has the same content). **Supplement** is Extended content, only examined on Papers 2 and 4.

Genetic modification Spec 21.3

What genetic modification is Spec 21.3.1, 21.3.2

Genetic modification is changing the genetic material of an organism by **removing**, **changing** or **inserting** individual genes. An organism that has had its genes altered in this way is called a **genetically modified organism** (GMO). The inserted gene is often taken from another species.

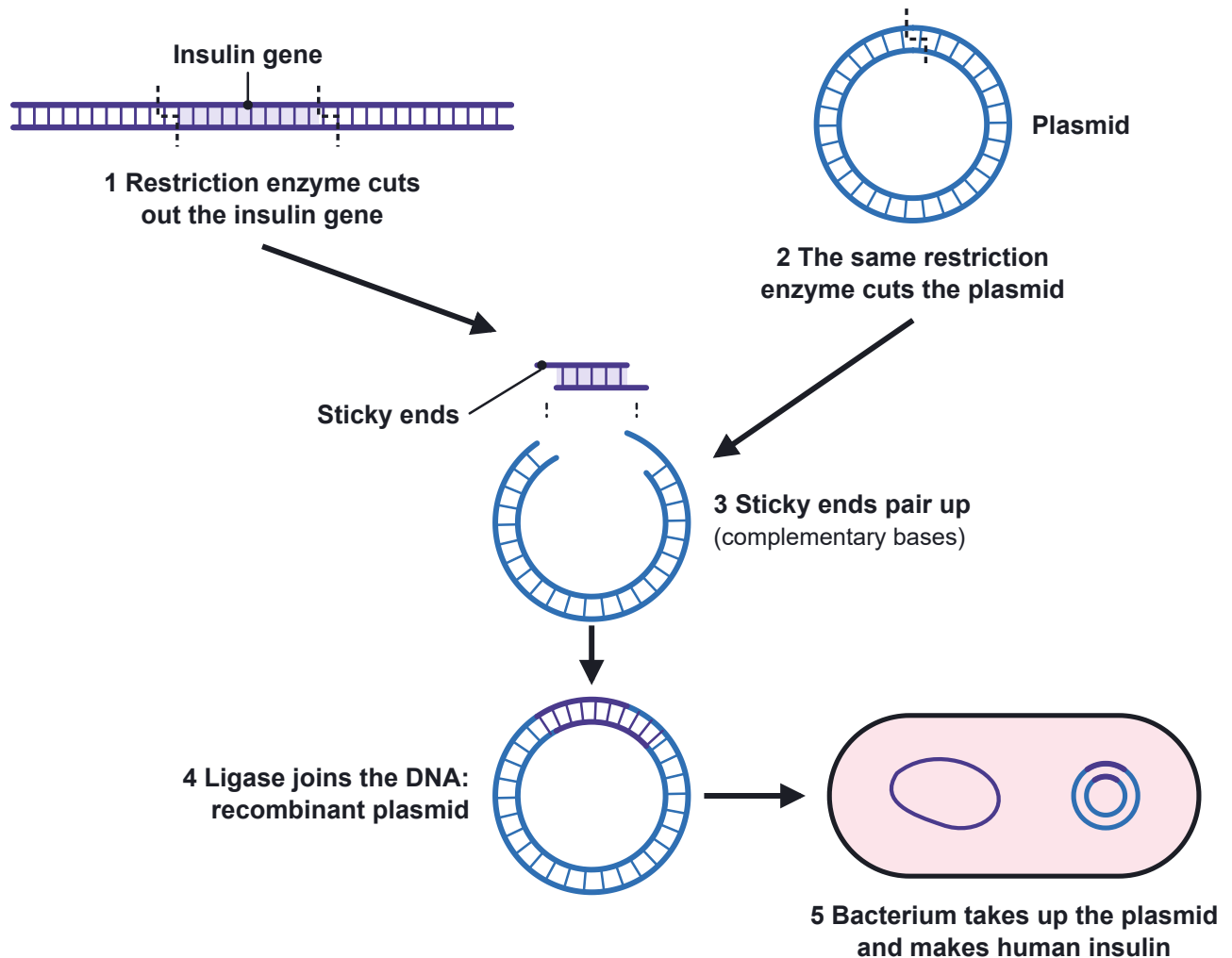
Examples of genetic modification		
Example	What is done	Result
Human protein from bacteria	Human genes are inserted into bacteria	Bacteria make human proteins, such as insulin
Herbicide resistance	Genes are inserted into crop plants	The crop is not killed by a herbicide, so the field can be sprayed to kill weeds without harming the crop
Insect resistance	Genes are inserted into crop plants	Crop is resistant to insect pests, so less insecticide is needed and yield is higher
Improved nutritional quality	Genes are inserted into crop plants	Crop contains more of a nutrient; for example, rice modified to contain a vitamin A precursor (golden rice)

Exam tip: Use the word 'gene' in the definition: genetic modification changes an organism by removing, changing or inserting individual genes, not 'changing the whole organism'.

How bacteria are modified to make a human protein Spec 21.3.3 Supplement

Human insulin can be made by bacteria. The same process can be used for other human proteins.

1. **Isolate the gene.** The DNA making up the human gene is cut out of human DNA using **restriction enzymes**. These cut the DNA leaving **sticky ends** (short single-stranded overhangs).
2. **Cut the plasmid.** A bacterial **plasmid** is cut open using the same restriction enzymes, which forms complementary sticky ends.
3. **Insert the gene.** The human gene is joined into the plasmid using the enzyme **DNA ligase**, which joins the sticky ends. This forms a **recombinant plasmid**.
4. **Put into bacteria.** The recombinant plasmids are inserted into bacteria (specific details of how are not required).
5. **Multiply.** The bacteria containing the recombinant plasmids are grown and multiply, so there are many copies of the gene.
6. **Expression.** The human gene is expressed in the bacteria, which make the human protein.



A human gene is cut out, inserted into a plasmid and put into bacteria, which make the protein.

Common mistake: Restriction enzymes cut DNA, and ligase joins DNA. Do not swap them. The same restriction enzyme is used on the gene and the plasmid so the sticky ends match.

GM crops: advantages and disadvantages Spec 21.3.4 Supplement

Crops such as **soya**, **maize** and **rice** have been genetically modified. Examples are herbicide-resistant soya, insect-resistant maize (which makes a toxin that kills insect pests that eat it), and golden rice, which makes a substance the body converts to vitamin A.

Advantages and disadvantages of genetically modifying crops

Advantages	Disadvantages
Higher yield, as less is lost to weeds and insect pests	Gene may spread to wild plants (for example weeds could become herbicide resistant)
Less insecticide needed, which saves money and reduces harm to other insects	May harm other organisms, such as non-pest insects, and reduce biodiversity
Improved nutrition, such as golden rice, which could help to reduce vitamin A deficiency	Seeds can be expensive, and farmers may need to buy new seed each year
Crops can be grown in conditions that would otherwise be unsuitable, helping to feed a growing population	Some people are concerned about eating GM food, as long-term effects on health are not fully known
Less time and money spent on spraying insecticide	Insect pests may become resistant to the toxin made by the crop

Exam tip: For 'discuss', give at least one advantage and one disadvantage, and name a crop with its modification, for example insect-resistant maize.

Quick check

1. Define genetic modification.
2. Give an example of a human protein made by genetically modified bacteria.
3. **Supplement** Which enzyme cuts DNA to leave sticky ends?
4. **Supplement** Which enzyme joins the gene into the plasmid?
5. **Supplement** Name one disadvantage of GM crops.

Quick check answers

Genetic modification

1. Changing the genetic material of an organism by removing, changing or inserting individual genes.
2. Insulin.
3. A restriction enzyme.
4. DNA ligase.
5. The gene may spread to wild plants; or it may harm other organisms.