

This is the **Higher Separate** version — includes all Higher Tier content (marked ★) and all Separate Science content.

Genetic engineering involves inserting a gene from one organism into another, allowing the recipient organism to produce a protein it could not make before.

- ★ **HT Step 1:** Identify the desired gene (e.g. human insulin gene).
- ★ **HT Step 2:** Cut out the gene using **RESTRICTION ENZYMES** — molecular scissors that cut DNA at specific sequences, leaving "sticky ends".
- ★ **HT Step 3:** Cut open a bacterial plasmid (vector) with the **SAME** restriction enzyme → matching sticky ends.
- ★ **HT Step 4:** Insert gene into plasmid. **DNA LIGASE** joins the sticky ends — creates recombinant DNA.
- ★ **HT Step 5:** Introduce the recombinant plasmid into a host cell (e.g. bacterium). The bacterium replicates and produces the desired protein.
- ★ **HT Example 1:** Human insulin gene → bacteria → produce insulin for diabetics (replaces insulin extracted from pigs/cows).
- ★ **HT Example 2:** GM crops — herbicide-resistant crops (can be sprayed without killing crop); Bt crops (produce insecticide protein); golden rice (vitamin A gene added).
- ★ **HT Concerns:** unknown ecological effects of GM organisms, ethical issues, allergen risk, corporate control of food supply.

Key Terms

Restriction enzyme	Enzyme that cuts DNA at specific sequences — used to cut out genes
Ligase	Enzyme that joins DNA strands together — seals genes into plasmids
Recombinant DNA	DNA containing genes from two different organisms — created by genetic engineering
Plasmid	Small circular DNA ring in bacteria — used as a vector to carry foreign genes into host cells
GM organism	Genetically modified organism — contains a gene from a different species
Vector	In genetic engineering: the plasmid used to carry a foreign gene into a host cell

■ **Exam Tip:** Always name BOTH enzymes: restriction enzymes CUT the DNA; ligase JOINS it. This is often tested as a 2-mark question. Also: sticky ends produced by restriction enzymes are complementary → this is how gene and plasmid join precisely.