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

Genetic engineering inserts genes from one organism into another, allowing production of proteins not normally made.

- ★ **HT** 1. Identify desired gene (e.g. human insulin)
- ★ **HT** 2. Cut out gene using restriction enzymes (leave sticky ends)
- ★ **HT** 3. Cut plasmid with same restriction enzyme → complementary sticky ends
- ★ **HT** 4. Insert gene into plasmid; ligase seals the joins
- ★ **HT** 5. Introduce plasmid into host bacterium; bacterium reproduces and produces insulin
- ★ **HT** Examples: insulin-producing bacteria, herbicide-resistant GM crops, Bt crops, golden rice
- ★ **HT** Concerns: unknown ecological effects, ethical issues, allergen risk

Key Terms

Restriction enzyme	Cuts DNA at specific sequences — used to remove genes
Ligase	Joins DNA strands — seals gene into plasmid
Recombinant DNA	DNA containing genes from two different organisms

■ **Exam Tip:** Two enzymes to know: restriction enzyme CUTS; ligase JOINS. Always name both in genetic engineering questions.