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

Humans have altered the genetics of organisms through selective breeding for thousands of years, and through genetic engineering more recently.

- Selective breeding: choose individuals with desired traits → breed → select → repeat. Reduces genetic diversity
- ★ **HT** Genetic engineering: restriction enzymes cut gene from donor → inserted into plasmid → plasmid into host cell
- ★ **HT** Ligase: joins the gene into the plasmid
- ★ **HT** Examples: insulin-producing bacteria, herbicide-resistant crops, golden rice
- ★ **HT** Cloning: tissue culture (plants), embryo splitting, adult cell cloning (Dolly)
- Concerns: unknown ecological effects, ethical issues, reduced genetic diversity

Key Terms

Restriction enzyme	Cuts DNA at specific sequences — removes desired gene
Ligase	Enzyme joining DNA strands — seals gene into plasmid
GM organism	Organism with a gene from a different species

■ **Exam Tip:** Restriction enzyme = CUT. Ligase = JOIN. Both needed in genetic engineering. Know this for 2-mark questions.