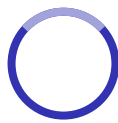


Biotechnology & Genetic Modification

IGCSE Biology ■ Topic 21

IGCSE Biology



Biotechnology & Genetic Modification

What we will cover

- 1 Why bacteria are useful
- 2 Yeast: biofuels & bread
- 3 Enzymes in industry
- 4 Fermenters
- 5 Genetic modification
- 6 GM examples



stirred, warm, sterile
fermenters

1 Biotechnology

Biotechnology & Genetic Modification

Biotechnology

Why bacteria are useful

reproduce
very fast

make complex
molecules

contain
plasmids 质粒

Biotechnology 生物技术 uses living things (or their **enzymes** 酶) to make useful products.

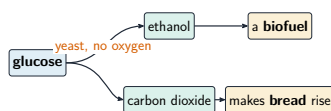


Biotechnology uses living systems for products

Biotechnology & Genetic Modification

Biotechnology

Yeast: biofuels and bread



- the ethanol can be used as a **biofuel** 生物燃料.
- in bread-making, the carbon dioxide makes the dough rise.

Biotechnology & Genetic Modification

Biotechnology

Enzymes in industry

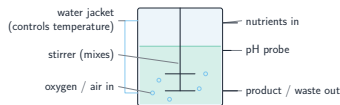
- **pectinase** 果胶酶 – more, clearer fruit juice
- **proteases & lipases** – wash out stains
- **lactase** 乳糖酶 – lactose-free milk

pectinase → more fruit juice

protease + lipase → wash out stains

lactase → lactose-free milk

Fermenters

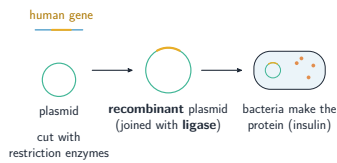


A **fermenter** 发酵罐 grows microbes to make **insulin** 胰岛素, **penicillin** 青霉素 & **mycoprotein** 真菌蛋白.

Control the temperature, pH, oxygen, nutrients & waste removal.

2 Genetic modification

Genetic modification



Genetic modification 基因改造 moves genes between organisms:

- 1 **restriction enzymes** 限制酶 cut (sticky ends)
- 2 **ligase** 连接酶 joins the gene into a plasmid
- 3 bacteria **express** 表达 it → the protein

GM examples

human **insulin** 胰岛素 from bacteria

herbicide 除草剂-resistant crops

insect-pest-resistant crops

crops with better nutrition

GM crops can give higher **yields** 产量, but raise worries about health, wild species & cost.

3 Recap

Worked example – making human insulin

Outline how bacteria are made to produce human insulin.

- Cut out the **human insulin gene** with a **restriction enzyme** 限制酶, leaving sticky ends.
- Cut a bacterial **plasmid** with the **same** enzyme, so the ends match.
- Join gene into plasmid with **DNA ligase** ⇒ recombinant plasmid.
- Put it into a bacterium and grow them in a **fermenter**: they read the gene and **make real human insulin**.

Use the **same restriction enzyme** on both, or the sticky ends will not match. The insulin is **identical** to human insulin, so fewer allergic reactions.

Topic 21 – key takeaways

1 Bacteria

fast, complex molecules, plasmids

2 Yeast

ethanol (biofuel) & CO₂ (bread)

3 Fermenter

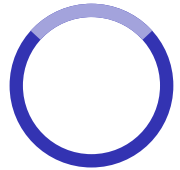
insulin, penicillin; controlled conditions

4 GM

cut with restriction enzymes, join with ligase

Check yourself

- 1 Why are bacteria useful in biotechnology?
- 2 What two products does yeast make?
- 3 What enzyme cuts out a gene?
- 4 Name one use of genetic modification.



Answers 1. fast, make complex molecules, have plasmids 2. ethanol & carbon dioxide
3. a restriction enzyme 4. e.g. making insulin