A-LEVEL BIOLOGY • EXERCISE SHEET

19.1 Principles of genetic technology

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

Objective

Build the skills to answer exam questions on the **principles of genetic technology** — **recombinant DNA** 重组 DNA, the tools of **genetic engineering** 基因工程, **PCR** 聚合酶链式反应 and **gel electrophoresis** 凝胶电泳.

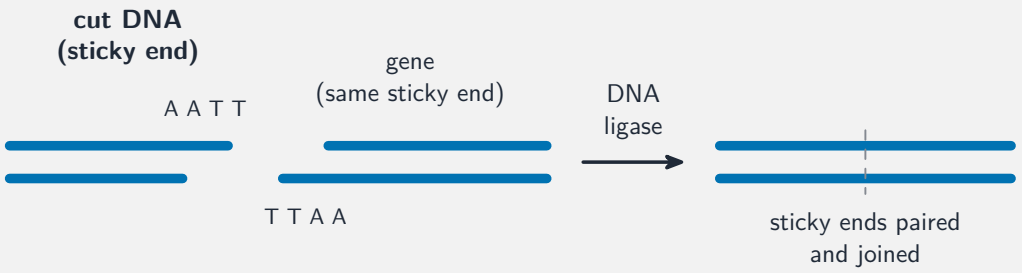
You must be able to:

- define recombinant DNA and explain the roles of the key enzymes and a plasmid vector
- explain why a promoter and a marker gene are transferred with a gene
- describe PCR and gel electrophoresis

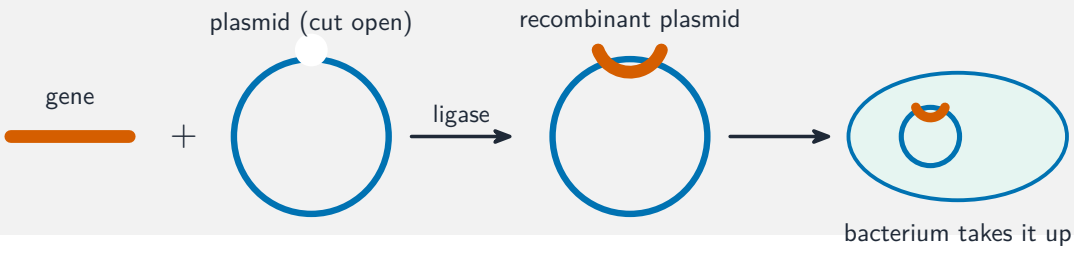
1 Worked examples

The tools

Recombinant DNA is DNA joined from two different sources. The gene can be cut from a **donor** 供体, made from its mRNA by **reverse transcriptase** 逆转录酶, or built from **nucleotides** 核苷酸.



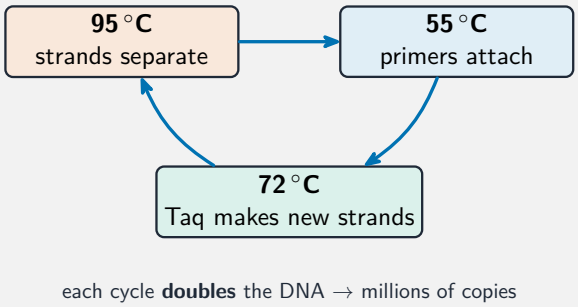
A restriction endonuclease leaves matching sticky ends; DNA ligase joins the gene to the cut DNA



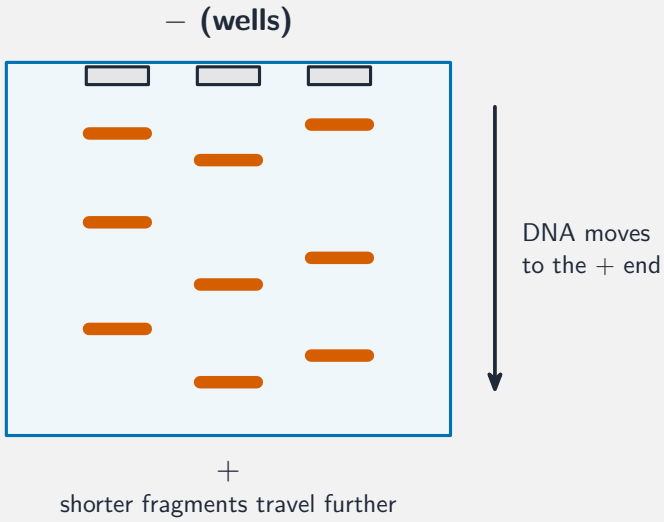
A plasmid is a cloning vector: the gene is joined into it, and the recombinant plasmid enters a bacterium

- **restriction endonuclease** 限制性内切酶—cuts DNA at a specific sequence (sticky ends); **DNA ligase** —joins DNA; **plasmid** 质粒—a vector to carry the gene; **DNA polymerase** —copies DNA.
- a **promoter** 启动子 (the gene's "switch") must be transferred so the gene is transcribed; a **marker gene** 标记基因 (e.g. fluorescent) confirms the transfer worked.

Copying and sorting DNA



PCR doubles the DNA each cycle, making millions of copies



Gel electrophoresis sorts DNA fragments by length —shorter fragments move further

2 Practice

2.1 Name the enzyme that (a) cuts DNA at a specific sequence and (b) joins DNA fragments. [2]

2.2 State why a marker gene is transferred along with the desired gene. [1]

3 Exam-style questions

3.1 What is the role of a plasmid in genetic engineering? [1]

- **A** to cut the DNA
- **B** to act as a vector that carries the gene into a cell
- **C** to copy the DNA millions of times
- **D** to separate DNA fragments by length

3.2 In gel electrophoresis, the DNA fragments that travel **furthest** are the: [1]

- **A** longest
- **B** shortest
- **C** most positively charged
- **D** circular ones

3.3 (a) Explain why a promoter must often be transferred along with a gene. [2]

(b) Describe how the polymerase chain reaction (PCR) makes many copies of a DNA sample. [3]

3.4 Explain why restriction enzymes and DNA ligase are both needed to make recombinant DNA. [2]

4 Go further

You are now ready for the real exam questions on this subtopic. Open the **19.1 Principles of genetic technology** past-paper sheet in the Library, or try these in **Practice mode**:

- 9700/41 N25 —Q8 (genetic technology, calculation)
- 9700/42 N25 —Q5 (gene transfer)
- 9700/44 N25 —Q3 (PCR / electrophoresis, calculation)

Solutions

2.1 (a) restriction endonuclease; (b) DNA ligase.

2.2 to check (confirm) that the gene has been taken up and is expressed.

3.1 B. A plasmid is a vector carrying the gene into the cell.

3.2 B. Shorter fragments move further through the gel.

3.3 (a) the promoter is the switch that starts transcription; without it the transferred gene would not be transcribed / stay silent.
(b) heat to ~95 °C to separate the strands; cool to ~55 °C so primers attach; 72 °C lets Taq polymerase build new strands —repeating the cycle doubles the DNA each time.

3.4 the restriction enzyme cuts the gene and the plasmid, leaving matching sticky ends; DNA ligase joins the gene into the plasmid to make recombinant DNA.