

16.3 Gene control

Name: _____ Class: _____ Date: _____

Total: 23 marks

KEY WORDS lac operon 乳糖操纵子 • regulatory gene 调节基因 • structural gene 结构基因
• transcription 转录 • transcription factor 转录因子

Objective

Build the skills to answer exam questions on **gene control** — **structural and regulatory genes** 结构/调节基因, **inducible and repressible enzymes** 可诱导/可抑制酶, the **lac operon** 乳糖操纵子, and **transcription factors** 转录因子.

You must be able to:

- distinguish structural and regulatory genes, and inducible and repressible enzymes
- explain the control of protein production by the lac operon
- state the role of transcription factors and explain gibberellin's action via DELLA proteins

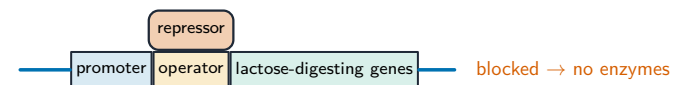
1 Worked examples

■ Genes and enzymes

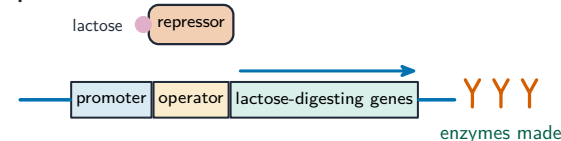
A **structural gene** codes for a useful protein (e.g. an enzyme); a **regulatory gene** controls whether other genes are switched on. An **inducible enzyme** is made only when needed; a **repressible enzyme** is normally made but can be switched off.

■ The lac operon

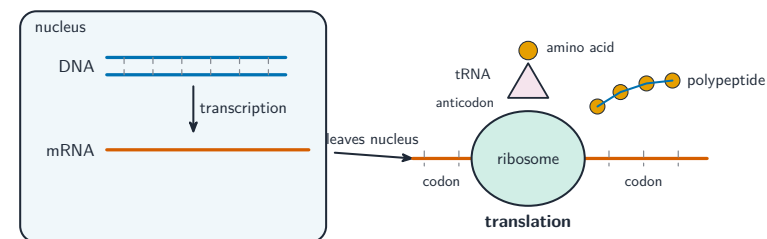
no lactose



lactose present



A repressor blocks the genes until lactose pulls it off — so the enzymes are inducible



Gene control acts on transcription and translation

- **no lactose:** a **repressor** 阻遏物 protein binds the operator and blocks **transcription** 转录 — no enzymes made.
- **lactose present:** lactose binds the repressor and pulls it off; transcription occurs and the lactose-digesting enzymes are made (they are **inducible**).

■ Transcription factors and gibberellin

In eukaryotes, **transcription factors** are proteins that bind DNA and raise or lower the rate of transcription. **Gibberellin** 赤霉素 switches genes on by causing the breakdown of **DELLA** protein repressors, which normally block the factors that promote transcription.

2 Practice

2.1 State the difference between a structural gene and a regulatory gene. [2]

2.2 State what is meant by an inducible enzyme. [1]

3 Exam-style questions

3.1 In the lac operon, when **no** lactose is present, the repressor protein: [1]

- | | |
|---|---|
| A | B |
| C | D |
- A is broken down
 - B binds the operator and blocks transcription
 - C is transcribed into mRNA
 - D binds the lactose-digesting enzymes

3.2 What is the role of a transcription factor in a eukaryotic cell? [1]

- | | |
|---|---|
| A | B |
| C | D |
- A to replicate DNA
 - B to bind DNA and control the rate of transcription
 - C to translate mRNA
 - D to break down glucose

3.3 Explain how the lac operon allows a bacterium to make lactose-digesting enzymes only when lactose is present. [4]

3.4 Explain how gibberellin switches on genes by acting on DELLA proteins. [2]

3.5 In *Escherichia coli* the *lac* operon controls the enzymes that break down lactose.

(a) Distinguish between a structural gene and a regulatory gene, using the *lac* operon as your example. [3]

(b) Describe what happens at the operon when **no** lactose is present. [3]

(c) Describe what happens when lactose **is** present, and explain why the enzymes are described as inducible. [4]

(d) Explain the advantage to the bacterium of controlling these genes in this way. [2]
