

14.1 Homeostasis in mammals

Name: _____ Class: _____ Date: _____

Total: 14 marks

KEY WORDS glucose 葡萄糖 • kidney 肾脏 • glucagon 胰高血糖素 • hormone 激素
• cell signalling 细胞信号传递

Objective

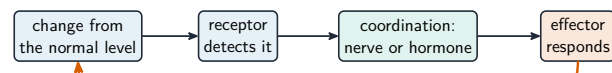
Build the skills to answer exam questions on **homeostasis in mammals** — **negative feedback** 负反馈, the **kidney** 肾脏 and urine formation, **osmoregulation** 渗透调节, and **cell signalling** 细胞信号传递 in blood-glucose control.

You must be able to:

- explain homeostasis and the principle of negative feedback
- describe ultrafiltration and selective reabsorption in the nephron
- explain osmoregulation by ADH and the glucagon signalling cascade

1 Worked examples

■ Homeostasis and negative feedback

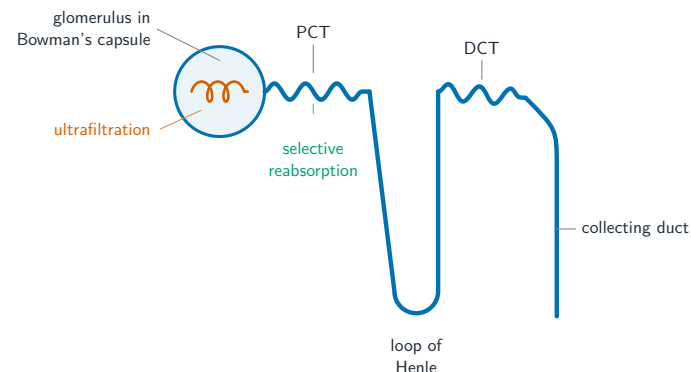


the response pushes the level back to normal (negative feedback)

Negative feedback: a receptor detects a change; an effector corrects it, returning to normal

Homeostasis keeps internal conditions steady. A **stimulus** 刺激 is detected by a **receptor** 受体; a coordination system (nervous or endocrine) signals an **effector** 效应器 that corrects the change.

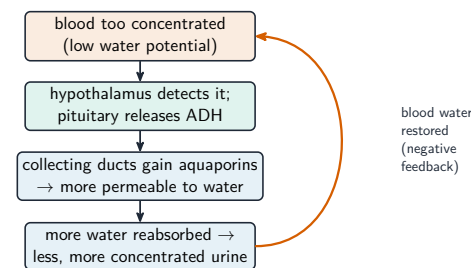
■ The nephron: making urine



Ultrafiltration in the Bowman's capsule; selective reabsorption in the proximal convoluted tubule

- **ultrafiltration** 超滤 (Bowman's capsule): high glomerular pressure forces water and small molecules (glucose, ions, urea) out; cells and proteins stay in the blood.
- **selective reabsorption** 选择性重吸收 (proximal convoluted tubule): glucose and much water/ions are taken back; the cells have **microvilli** and many **mitochondria** for active transport.

■ Osmoregulation by ADH

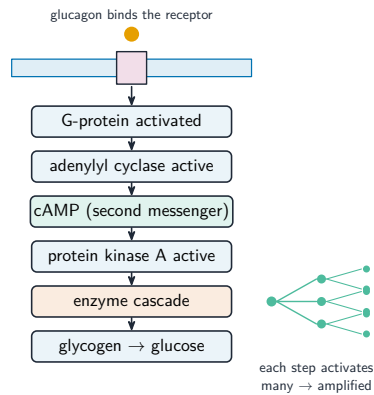


blood water
restored
(negative
feedback)

When blood is too concentrated, ADH makes the collecting ducts reabsorb more water

The **hypothalamus** 下丘脑 detects low water potential; the **pituitary** 垂体 releases **ADH** 抗利尿激素; the collecting ducts gain **aquaporins** 水通道蛋白, so more water is reabsorbed → less, more concentrated urine.

■ Cell signalling: glucagon



A second messenger (cAMP) and an enzyme cascade amplify the signal — each step activates many

2 Practice

2.1 Name the coordination system that uses (a) nerve signals and (b) hormones. [2]

2.2 State **two** substances reabsorbed in the proximal convoluted tubule. [1]

3 Exam-style questions

3.1 Which substance does **not** normally pass into the glomerular filtrate during ultrafiltration? [1]

- A glucose
- B urea
- C plasma protein
- D water

3.2 When the blood is too concentrated, ADH causes: [1]

- A less water to be reabsorbed
- B the collecting ducts to become more permeable to water
- C more dilute urine to be produced
- D glycogen to break down

3.3 (a) Explain how the proximal convoluted tubule is adapted for selective reabsorption. [3]

(b) Explain how ADH restores the water potential of the blood when it is too low. [3]

3.4 Glucagon controls blood glucose by an enzyme cascade.

(a) Name the second messenger formed inside the liver cell. [1]

(b) Explain why the use of an enzyme cascade amplifies the signal. [2]

Solutions

2.1 (a) the nervous system; (b) the endocrine system.

2.2 any two of: glucose; water; (named) ions.

3.1 C. Plasma proteins are too large to be filtered; the others pass into the filtrate.

3.2 B. ADH makes the collecting ducts more permeable to water (more aquaporins).

3.3 (a) microvilli give a large surface area for reabsorption; many mitochondria release ATP for active transport; carrier proteins reabsorb glucose/ions.

(b) the hypothalamus detects the low water potential and the pituitary releases ADH; the collecting ducts gain aquaporins and become more permeable; more water is reabsorbed into the blood, raising its water potential.

3.4 (a) cyclic AMP (cAMP).

(b) each enzyme activates many molecules of the next enzyme, so a few hormone molecules trigger a large response.