

Exercise walk-through

Homeostasis in mammals ■ 14.1

eXercise

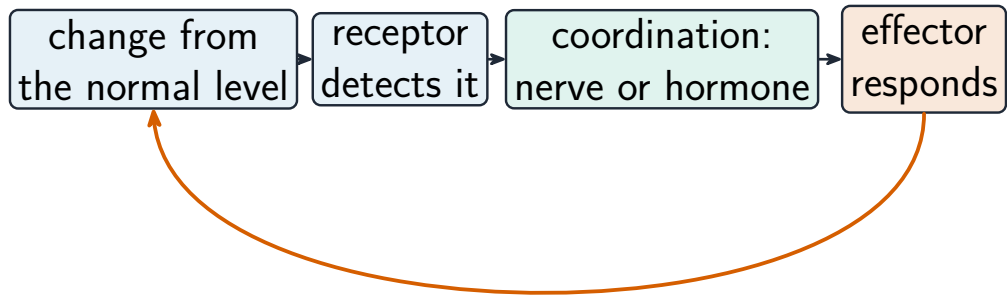
You must be able to

- 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

Method — Homeostasis and negative feedback

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.

Method — Homeostasis and negative feedback

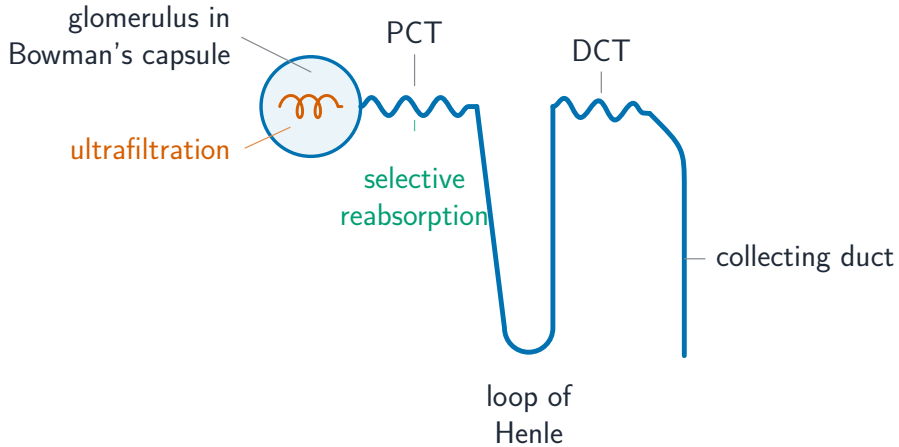


the response pushes the level back to normal (negative feedback)

Method — The nephron: making urine

- **ultrafiltration** 超濾 (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.

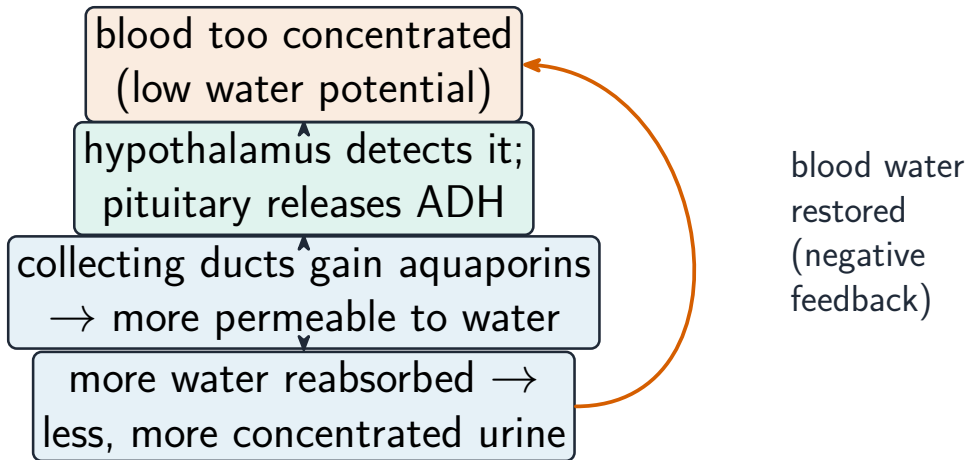
Method — The nephron: making urine



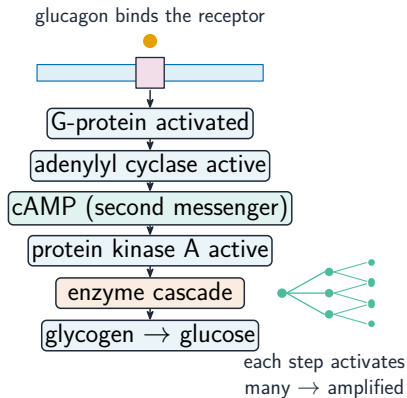
Method — Osmoregulation by ADH

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.

Method — Osmoregulation by ADH



Method — Cell signalling: glucagon



Practice 2.1 ■ 2 marks

Name the coordination system that uses (a) nerve signals and (b) hormones.

Solution 2.1

Method: Homeostasis and negative feedback

Worked steps

(a) the nervous system **B1**; (b) the endocrine system **B1**.

Practice 2.2 ■ 1 mark

State **two** substances reabsorbed in the proximal convoluted tubule.

Solution 2.2

Method: The nephron: making urine

Worked steps

any two of: glucose; water; (named) ions **B1** *for two*.

Exam-style 3.1 ■ 1 mark

Which substance does **not** normally pass into the glomerular filtrate during ultrafiltration?

A glucose

B urea

C plasma protein

D water

Solution 3.1

Method: The nephron: making urine

A glucose

B urea

C plasma protein



D water

Worked steps

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

Exam-style 3.2 ■ 1 mark

When the blood is too concentrated, ADH causes:

- 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

Solution 3.2

Method: Osmoregulation by ADH

- 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

Worked steps

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

Exam-style 3.3 ■ 3 marks

- (a) Explain how the proximal convoluted tubule is adapted for selective reabsorption.
- (b) Explain how ADH restores the water potential of the blood when it is too low.

Solution 3.3

Method: The nephron: making urine

Worked steps

- (a) microvilli give a large surface area for reabsorption **B1**; many mitochondria release ATP for active transport **B1**; carrier proteins reabsorb glucose/ions **B1**.
- (b) the hypothalamus detects the low water potential and the pituitary releases ADH **B1**; the collecting ducts gain aquaporins and become more permeable **B1**; more water is reabsorbed into the blood, raising its water potential **B1**.

Exam-style 3.4 ■ 1 mark

Glucagon controls blood glucose by an enzyme cascade.

- (a) Name the second messenger formed inside the liver cell.
- (b) Explain why the use of an enzyme cascade amplifies the signal.

Solution 3.4

Method: Cell signalling: glucagon

Worked steps

(a) cyclic AMP (cAMP) **B1**.

(b) each enzyme activates many molecules of the next enzyme **M1**, so a few hormone molecules trigger a large response **A1**.