

14.4 Homeostasis

Name: _____ Class: _____ Date: _____ Total: 29 marks

KEY WORDS blood glucose 血糖 • set point 设定点 • environment 环境 • diabetes 糖尿病
• blood vessels 血管

Objective

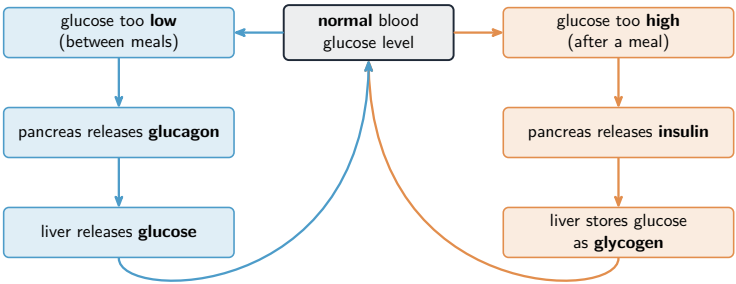
Build the skills to answer exam questions on **homeostasis** 稳态 — **negative feedback** 负反馈, controlling **blood glucose** 血糖, **diabetes** 糖尿病, and temperature control.

You must be able to:

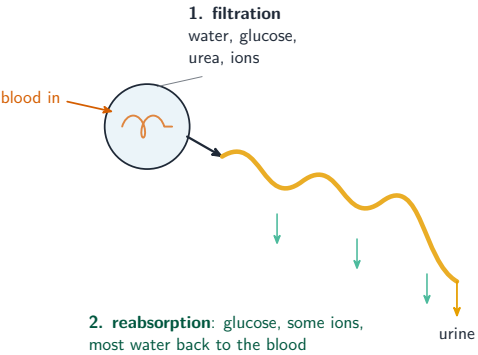
- define homeostasis and explain negative feedback
- describe how insulin and glucagon control blood glucose
- describe how the skin controls body temperature

1 Worked examples

■ Blood glucose control



Negative feedback keeps blood glucose near a set point



The kidney is a key homeostatic organ

- **insulin**: after a meal, liver stores glucose as glycogen (lowers glucose).
- **glucagon**: between meals, liver releases glucose (raises glucose).
- **too hot**: sweating + vasodilation; **too cold**: shivering + vasoconstriction.

■ One loop, three examples

Homeostasis 稳态 is the maintenance of a constant internal environment. Every example follows the same **negative feedback** 负反馈 loop, and writing it in this order earns the marks:

a change from the set point → receptor detects it → coordinator → effector acts → the change is RE

The word that makes it *negative* feedback is **reversed**: the response acts in the opposite direction to the change.

Temperature.

Too HOT	Too COLD
more sweat; its water evaporates , taking heat from the skin	little sweat
vasodilation 血管舒张 — surface arterioles widen, more blood flows near the surface, more heat lost by radiation hairs lie flat	vasoconstriction 血管收缩 — arterioles narrow, less blood near the surface, less heat lost hairs stand up, trapping insulating air; shivering , whose respiration releases heat

△ The arterioles **widen or narrow**; blood vessels do not move up and down in the skin, and saying they “rise to the surface” is specifically penalised.

Blood glucose. Too high → the **pancreas** releases **insulin** → the liver converts glucose to **glycogen** and cells take up more glucose → the level falls. Too low → the pancreas releases **glucagon** → the liver converts glycogen back to glucose → the level rises. **Type 1 diabetes** is a failure to produce enough insulin, treated by injection with diet and exercise control.

Water. Too little water in the blood → the pituitary releases more **ADH** → the kidney tubules become more permeable → more water is reabsorbed → a small volume of concentrated urine. Too much water → less ADH → less reabsorption → a large volume of dilute urine.

Worked example. Explain what happens in the body during 20 minutes of hard exercise on a hot day.

1. Respiration in the muscles releases heat, so core temperature rises above the set point.
2. The hypothalamus detects the rise; sweat glands produce more sweat and the surface arterioles vasodilate.
3. Evaporation and radiation remove heat, so the temperature falls back — negative feedback.
4. Meanwhile water is lost in sweat, so the blood becomes more concentrated; more ADH is released and the kidney reabsorbs more water, producing a small volume of concentrated urine.

2 Practice

2.1 Define homeostasis. [1]

2.2 Name the hormone that lowers blood glucose. [1]

2.3 State what is meant by negative feedback. [2]

2.4 Name the hormone released when blood glucose falls, and state its effect on the liver. [2]

2.5 Explain the effect of ADH on the kidney when a person is dehydrated. [2]

3 Exam-style questions

3.1 When you are too hot, the blood vessels near the skin surface: [1]

- **A** narrow (vasoconstriction)
- **B** widen (vasodilation)
- **C** disappear
- **D** stop carrying blood

3.2 Blood glucose is kept steady by negative feedback.

(a) Describe what happens after a meal raises blood glucose. [3]

(b) State what causes Type 1 diabetes. [1]

3.3 Explain how sweating helps cool the body. [2]

3.4 A student runs for 20 minutes on a hot day.

(a) Describe two changes in the skin that help lower body temperature, explaining how each works. [4]

(b) Explain why the student's urine is a smaller volume and more concentrated afterwards, naming the hormone involved. [4]

(c) After the run the student drinks a sugary sports drink and blood glucose rises. Describe the response that returns it to normal, naming the organ, the hormone and the storage compound. [4]

(d) Explain why all three of these responses are described as negative feedback. [2]

Solutions

2.1 keeping a constant internal environment inside the body.

2.2 insulin.

2.3 A change away from the set point is detected, and the response acts to reverse that change and restore the set point.

2.4 Glucagon; it makes the liver convert stored glycogen back into glucose.

2.5 More ADH makes the kidney tubules more permeable to water, so more water is reabsorbed into the blood and a smaller volume of more concentrated urine is produced.

3.1 B. When too hot, the vessels widen (vasodilation) to lose more heat.

3.2 (a) the pancreas releases insulin; the liver takes up glucose and stores it as glycogen; so blood glucose falls back to normal.

(b) the pancreas cannot make insulin.

3.3 sweat evaporates from the skin; evaporation takes heat from the body, cooling it.

3.4 (a) Any two, each for two marks: more sweat is produced, and its evaporation takes heat energy from the skin; vasodilation widens the surface arterioles so more blood flows near the surface and more heat is lost by radiation; the hairs lie flat so no insulating layer of air is trapped.

(b) Water is lost in sweat, so the blood becomes more concentrated; this is detected and the pituitary releases more ADH; ADH makes the kidney tubules more permeable to water, so more water is reabsorbed and less is lost as urine.

(c) The pancreas detects the rise in blood glucose; it releases insulin; insulin makes the liver convert glucose into glycogen for storage; body cells also take up more glucose, so the blood glucose level falls back to normal.

(d) In each case a change away from the norm is detected, and the response acts in the opposite direction, reversing the change and restoring the norm.