Week 40

A-Level Biology

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

14. Homeostasis

Starter Quiz · 课前小测

A-Level Biology Name: _____ Score: _____

1. Homeostasis is:

   ☐ keeping internal conditions steady despite changes outside

   ☐ making the body match the outside temperature

   ☐ growing new cells

   ☐ breaking down food

2. The nephron is:

   ☐ the tiny tube that is the kidney's functional unit

   ☐ the outer capsule of the kidney

   ☐ a hormone

   ☐ the tube to the bladder

3. The hormone that controls water reabsorption in the kidney is _____.

   _____

4. When blood glucose is high, insulin:

   ☐ makes liver and muscle cells take in glucose and store it as glycogen

   ☐ breaks glycogen into glucose

   ☐ raises blood glucose

   ☐ has no effect

5. Guard cells close the stomata to reduce water loss when the plant is short of water.

   ☐ True ☐ False

6. Removing the amino group from excess amino acids in the liver is called _____.

   _____

7. Ultrafiltration happens at the _____ — the knot of capillaries inside the Bowman's capsule.

   _____

8. Which part of the brain detects the water potential of the blood?

   ☐ the hypothalamus

   ☐ the collecting duct

   ☐ the glomerulus

☐ the ureter

9. When blood glucose is low, glucagon:

   ☐ makes liver cells break glycogen back into glucose, raising the level

   ☐ stores glucose as glycogen

   ☐ lowers blood glucose

   ☐ splits water

10. The hormone that LOWERS blood glucose, by making cells store it as glycogen, is _____.

    _____

A-Level Biology

1. **keeping internal conditions steady despite changes outside**

   Homeostasis keeps internal conditions (temperature, water, glucose) steady so cells work well.

2. **the tiny tube that is the kidney's functional unit**

   Each kidney has about a million nephrons; each makes urine by filtration and reabsorption.

3. **ADH**

   ADH makes the collecting duct more permeable to water.

4. **makes liver and muscle cells take in glucose and store it as glycogen**

   Insulin lowers blood glucose by promoting uptake and storage as glycogen.

5. **True**

   Closing the stomata is how a plant conserves water — part of homeostasis in plants.

6. **deamination**

   It produces ammonia, which the liver converts to urea for the kidneys to excrete.

7. **glomerulus**

   High blood pressure in the glomerulus forces small molecules out into the capsule.

8. **the hypothalamus**

   The hypothalamus monitors blood water potential and triggers ADH release from the pituitary.

9. **makes liver cells break glycogen back into glucose, raising the level**

   Glucagon raises blood glucose by breaking down glycogen into glucose in the liver.

10. **insulin**

    Insulin lowers blood glucose; its opposite, glucagon, raises it.

A-LEVEL BIOLOGY • EXERCISE SHEET

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

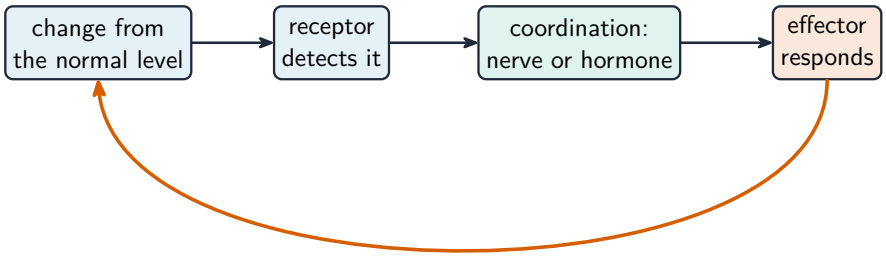
Build the skills to answer exam questions on **homeostasis in mammals** — **negative feedback** 负反馈, the **kidney** 肾脏 and urine formation, **osmoregulation** 渗透调节, and **cell signalling** 细胞信号传递 in blood-glucose control.

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

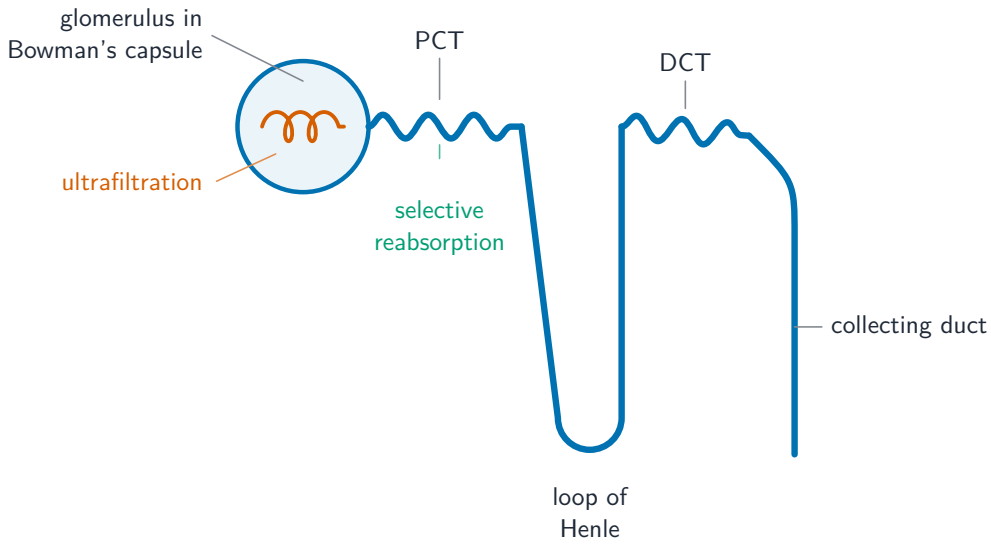


the response pushes the level back to normal (negative feedback)

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.

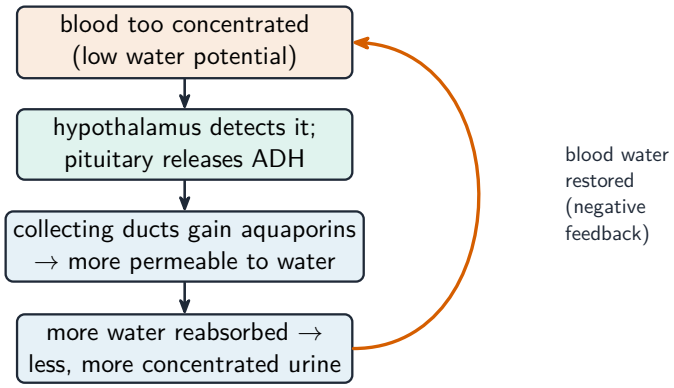
The nephron: making urine



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.

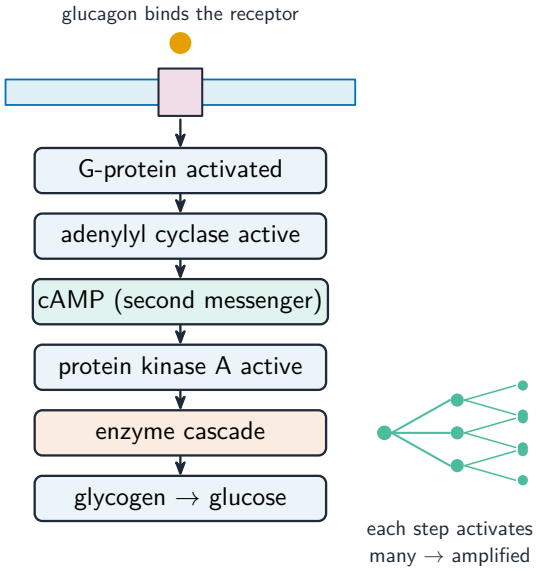
Osmoregulation by ADH



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.

5 The endocrine system and the nervous system both coordinate responses in mammals.

(a) Complete Table 5.1 to show the features of three cell-signalling molecules of the endocrine system: antidiuretic hormone (ADH), glucagon and insulin.

Use a tick (✓) if the molecule has the feature and a cross (✗) if the molecule does **not** have the feature.

Put a tick (✓) or a cross (✗) in every box.

Table 5.1

feature	ADH	glucagon	insulin
binds to receptors on cell surface membranes			
results in molecules moving from cells into the blood			
is secreted as a result of detection by osmoreceptors			

[3]

(b) The endocrine system has a slower transmission speed than the nervous system.

Describe **other** ways in which the endocrine system and the nervous system differ.

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(c) The endocrine system and the nervous system can affect muscle function.

Fig. 5.1 shows a transmission electron micrograph of a longitudinal section of striated muscle tissue that is in a relaxed state.

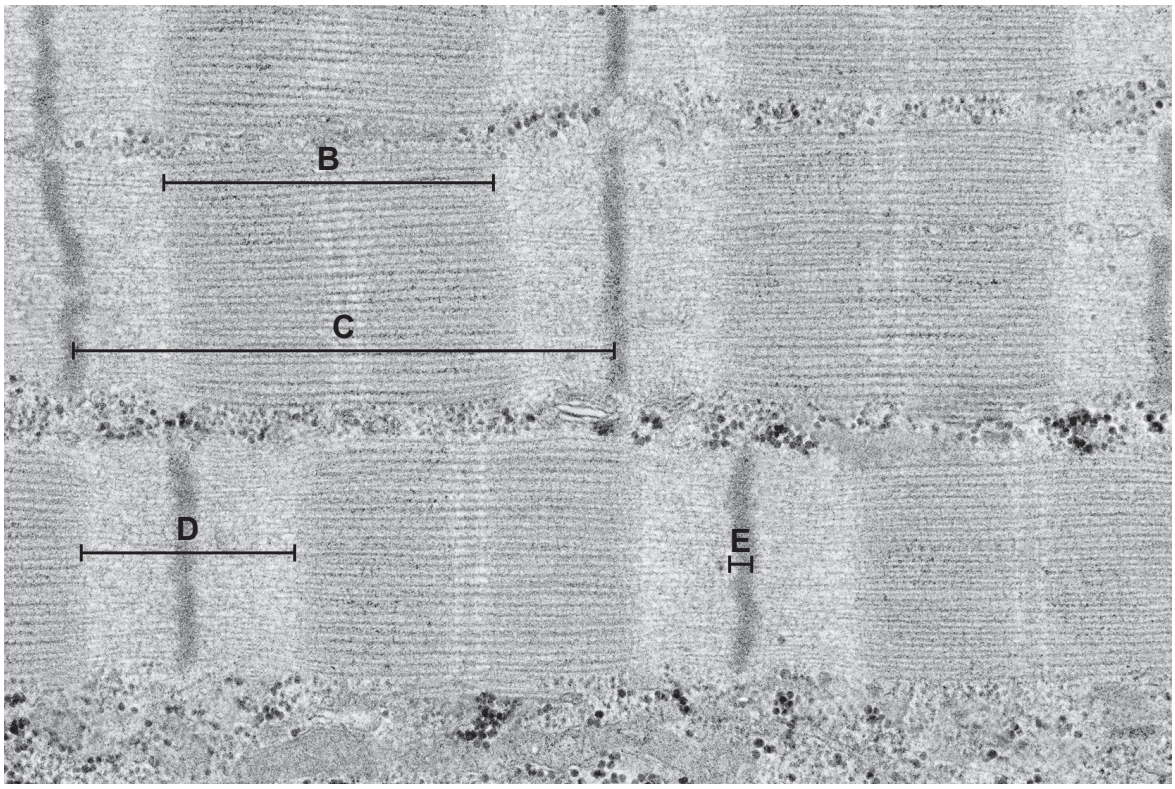

Fig. 5.1

(i) State the letter on Fig. 5.1 that indicates the length of a sarcomere.

..... [1]

(ii) State the letter on Fig. 5.1 that indicates a region where actin and myosin overlap.

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(iii) Describe **and** explain how the region labelled **D** on Fig. 5.1 changes during muscle contraction.

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[Total: 12]

9 **(a)** Fig. 9.1 shows a longitudinal section of a human kidney.

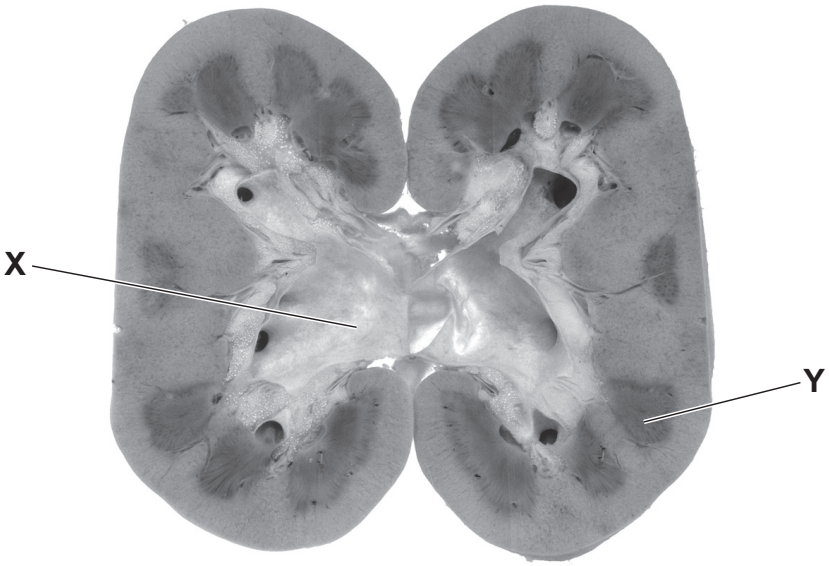

Fig. 9.1

Name the regions of the kidney labelled **X** and **Y** in Fig. 9.1.

X .....

Y .....

[2]

(b) A biosensor can be used to measure the concentration of glucose in urine.

Outline how a biosensor measures the concentration of glucose in urine.

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[Total: 6]

6 **(a)** Phosphoinositide 3-kinase (PI3K) and protein kinase B (PKB) are enzymes involved in the regulation of blood glucose concentration.

Fig. 6.1 shows a cell-signalling pathway involving insulin, PI3K and PKB in a muscle cell.

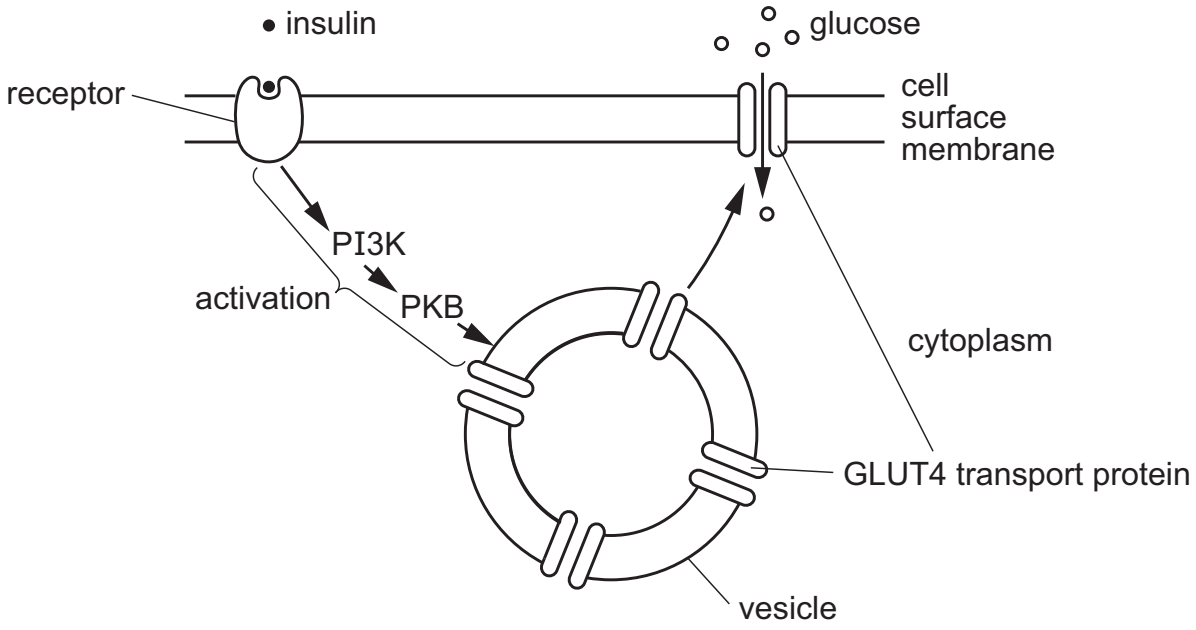

Fig. 6.1

Type 2 diabetes mellitus is a common disease. Some people with type 2 diabetes have a low concentration of PI3K in their muscle cells and cannot maintain their blood glucose concentration within normal limits.

With reference to Fig. 6.1, suggest why a low concentration of PI3K can lead to type 2 diabetes.

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(b) Describe how a biosensor can be used to measure blood glucose concentration.

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[Total: 11]

6 Some people can develop a condition called type 2 diabetes. In people with type 2 diabetes, glucose uptake from the blood is decreased. In some cases, the pancreas cannot make enough insulin to keep blood glucose concentration within a healthy range.

(a) A person with type 2 diabetes and a person without type 2 diabetes were given a glucose drink. The blood glucose concentration of each person was measured at regular intervals for 120 minutes.

The results are shown in Fig. 6.1.

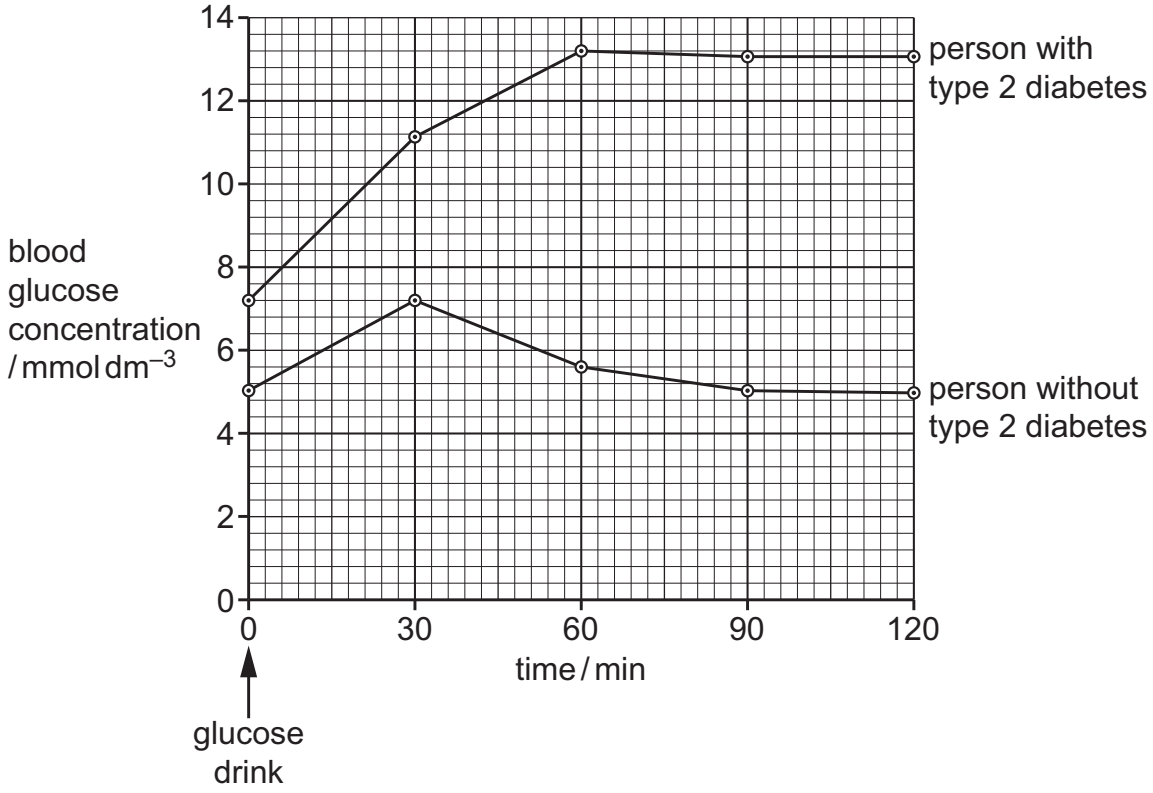

Fig. 6.1

(i) Describe the curve for the person **without** type 2 diabetes.

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..... [2]

(ii) Calculate the percentage increase in blood glucose concentration, between 0 and 60 minutes, for the person **with** type 2 diabetes.

ɪswer ..... [2]

(iii) Suggest ways in which people with type 2 diabetes can help to control their condition.

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..... [2]

(b) Glucagon has a role in the control of blood glucose concentration.

Describe the cell signalling pathway involving glucagon, and describe how this pathway leads to a change in the blood glucose concentration.

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[Total: 13]

6 **(a)** In the kidney, various molecules move between the blood and the kidney nephron.

Table 6.1 describes the movements of molecules at three regions of the nephron, **P**, **Q** and **R**.

Table 6.1

region of nephron	molecule(s)	direction of movement
P	amino acids, glucose and water	from nephron to blood
Q	water	from nephron to blood in the presence of antidiuretic hormone (ADH)
R	water and molecules with a molecular mass of less than 68,000	from blood to nephron

(i) Name the processes, **other than** diffusion, osmosis and active transport, that are occurring at **P**, **Q** and **R**.

P .....

Q .....

R .....

[3]

(ii) Identify the regions of the nephron represented by **P**, **Q** and **R**.

P .....

Q .....

R .....

[3]

(b) A student cut a fresh kidney lengthways and placed one half in the freezer. After 24 hours, the student examined the kidney section and tested its firmness with a mounted needle.

Sodium chloride concentration affects the freezing point of a solution.

The student drew the diagram in Fig. 6.1 to show an area that had frozen hard and an area that was softer and less frozen.

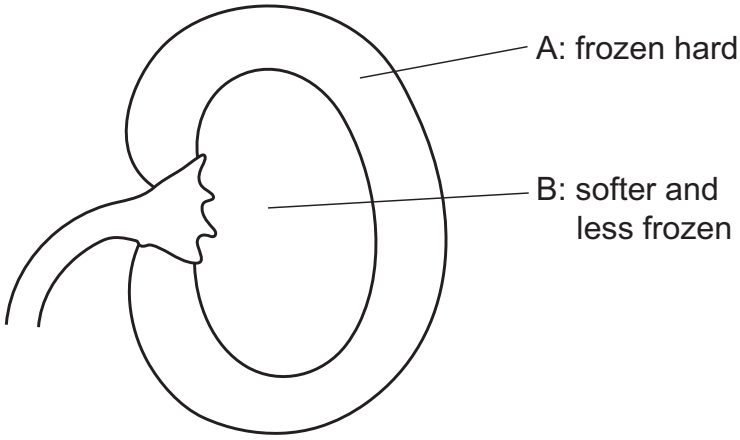

Fig. 6.1

Suggest an explanation for the observations in Fig. 6.1 made by the student.

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..... [2]

[Total: 8]

7 Insulin is an example of a cell-signalling molecule of the endocrine system.

(a) Outline why insulin can be described as an example of a cell-signalling molecule of the endocrine system.

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..... [4]

(b) Researchers compared the effect of two types of meal on the mean blood glucose concentration and the mean blood insulin concentration of twelve volunteers. The measurements were made for three hours after the meal.

Meal A contained 55% carbohydrate, 27% fat and 18% protein.
Meal B contained 3% carbohydrate, 90% fat and 7% protein.

Fig. 7.1 shows the results.

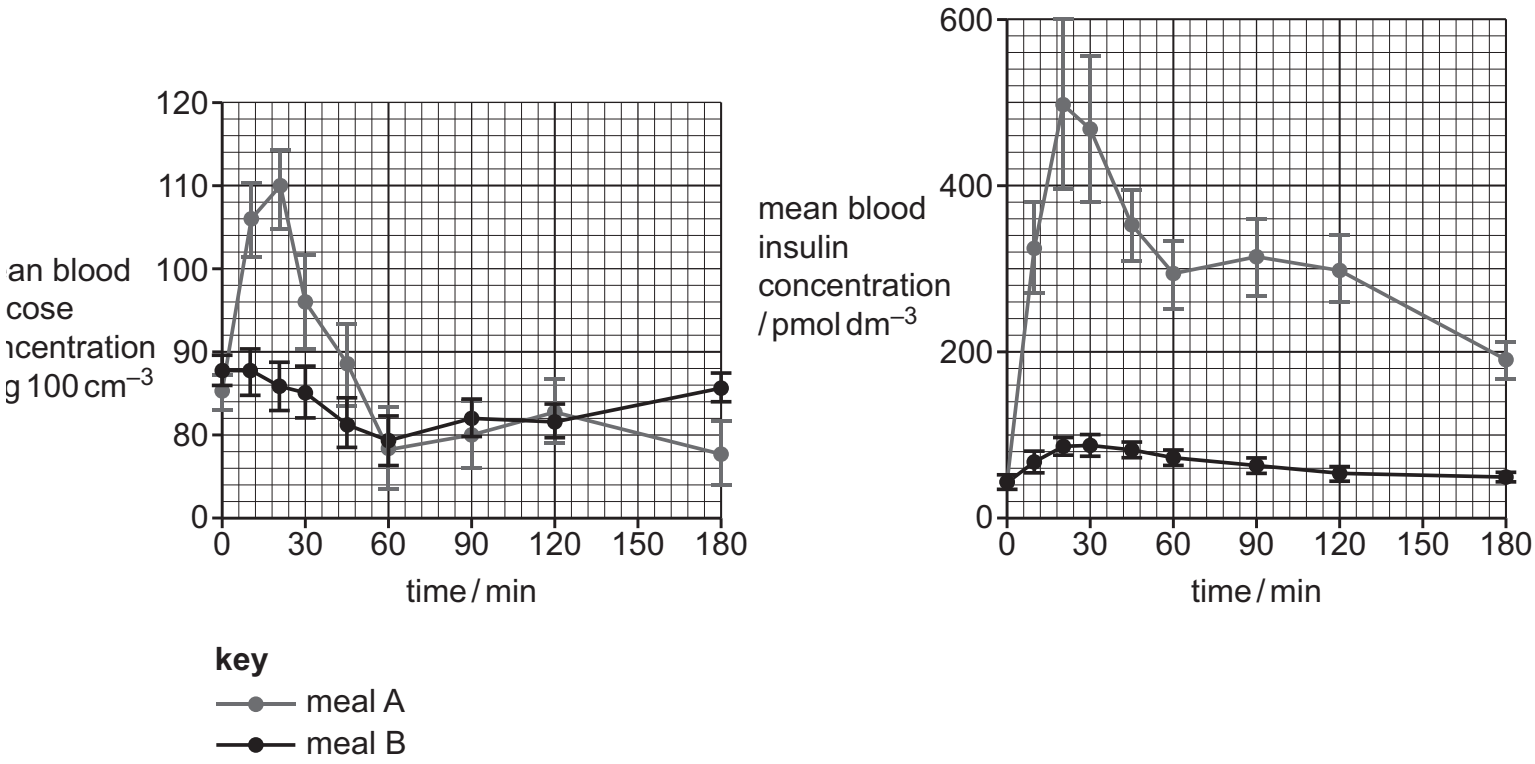

Fig. 7.1

(i) With reference to Fig. 7.1, explain how negative feedback operates to control mean blood glucose concentration in the volunteers who ate meal A.

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..... [4]

(ii) Suggest explanations for the changes in mean blood glucose concentration of the volunteers who ate meal B.

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..... [3]

[Total: 11]

A-LEVEL BIOLOGY • EXERCISE SHEET

14.2 Homeostasis in plants

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

KEY WORDS stomata 气孔 • guard cell 保卫细胞 • abscisic acid 脱落酸 • transpiration 蒸腾作用 • calcium ion 钙离子

Objective

Build the skills to answer exam questions on **homeostasis in plants** — how **stomata** 气孔 open and close, the role of **guard cells** 保卫细胞, and **abscisic acid** 脱落酸 (ABA) in water stress.

You must be able to:

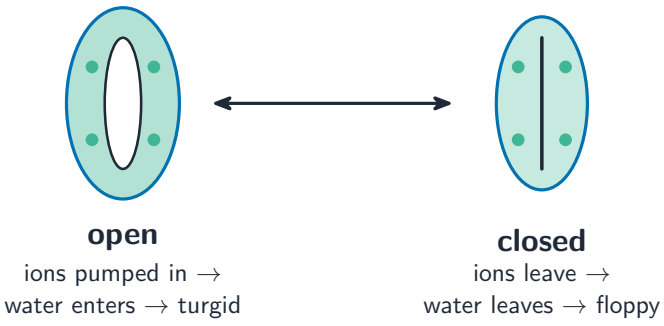
- explain why stomatal aperture balances CO_2 uptake against water loss
- describe how guard cells open and close stomata
- describe the role of ABA and calcium ions in closing stomata during water stress

1 Worked examples

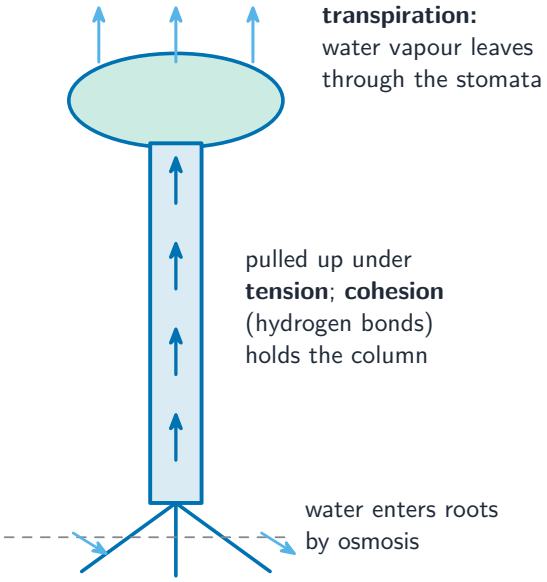
Why stomata open and close

A stoma must let in **carbon dioxide** 二氧化碳 for photosynthesis while limiting water loss by **transpiration** 蒸腾作用. So stomata usually open by day and close at night (a daily rhythm).

How guard cells work



Guard cells open the stoma when turgid (swollen with water); they close it when floppy



Guard cells control water loss through the stomata

- to **open**: guard cells pump in ions, lowering their **water potential** 水势; water enters by **osmosis** 渗透; they swell, become turgid and bend apart, opening the pore.
- to **close**: ions leave, water follows out, the guard cells go floppy and the pore closes.

■ Water stress and ABA

When the plant is short of water, the hormone **abscisic acid** (ABA) is released. It makes the guard cells lose ions and water, so the stomata close and save water. **Calcium ions** 钙离子 act as a **second messenger** 第二信使 inside the guard cells.

2 Practice

2.1 State the **two** opposing needs that the opening of stomata must balance. [2]

2.2 Name the hormone that closes stomata when a plant is short of water. [1]

3 Exam-style questions

3.1 A stoma opens when its guard cells: [1]

- **A** lose ions and become floppy
- **B** gain ions, so water enters by osmosis and they become turgid
- **C** lose water by osmosis
- **D** release abscisic acid

3.2 What is the role of calcium ions in the response to water stress? [1]

- **A** they are pumped out to open the stomata
- **B** they act as a second messenger inside the guard cells
- **C** they replace water in the guard cells
- **D** they are absorbed for photosynthesis

3.3 Explain the mechanism by which guard cells open a stoma. [3]

3.4 (a) Explain why a plant closes its stomata when the soil becomes dry. [2]

(b) Suggest one disadvantage to the plant of keeping its stomata closed for a long time. [2]

Solutions

2.1 letting in carbon dioxide for photosynthesis; limiting water loss by transpiration.

2.2 abscisic acid (ABA).

3.1 B. Gaining ions lowers the water potential, water enters by osmosis, and the turgid guard cells open the pore.

3.2 B. Calcium ions act as a second messenger inside the guard cells.

3.3 guard cells actively pump in ions, lowering their water potential; water enters by osmosis, so they become turgid; the unevenly thickened walls make them bend apart, opening the pore.

3.4 (a) closing the stomata reduces water loss by transpiration, conserving the limited water.
(b) less carbon dioxide can enter, so the rate of photosynthesis falls / less food is made.

5 A plant that is described as a mesophyte has evolved to grow in conditions that do not normally experience water stress (low availability of water).

(a) Fig. 5.1 is a diagram of a cross section through the leaf of a herbaceous dicotyledonous mesophyte.

Complete Fig. 5.1 by naming structure **A** and tissue layer **B**.

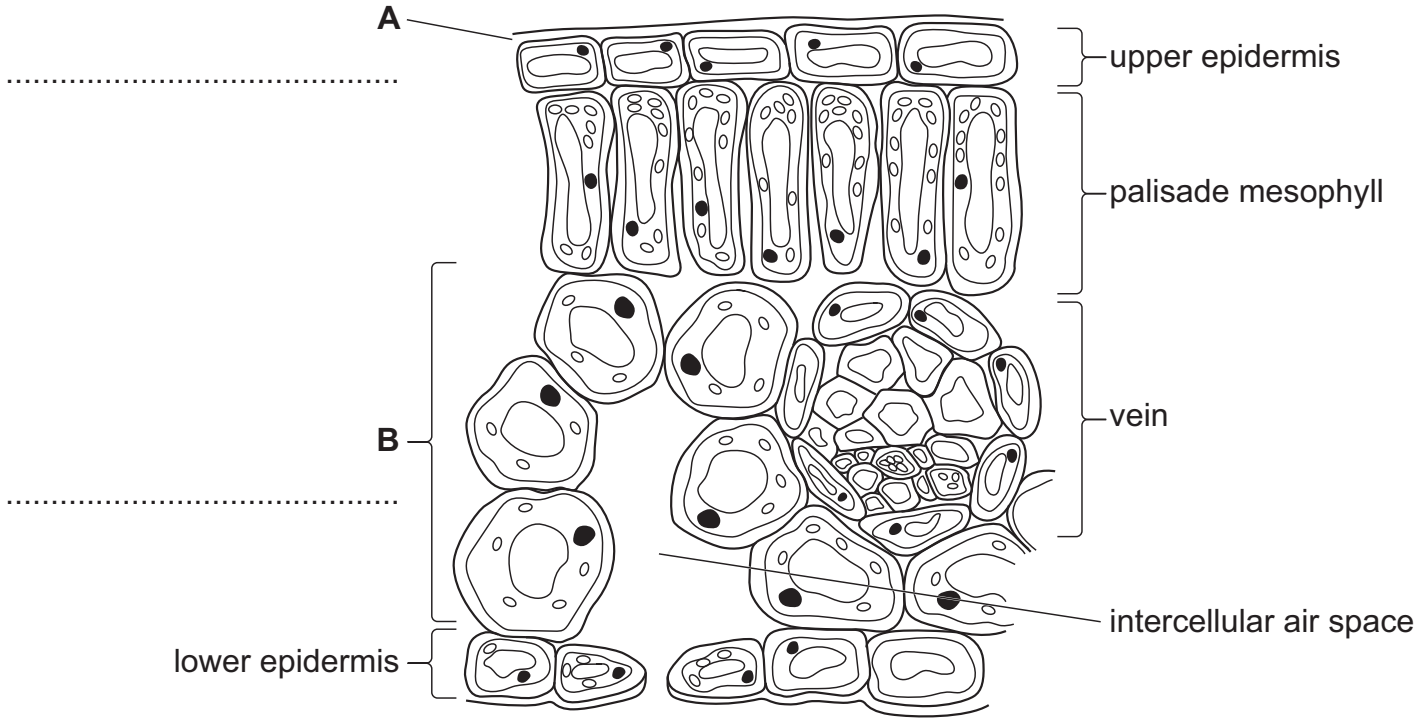


Fig. 5.1

[2]

(b) In **xerophytes**, some of the structural features shown in Fig. 5.1 are modified as adaptations for surviving conditions of water stress.

Complete **Table 5.1** to show how the structural feature listed may be modified in the leaf of a **xerophyte**.

Each feature should have a **different** example of a modification.

Table 5.1

structural feature in Fig. 5.1	**one example of a xerophytic adaptation**
structure **A**	
upper epidermis	
lower epidermis	

[3]

[Total: 5]

8 **(a)** When the water supply to a plant is reduced, the concentration of abscisic acid (ABA) in the leaves increases.

ABA binds to receptors in the cell surface membranes of guard cells. This triggers a series of events in the cells, which results in stomatal closure.

Fig. 8.1 is a diagram of part of a guard cell showing some of the events that occur when ABA binds to its receptor.

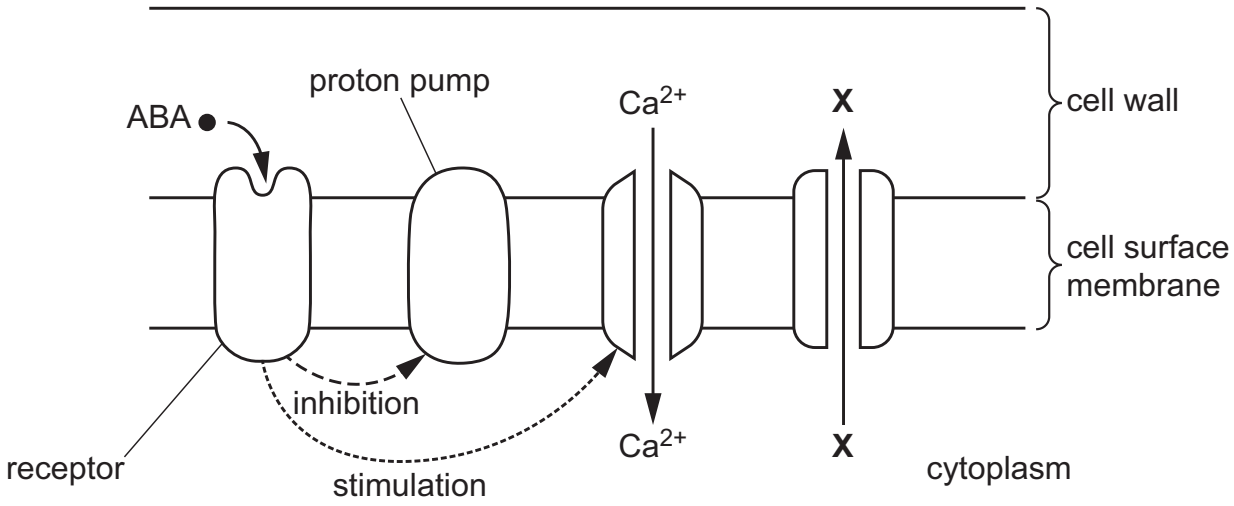


Fig. 8.1

Fig. 8.1 shows that calcium ions are involved in the events within a guard cell that result in stomatal closure.

Outline the role of calcium ions in the response of the guard cell to a reduced water supply **and** explain how this response results in stomatal closure.

Identify **X** in your answer.

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(b) Explain, using examples, why the homeostatic control involving the opening and closing of stomata is important for the efficient functioning of plants.

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..... [4]

[Total: 8]

1 The plantain lily, *Hosta plantaginea,* as shown in Fig. 1.1, is a flowering plant found in Asia.

Fig. 1.1

The hydrostatic pressure increases inside guard cells when water enters the guard cells down a water potential gradient. This affects the width of the stomata.

Fig. 1.2 shows 1 open stoma from the plantain lily surrounded by 2 guard cells.

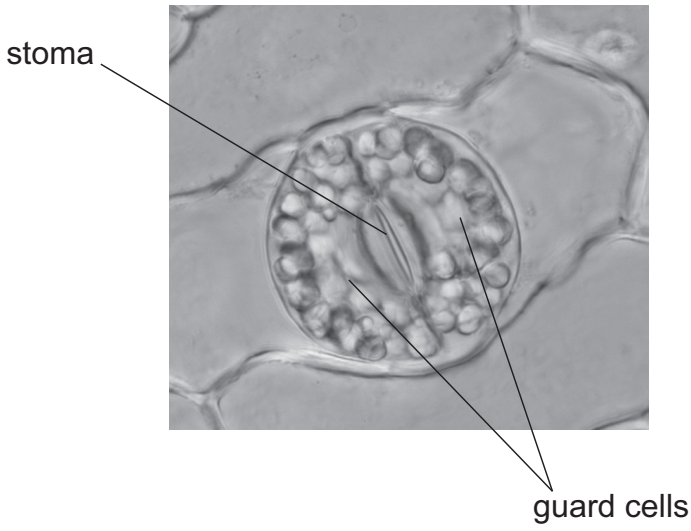

Fig. 1.2

A student investigated the effect of different sucrose solutions on the width of stomata in the leaves of plantain lily.

The student:

- prepared 5 microscope slides as shown in Table 1.1

Table 1.1

microscope slide number	liquid added to microscope slide
1	large drop of distilled water
2	large drop of 2.5% sucrose solution
3	large drop of 5.0% sucrose solution
4	large drop of 10.0% sucrose solution
5	large drop of 20.0% sucrose solution

- removed the lower epidermis from a leaf of plantain lily
- immersed 1 small piece of lower epidermis in the drop on microscope slide 1
- placed a cover slip over the piece of lower epidermis
- observed the stomata using a light microscope fitted with an eyepiece graticule
- repeated the steps for microscope slides 2, 3, 4 and 5.

(a) (i) State the independent and dependent variables in the investigation.

independent .....

.....

dependent .....

.....

[2]

(ii) The student prepared 20 cm^3 of 2.5%, 5.0% and 10.0% sucrose solutions from a 20.0% w/v stock solution.

Complete the description of the student's dilution method for the 2.5% and 5.0% sucrose solutions by writing the correct volumes in the following sentences.

The student mixed ..... cm^3 of 20.0% sucrose stock solution with ..... cm^3 of distilled water to produce a 2.5% sucrose solution.

The student mixed ..... cm^3 of 20.0% sucrose stock solution with ..... cm^3 of distilled water to produce a 5.0% sucrose solution.

[2]

(iii) The student observed stomata on the microscope slides using the high-power objective lens.

Outline a method the student could use to investigate the effect of the sucrose solutions in Table 1.1 on the width of stomata in the leaves of plantain lily.

Your method should be set out in a logical order and be detailed enough to allow another person to follow it.

Details of how to prepare the microscope slides should **not** be included.

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(iv) Predict the effect of increasing the sucrose concentration from 0.0% to 20.0% on the width of stomata in the leaves of plantain lily.

Explain your prediction.

prediction .....

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explanation .....

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[2]

(b) Another piece of lower epidermis from a leaf of plantain lily was immersed in a large drop of distilled water on a microscope slide.

Fig. 1.3 shows the lower epidermis viewed using the low-power objective lens.

The student determined the stomatal density on the lower epidermis using Fig. 1.3 only.

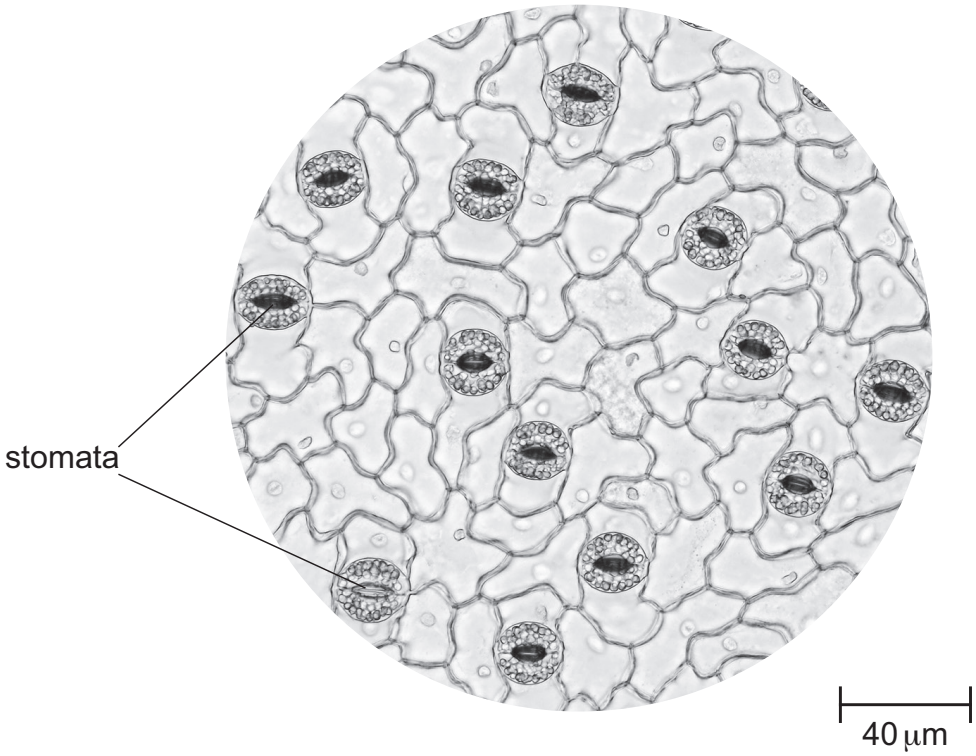

Fig. 1.3

(i) Use Fig. 1.3 to calculate the stomatal density on the lower epidermis.

Use the equation:

area = πr^2 and π = 3.14

Give your answer to the nearest whole number and show your working.

stomatal density = ... mm^{-2}

[4]

(ii) Suggest how this investigation could be improved to increase confidence in your answer in **(b)(i)**.

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[1]

(iii) A different plant species had a lower stomatal density than the value calculated for plantain lily in **(b)(i)**.

Suggest how the environmental conditions of the different plant species may vary from those of the plantain lily.

Explain your answer.

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..... [2]

[Total: 18]

2 Scientists investigated the effect of abscisic acid (ABA) on reducing water loss in plants. The scientists predicted that ABA, as well as stimulating stomatal closure, also reduces water loss in plants in other ways.

The scientists used a mutant variety of thale cress, *Arabidopsis thaliana*, that has stomata that do **not** respond to ABA. When ABA is present, the stomata of the mutant variety remain open.

The scientists sprayed different concentrations of ABA on the leaves of the mutant variety and measured the transpiration rates of the plants.

The results are shown in Fig. 2.1.

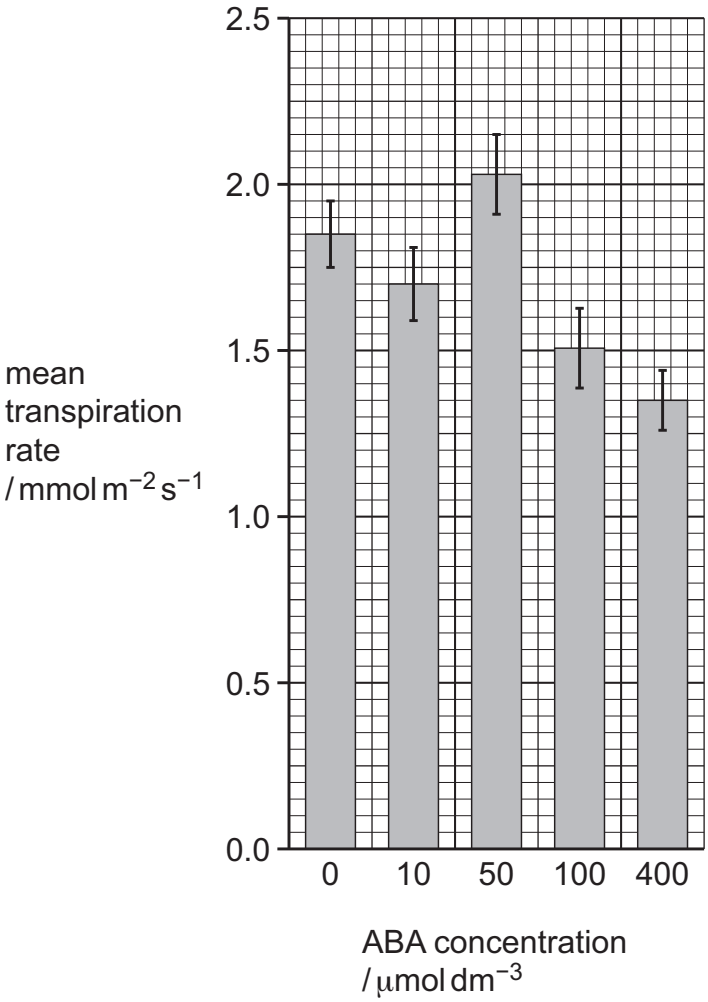

Fig. 2.1

(a) Calculate the percentage decrease in transpiration rate from 0 to 400 μmol dm^{-3} of ABA for the mutant variety.

Show your working.

percentage decrease = ...

[2]

(b) With reference to Fig. 2.1, suggest conclusions that can be made about the effect of different concentrations of ABA on the transpiration rates of the mutant variety.

State the evidence that supports your conclusions.

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..... [2]

(c) The scientists used a mutant variety of thale cress that has stomata that do **not** respond to ABA.

The scientists concluded that ABA reduces water loss in thale cress by ways other than stomatal closure.

Suggest additional information that is required to increase the confidence in this conclusion.

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..... [3]

[Total: 7]