

Past-paper walk-through

Homeostasis in plants ■ 14.2

eXercise

Questions in this set

- 9700/22 N25 Q5 ■ 5 marks
- 9700/44 N25 Q8 ■ 8 marks
- 9700/52 N25 Q1 ■ 18 marks
- 9700/52 N25 Q2 ■ 7 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- **//** separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = “or words to that effect” – the wording need not match.

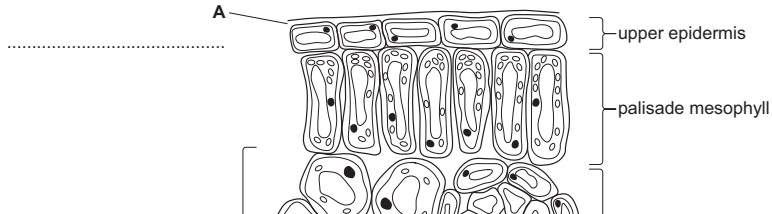
Question 5

9700/22 N25 ■ Q5 ■ 5 marks

- 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**.



Question 5

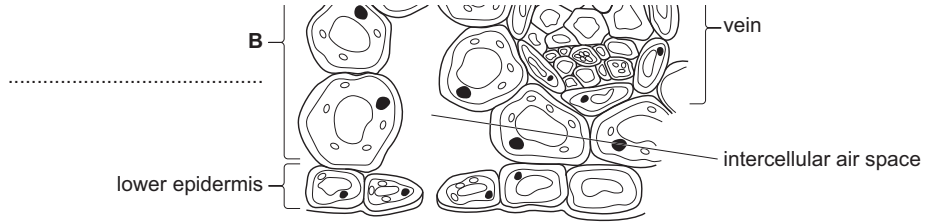


Fig. 5.1

[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**.

.....

Question 5

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] _

Question 5

Solution 5

(a)

Mark scheme

- A = (waxy) cuticle ;
- B = spongy mesophyll (layer / tissue) ;
- R spongy mesophyll cell
- I parenchyma
- 2

Solution 5

(b) Mark scheme

- one mark each correct row and each example must be different
- structural feature in Fig. 5.1
- one example of xerophytic adaptation
- structure A
- thick / thicker, (waxy cuticle) ;
- A reflective layer / AW
- upper epidermis
- multi-layered / more than one cell layer / hypodermis

Solution 5

- or
- thick walled / thick cell walls / sclerenchyma
- or
- presence of, trichomes ;
- lower epidermis
- sunken stomata
- or
- stomata in, pits / grooves / crypts / chambers
- or
- presence of, trichomes

Solution 5

- or
- thick / thicker, (waxy) cuticle
- or
- few(er) stomata (per unit area) R no / fewer
- or
- stoma / stomata, with smaller, aperture / pore ;
- 3
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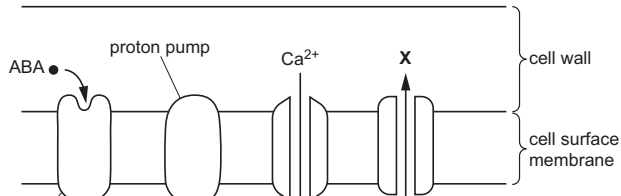
Question 8

9700/44 N25 ■ Q8 ■ 8 marks

- 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.



Question 8

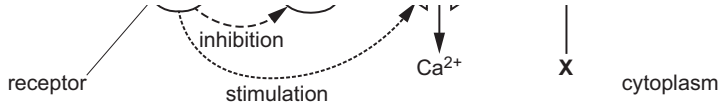


Fig. 8.1

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.

Question 8

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

Question 8

[Total: 8]

Solution 8

(a) Mark scheme

- any four from:
- 1
- Ca^{2+} act as second messenger ;
- 2
- causes (K^+) channel proteins to open ;
- 3
- $\text{X} = \text{potassium ions} / \text{K}^+ \text{ (that leave the cell) ;}$
- 4

Solution 8

- water potential of cell increases / water leaves cell by osmosis ;
- 5
- (guard) cell, becomes flaccid / loses turgidity ;
- 4

Solution 8

(b) Mark scheme

- any four from:
- 1
- (stomata) open to take up carbon dioxide for photosynthesis ;
- 2
- (stomata) close to prevent, transpiration / (excessive) water loss ;
- 3
- e.g. conditions when stomata close ;
- 4

Solution 8

- (water homeostasis needed to) maintain turgidity of cells / supply water for reactions ;
- 5
- ref. to daily rhythm or open during, day / light, and close, at night / at low light intensity / in the dark ;
- 6
- AVP ;
- 4

Question 1

9700/52 N25 ■ Q1 ■ 18 marks

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



leaf with
stomata on
the lower
epidermis

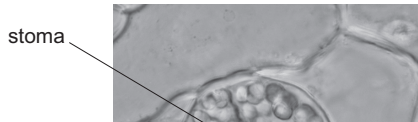
Question 1



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.



Question 1

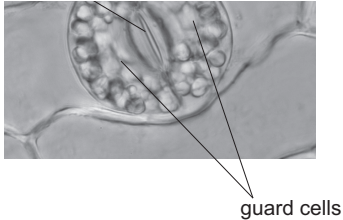


Fig. 1.2

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

—

Question 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

Question 1

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

Question 1

Question 1

[2]

- (ii) The student prepared 20 cm³ 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.

Question 1

of distilled water to produce a 2.5% sucrose solution.

Question 1

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.

Question 1

- (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.

Question 1

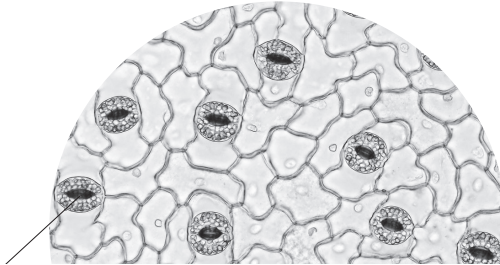
Question 1

[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.



Question 1

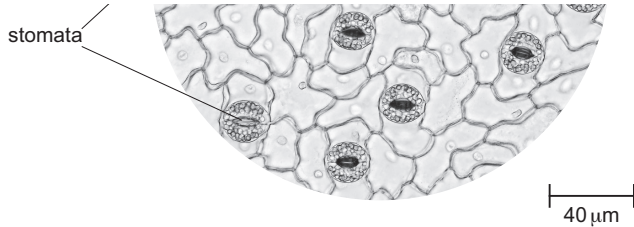


Fig. 1.3

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

Use the equation:

$$\text{area} = \pi r^2 \text{ and } \pi = 3.14$$

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

Question 1

Question 1

[4]

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

Question 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.

Question 1

[Total: 18]

Solution 1

(a)(i)

Mark scheme

- independent: sucrose concentration ;
- dependent: width of stomata ;
- 2

Solution 1

(a)(ii)

Mark scheme

- 2.5 and 17.5 (to produce a 2.5% sucrose solution) ;
- 5 and 15 (to produce a 5.0% sucrose solution) ;
- 2

Solution 1

(a)(iii) Mark scheme

- 1
- use all sucrose concentrations ;
- any four from:
- 2
- leave the epidermis in sucrose solution for the same time ;
- 3
- calibrate, the eyepiece graticule ;
- 4

Solution 1

- measure the width of the stomata ;
- 5
- measure stomata at their widest point ;
- 6
- idea of (measuring) 3 or more (different) stomata (for any single concentration) ;
- 7
- calculate the mean (width of the stomata) for any single concentration ;
- 8
- named hazard and risk and precaution ;
- hazard

Solution 1

- risk
- Precaution
- plant material
- allergy / irritant
- gloves / eye protection / PPE
- slides / cover slip cuts
- ensure it is not placed near edge of bench
- or
- use glass bin / dustpan and brush / AW, for disposal.
- scalpel / knife

Solution 1

- cuts
- cut away from hand / cut onto board / tile / AW
- 5
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Solution 1

(a)(iv) Mark scheme

- predict:
- (as sucrose concentration increases width of stomata) decreases ;
- Explain (must match the prediction):
- (as the sucrose concentration increases) water leaves the guard cells, by, osmosis / down a water potential gradient / from
- high to low water potential ;
- or

Solution 1

- (as the sucrose concentration increases) less water enters the guard cells, by osmosis / down a water potential gradient
- from high to low water potential ;
- 2

Solution 1

(b)(i) Mark scheme

- 1
- stomatal density = $367 \text{ (mm}^{-2}\text{)}$;
- Any three of:
- 2
- (number of stomata) = 13 ;
- 3
- diameter of picture = $8.5 \text{ cm} / 85 \text{ mm}$
- or

Solution 1

- radius of picture = $4.25 \text{ cm} / 42.5 \text{ mm}$
- or
- length of scale bar / $40 \mu\text{m} = 1.6 \text{ cm} / 16 \text{ mm}$;
- 4
- show stomatal density calculation ;
- 5
- show magnification (calculation) ;
- 4

Solution 1

(b)(ii)

Mark scheme

- use more than one, field of view / slide / epidermis / (plantain lily) leaf ;
- 1
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Solution 1

(b)(iii) Mark scheme

- 1 Environmental condition ;
- 2 Explanation ;
- dry / arid / less water
- So less water lost / less transpiration
- low humidity
- high temperature / warm / hot
- windy / high wind speed
- 2

Question 2

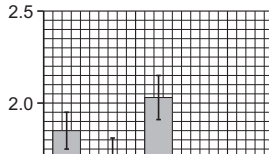
9700/52 N25 ■ Q2 ■ 7 marks

- 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.

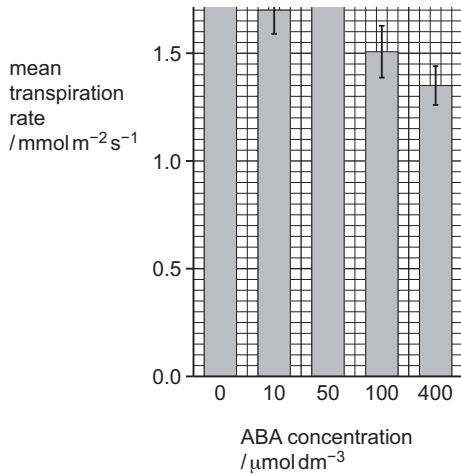
The scientists sprayed different concentrations of ABA on the leaves of the mutant variety and measured the transpiration rates of the plants.

The results are shown in Fig. 2.1.



Error bars show ± 1 standard error (SE).
 $0 \mu\text{mol dm}^{-3}$ ABA = distilled water

Question 2



Question 2

Fig. 2.1

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

Show your working.

Question 2

[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.

Question 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.

Question 2

[Total: 7]

Solution 2

(a)

Mark scheme

- ($0 \mu\text{mol dm}^{-3}$ ABA =) 1.85 and ($400 \mu\text{mol dm}^{-3}$ ABA =) 1.35 ;
- 27 ;
- 2

Solution 2

(b) Mark scheme

- any two from:
- 1
- as ABA concentration increases, transpiration rate decreases, except at (ABA concentration of) 50 ;
- 2
- error bars for (ABA concs) 10 or 50 overlap with (ABA conc) 0 so, there is no significant difference
- (in transpiration rates)

Solution 2

- or
- error bars for (ABA concs) 100 overlap with (ABA conc) 10 so, there is no significant difference
- (in transpiration rates)
- or
- error bars for (ABA concs) 100 overlap with (ABA conc) 400 so, there is no significant difference
- (in transpiration rates) ;
- 3
- error bars for (ABA concs) 100 or 400 do not overlap with (ABA conc) 0 so, there maybe, a significant difference

Solution 2

- (in transpiration rates) ;
- 2
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Solution 2

(c) Mark scheme

- any three from:
 - 1
 - data for the non-mutant variety ;
 - 2
 - need to carry out a statistical test ;
 - 3 & 4
 - ref. to a named standardised variable ; ;
 - 5

Solution 2

- ref. to knowing that water is lost from a named part of plant (somewhere other than the stomata) ;
- 3