Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

5818991458

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
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Answer **all** questions.

Electronic calculators may be used.
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1 **(a)** The opening and closing of stomata involves the movement of potassium ions into and out of guard cells. Opening and closing of stomata is influenced by a number of environmental factors, for example light and temperature.

A student investigated the effect of potassium chloride (K*Cl*) on the opening of stomata.

The student was provided with:

- 500 cm^3 of 250 mmol dm^{-3} K*Cl* solution
- freshly picked leaves from a plant that had been kept in the dark and a high concentration of carbon dioxide for an hour. This ensured that all the stomata were closed.

Strips of leaf tissue were obtained by cutting a leaf into sections as shown in Fig. 1.1.

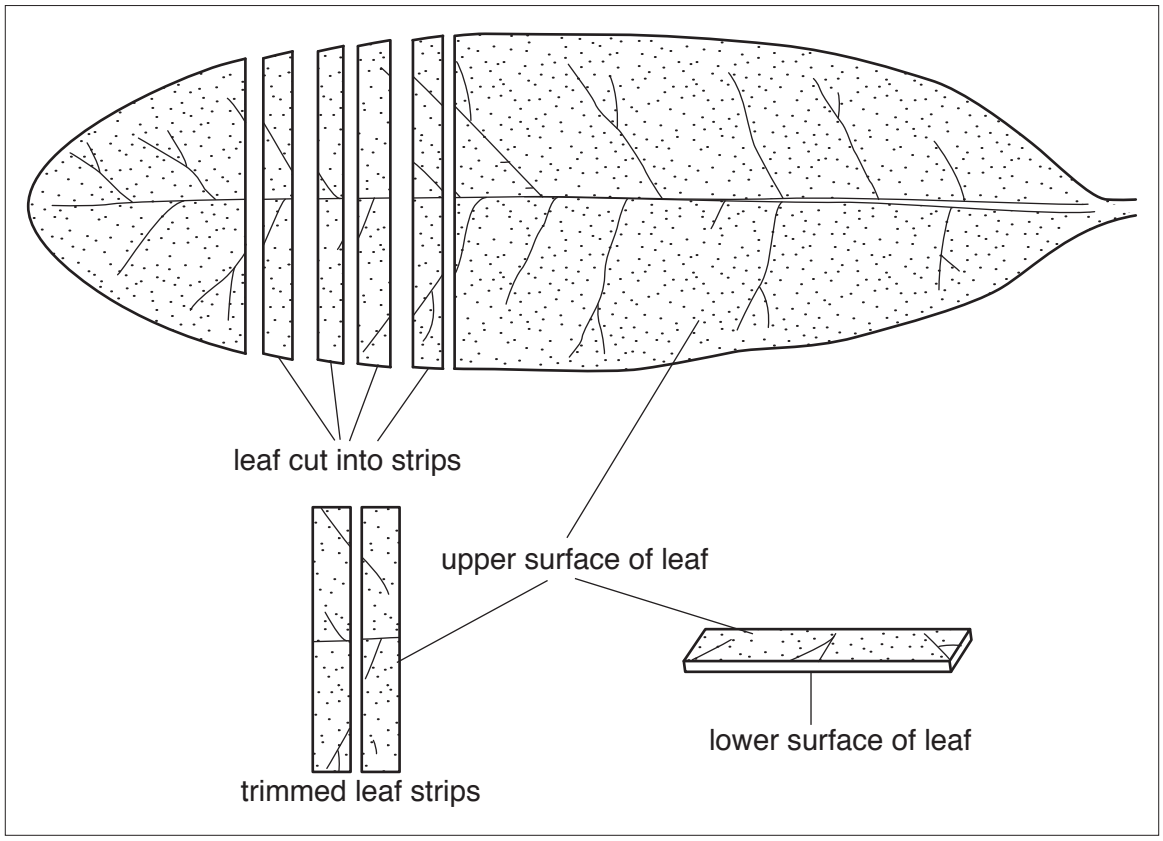


Fig. 1.1

The student floated three strips of leaf tissue in each of a range of buffered potassium chloride solutions for 2 hours and then recorded the number of open stomata.

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(i) Identify the independent and dependent variables in this investigation.

independent variable .....

.....

dependent variable .....

.....[2]

(ii) The student used the 250 mmol dm^{-3} KCl solution to make 100 cm^3 of four other concentrations by reducing the concentration by 50 mmol dm^{-3} each time.

Describe a procedure that the student could use to prepare these four concentrations.

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(b) (i) Suggest a hypothesis that the student could test about the effect of KCl on the opening and closing of stomata.

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.....[1]

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(ii) Describe a method that the student could use to investigate the effect of different concentrations of KC*l* on the opening of stomata.

The description of your method should be detailed enough for another person to follow and should **not** repeat the details from **(a)(ii)** of how to dilute the 250 mmol dm^{-3} solution of KC*l*.

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(c) The student also tested the hypothesis:

The more light the wider the stomata open.

- Eight leaves from young plants that had been kept in the dark for 24 hours were covered by metal foil.
- A fluorescent lamp of fixed intensity was placed 10 cm from the plant. The metal foil was removed from the leaves.
- Two leaves were removed at the start of the experiment and three epidermal strips were made from each leaf. An epidermal strip is made by peeling the epidermis from a leaf as a single layer.
- The diameter of the stomatal aperture of five of the stomata with the widest aperture on each strip was measured.
- At one hour intervals two more leaves were removed and the same procedure repeated.

Fig. 1.2 shows stomata at different stages of opening.

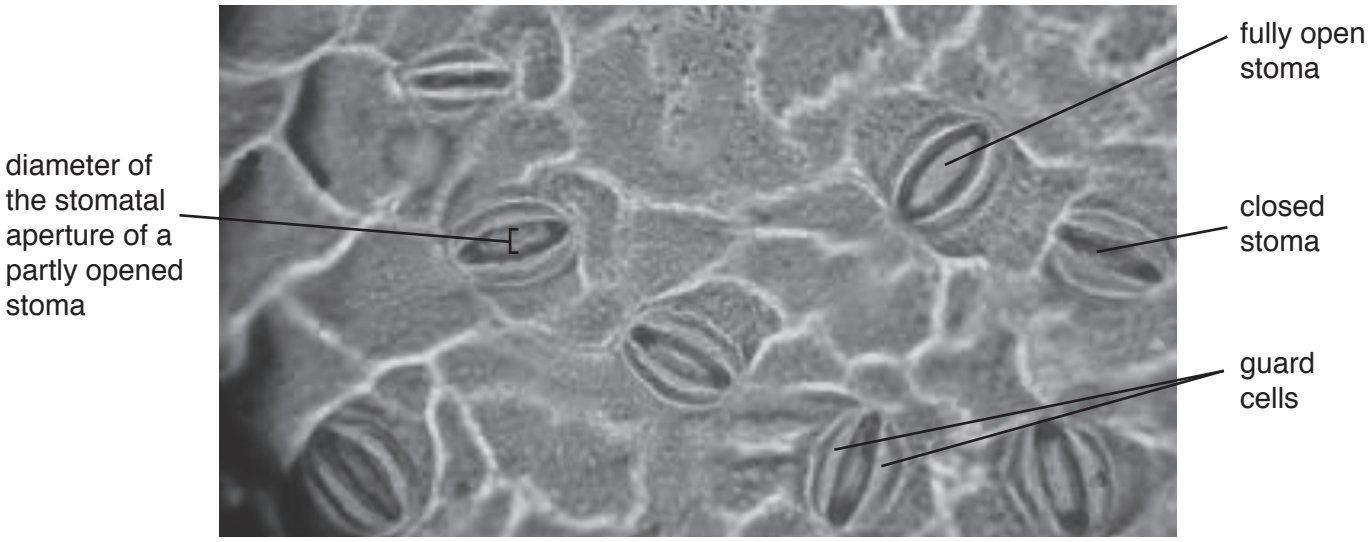


Fig. 1.2

(i) Outline how the student could find the actual diameter of a stomatal aperture.

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.....[2]

Table 1.1 shows the results of the student's experiment.

Table 1.1

time / min	diameter of stomatal aperture / μm														
0 (control)	0.5	0.1	0.2	0.3	0.4	0.1	0.5	0.2	0.3	0.3	0.1	0.2	0.2	0.2	0.4
60	0.9	1.1	1.0	1.3	1.2	1.8	1.5	0.8	0.2	1.3	1.1	0.8	1.0	1.9	0.9
120	1.9	2.4	2.6	2.6	2.5	2.2	2.8	2.4	2.4	3.9	2.6	2.3	2.5	2.2	2.7
180	4.1	4.8	4.2	4.0	5.7	4.7	3.9	4.1	5.5	4.5	4.3	4.0	3.1	4.1	4.3

(ii) **On Table 1.1**, draw circles around **two** values that are anomalous. [1]

(iii) The student calculated the mean diameter of the stomatal apertures and the rate at which the diameter of the stomatal apertures increased.
Table 1.2 shows some of these calculations.

Table 1.2

time / min	mean diameter of stomatal apertures / μm	rate of increase of diameter of stomatal apertures / μm min^{-1}
0	0.3	
60	1.2	0.015
120	2.5	0.022
180	4.6	

Complete Table 1.2 by calculating the rate of increase of the diameter of the stomatal apertures between 120 minutes and 180 minutes.

Space for working

[1]

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(iv) The experimental procedure described in **(c)** could be criticised for poor technique in obtaining results.

Suggest how the procedure could be modified to improve the quality of these results.

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.....[3]

(d) The experimental procedure used in **(c)** is not completely valid for the stated hypothesis:

The more light the wider the stomata open.

Suggest how this hypothesis could be modified to match the procedure described in **(c)**.

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[Total: 19]

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2 Cereal crops are often sprayed with selective herbicides which can reduce the population of the local wildlife. One method of helping to conserve wildlife is to leave a 6 m strip, called a headland, around fields where cereal crops are grown. The headland is not sprayed with any herbicides.

An investigation was carried out into the effect on the butterfly populations of leaving headlands unsprayed.

- Two groups of 20 fields growing the same cereal crop were studied.
- The headlands of one group of 20 fields were left unsprayed by herbicide.
- The headlands of the other group of 20 fields were sprayed with herbicide.
- The total number of each species of butterfly was counted in each group of 20 fields.
- A chi-squared (χ^2) test was used to find out if the differences in the butterfly populations were significant.

(a) State two variables that were standardised in this investigation.

1 .....

2 .....[1]

(b) **(i)** State a reason why the chi-squared (χ^2) test is suitable to use for comparing the butterfly populations.

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.....[1]

(ii) State a null hypothesis for the chi-squared test for this investigation.

.....

.....[1]

(iii) Table 2.1 shows the results for one of the species of butterfly, species **Q**.

Complete Table 2.1 to calculate the value of χ^2 using the equation below.

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

$$v = c - 1$$

O = observed result
E = expected result
v = degrees of freedom
c = number of classes

Table 2.1

species **Q**	O	E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
number on headland sprayed with herbicide	3			
number on headland not sprayed with herbicide	37			

χ^2 = ...[3]

Table 2.2 shows some chi-squared (χ^2) values.

Table 2.2

degrees of freedom	p <			
	0.10	0.05	0.01	0.001
1	2.71	3.84	6.64	10.83
2	4.61	5.99	9.21	13.82
3	6.25	7.82	11.34	16.27

(iv) State the critical value at $p < 0.05$ for this chi-squared test. .....[1]

(v) State what you conclude from the result of the chi-squared test for species **Q**.

.....[1]

Table 2.3 shows the results of the investigation and the significance of the results from chi-squared tests for the other species of butterflies counted.

Table 2.3

butterfly species	number of each species on headland sprayed with herbicide	number of each species on headland not sprayed with herbicide	significance of chi-squared test
R	1	17	p< 0.001
S	38	56	not significant
T	13	29	p< 0.05
U	59	93	p< 0.05
V	0	11	p< 0.01
W	23	52	p< 0.01

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(c) With reference to Table 2.3 **and** your calculation for species **Q**, state **three** conclusions that can be drawn from these results about the effect of herbicides on the species of butterfly studied.

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[Total: 11]

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CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

5699843206

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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The student was provided with:

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Strips of leaf tissue were obtained by cutting a leaf into sections as shown in Fig. 1.1.

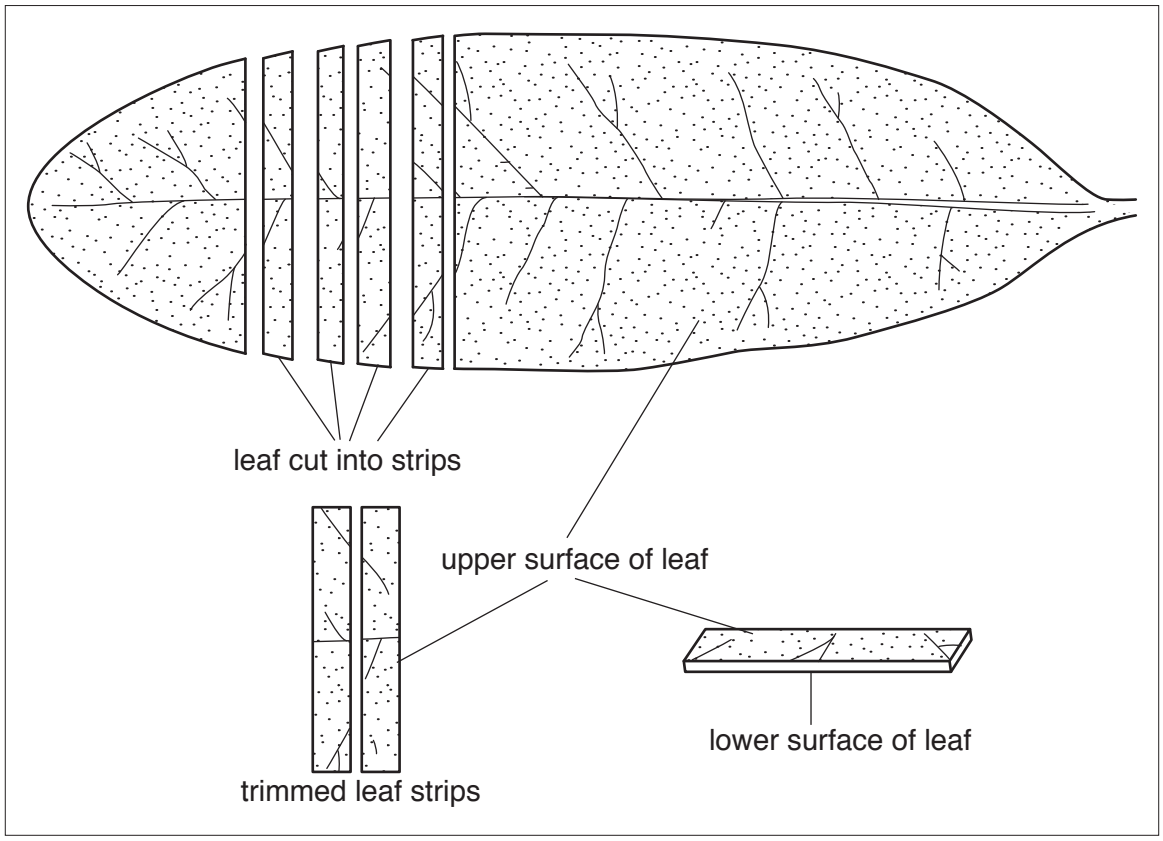


Fig. 1.1

The student floated three strips of leaf tissue in each of a range of buffered potassium chloride solutions for 2 hours and then recorded the number of open stomata.

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independent variable .....

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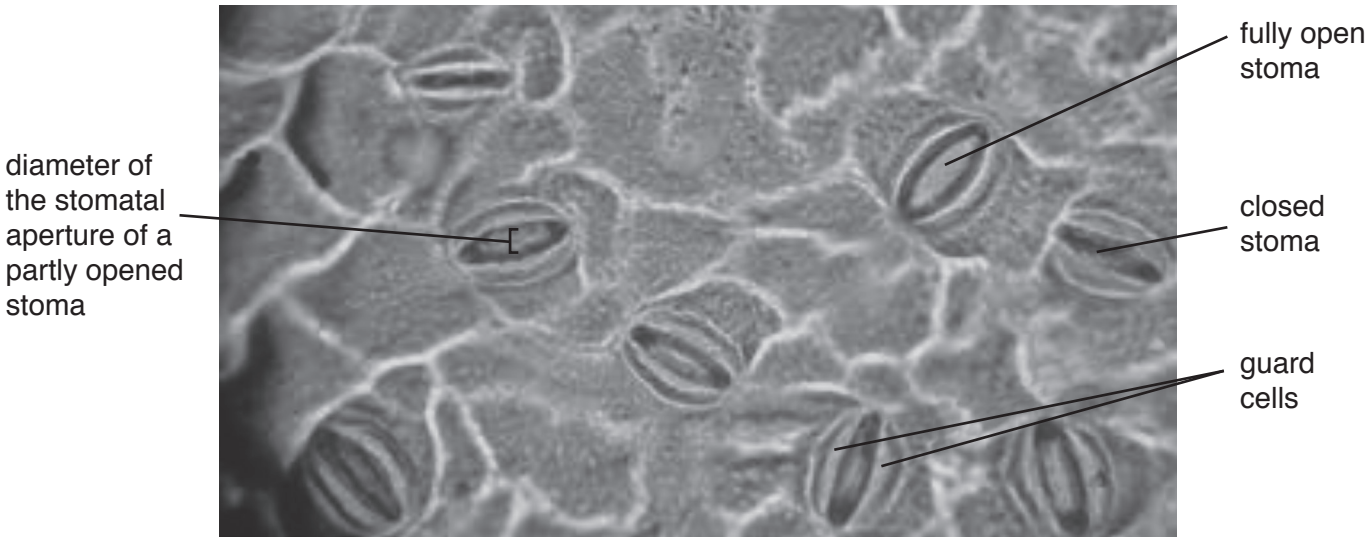


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V	0	11	p< 0.01
W	23	52	p< 0.01

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(c) With reference to Table 2.3 **and** your calculation for species **Q**, state **three** conclusions that can be drawn from these results about the effect of herbicides on the species of butterfly studied.

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CANDIDATE NAME	
CENTRE NUMBER	CANDIDATE NUMBER

5839121393

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **October/November 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

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1 **(a)** The opening and closing of stomata involves the movement of potassium ions into and out of guard cells in response to environmental factors, for example light and water stress.

This movement of potassium ions is influenced by the concentration of calcium ions in the cytoplasm of guard cells. When plants are water stressed, abscisic acid (ABA) release causes the concentration of calcium ions in the cytoplasm to increase. The increase in calcium ions causes a series of changes resulting in the loss of potassium ions, so the stomata close in light.

A student investigated the effect of calcium chloride in overcoming the effect of light on stomata.

The student was provided with:
- 500 cm^3 of 1.0 mmol dm^{-3} buffered calcium chloride ($CaCl_2$) solution
- freshly picked leaves from a plant that had been kept in light for 2 hours so that all the stomata were open.

The student soaked three epidermal strips of leaves in each of a range of calcium chloride solutions for 3 hours and recorded the number of closed stomata. An epidermal strip is made by peeling the epidermis from a leaf as a single layer.

(i) Identify the independent and dependent variables in this investigation.

independent variable .....

.....

dependent variable .....

.....[2]

(ii) The student used the 1.0 mmol dm^{-3} $CaCl_2$ solution provided to prepare 50 cm^3 of four other concentrations by reducing the concentration by half each time.

State the method that the student used to make these four concentrations.

.....

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.....[1]

(b) **(i)** Suggest a hypothesis that the student could test about the effect of $CaCl_2$ on the opening and closing of stomata.

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.....[1]

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(ii) Describe a method the student could use to investigate the effect of different concentrations of $CaCl_2$ solution on the closing of stomata.

Your method should be detailed enough for another person to follow and should **not** include the details of how to dilute the 1.0 mmol dm^{-3} solution of $CaCl_2$.

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(c) The student also tested the hypothesis:

The stomata on the upper epidermis of a leaf and the stomata on the lower epidermis respond differently to ABA.

- Young leaves that had just expanded were removed from seedling plants and cut into strips 5 mm wide and 10 mm long.
- The upper and lower epidermis were removed from five leaf strips and put into the same concentration of buffered ABA solution.
- This process was repeated for each different concentration of ABA solution.
- These were left in a constant environment and supplied with carbon dioxide-free air for two hours.
- The diameter of each stomatal aperture was measured using an eyepiece graticule.
- The eyepiece graticule was calibrated using a stage micrometer at ×400 and the stomata measured at the same magnification using the same microscope.
- 10 randomly selected stomata on each of 5 epidermal strips from the lower and upper epidermis were measured at each ABA concentration.

(i) State two ways in which the method of measuring the diameter of the stomata has been standardised.

1. .....

2. .....[1]

Fig. 1.1 shows stomata at different stages of opening.

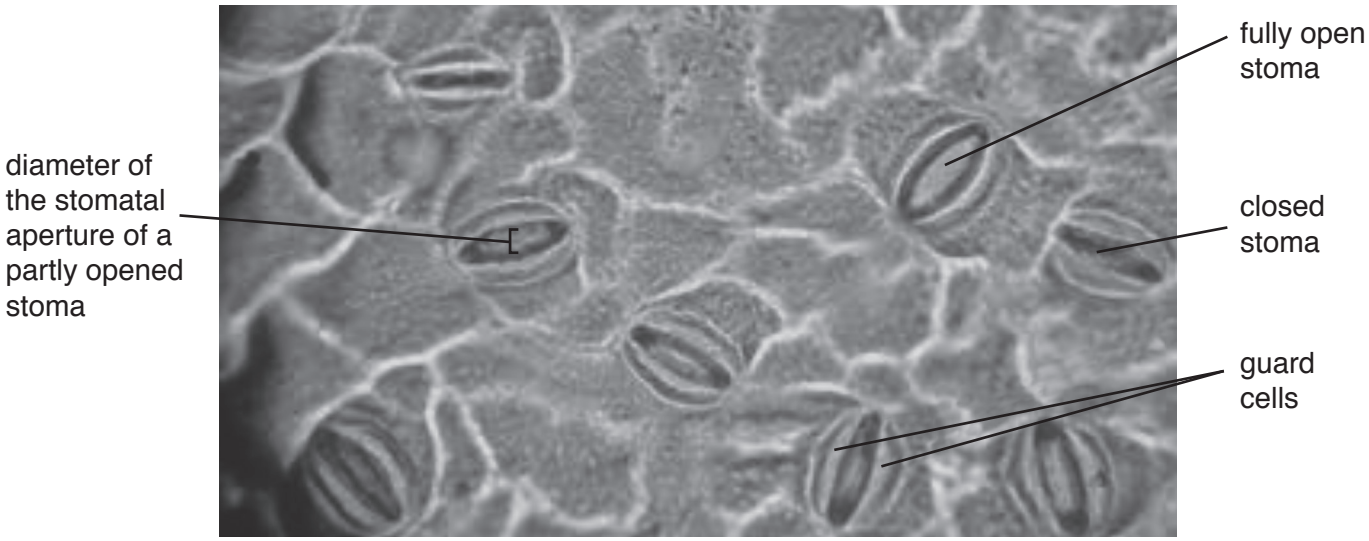


Fig. 1.1

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(ii) Fig. 1.2 shows the eyepiece graticule and stage micrometer used by the student.

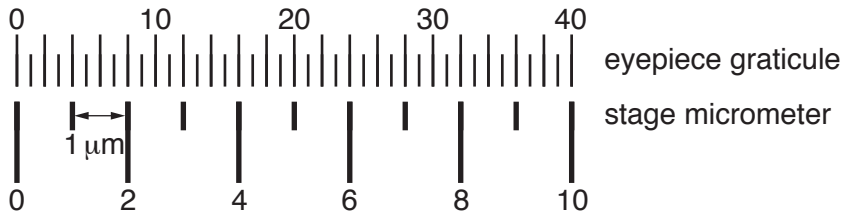


Fig. 1.2

The diameter of a stomatal aperture was 3 eyepiece units.

Calculate the actual size of the aperture.

..... μm [1]

(d) Fig. 1.3 shows the results of the experiment. The 95% confidence limits are shown for each mean stomatal aperture.

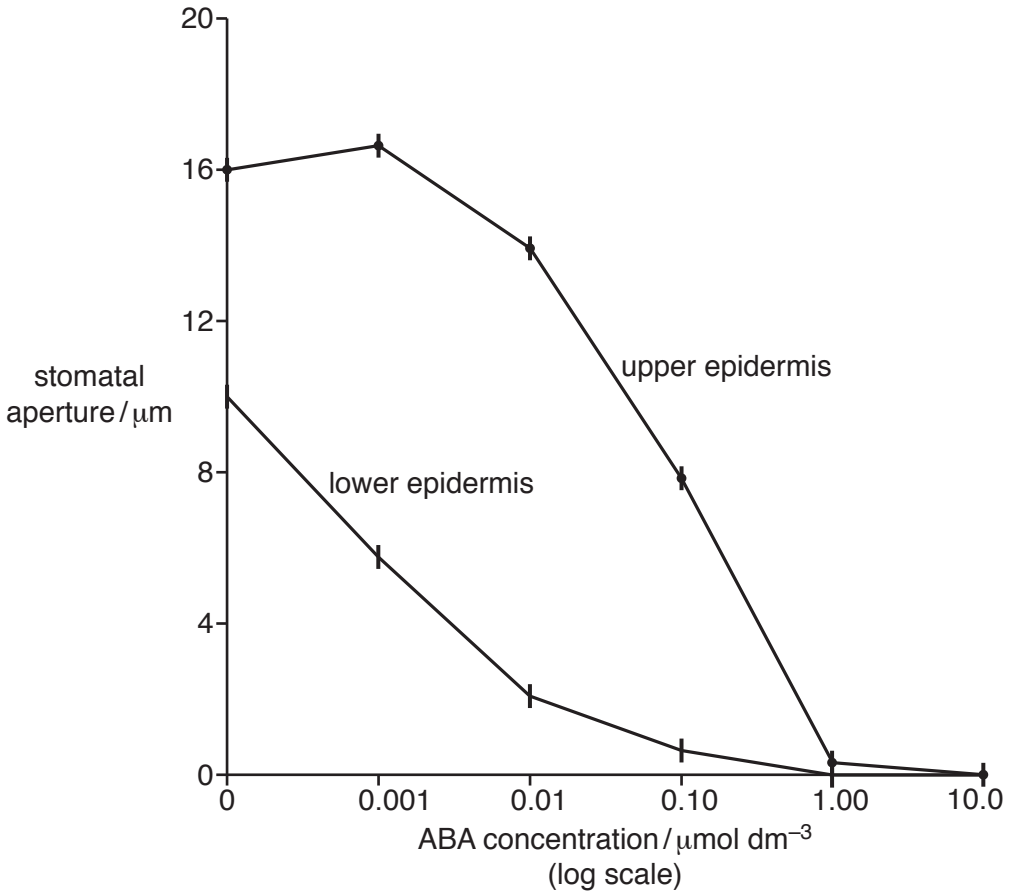


Fig. 1.3

(i) State **one** piece of evidence in Fig. 1.3 that supports the student's hypothesis that:

The stomata on the upper epidermis of a leaf and the stomata on the lower epidermis respond differently to ABA.

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.....[1]

(ii) The confidence limit of each of the mean values plotted on Fig. 1.3 is 95%.
State what this tells you about each mean value.

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.....[1]

(iii) State a statistical test that could be used to find out if the difference in the stomatal aperture at different concentrations of ABA is significant.

Give a reason for your choice.

test .....

reason .....[2]

(e) The experimental procedure carried out by the student was considered to have given data that could be trusted to support the hypothesis:

The stomata on the upper epidermis of a leaf and the stomata on the lower epidermis respond differently to ABA.

Describe the aspects of the experimental procedure which ensure that the data can be trusted.

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2 A common weed in barley fields is couch grass. A laboratory investigation was carried out to study the effect of couch grass on the yield of barley.

Barley was grown in standard sized pots in a glasshouse. The number of barley plants per pot was constant. The supply of water and mineral salts, the light and the temperature were controlled automatically. Six replicates of each of four different experiments were carried out.

experiment 1: Couch grass and barley were sown together at the same time.

experiment 2: Couch grass was sown 14 days before the barley.

experiment 3: Barley sown 14 days before the couch grass.

experiment 4: Barley grown alone.

The yield of barley from each of the different experiments was measured.

The results showed that the yield of barley from experiments 1, 3 and 4 were the same.
The results from experiment 2 showed a significant decrease in the yield of barley in comparison to the others.

(a) One hypothesis to explain the results of these experiments is:

Older couch grass roots produce a substance that inhibits the growth of younger barley roots.

(i) Outline how this hypothesis could be tested.

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(ii) Suggest **one other** hypothesis that could explain the results of experiment 2.

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.....

.....[1]

(iii) Suggest a null hypothesis that could be used in a statistical test to compare the yield of barley with the control.

.....

.....[1]

(b) In a second investigation the biodiversity in two fields of barley was studied.

Barley was planted at the same density in each field and left to grow until it reached maturity.

In one of the fields pesticides (herbicides and insecticides) were used to manage pests. In the other field pesticides were not used.

When the barley was mature, a standard sampling method was used to estimate the number of each different type of organism found in each field. These numbers were used to calculate the species diversity of each field using the formula for Simpson's Index of Diversity (*D*).

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

n = number of individuals of each type present in the sample
N = the total number of all individuals of all types
$\sum$ = the sum of

Table 2.1 shows the results of this investigation and some of the calculations for Simpson's Index of Diversity.

Table 2.1

type of organism	mean number of individuals in 10 m^2 samples from fields using pesticides	$\left(\frac{n}{N}\right)^2$	mean number of individuals in 10 m^2 samples from fields without pesticides	$\left(\frac{n}{N}\right)^2$
dicotyledons	3	0.004	60	0.021
monocotyledons	15	0.102	120	0.084
ground beetles	20		45	
butterflies and moths	4	0.007	35	0.007
bees	0	0.000	95	0.053
small mammals	3	0.004	23	0.003
birds	2	0.002	36	0.008
total	47		414	

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(i) Complete Table 2.1 **and** use the data to calculate *D* for both fields of barley.

In fields using pesticides *D* = ...

In fields without pesticides *D* = ...[3]

(ii) State what the results of this investigation show about the effect of pesticides on the plants and animals studied.

.....

.....

.....

.....

.....[2]

[Total:11]

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