Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

2990725485

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 30.
- The number of marks for each question or part question is shown in brackets [ ].

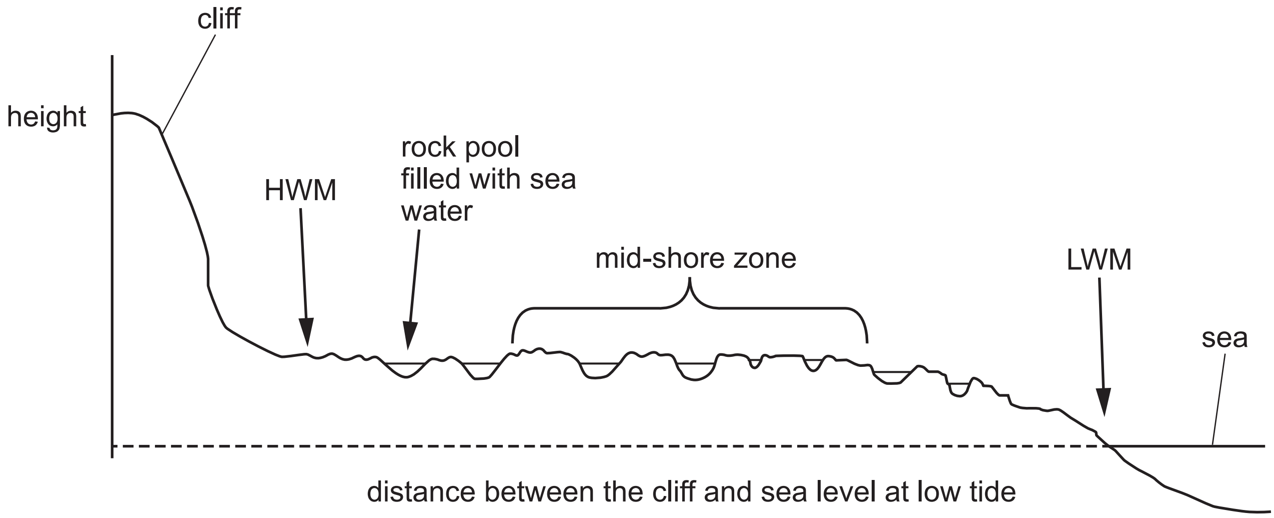
This document has **16** pages. Any blank pages are indicated.

1 Rocky shore ecosystems are found in some coastal regions. These ecosystems are inhabited by many different species of algae and animals. Twice each day the sea level rises to the high tide level and decreases to the low tide level in a regular pattern. The organisms in these ecosystems are exposed to very different conditions during the course of each day.

Algae are photosynthetic protoctists. Multicellular algae are found in many marine ecosystems.

Rock pools are formed in depressions in the shore as the water level lowers when the tide goes out.

Fig. 1.1 is a profile of a rocky shore ecosystem showing the positions of some rock pools. The mid-shore zone lies between the lower-shore zone and the upper-shore zone.



HWM = high-water mark – the highest point on the shore that is covered by sea water at high tide
LWM = low-water mark – the lowest point on the shore that is exposed to the air at low tide

Fig. 1.1

Fig. 1.2 shows a large rock pool on the mid-shore zone surrounded by smaller rock pools at low tide.

Fig. 1.2

A student investigated the distribution and abundance of large, multicellular algae on a rocky shore in North Wales in the UK at low tide on one day in October 2011.

The student completed a preliminary survey of the shore at low tide and made some observations.

1. There were several different species of algae growing in the mid-shore zone.

2. Some algae were exposed to the air at low tide, but most grew in rock pools.

3. The distribution and abundance of the algae differed on the shore between the low-water mark (LWM) and the high-water mark (HWM).

4. Large rock pools appeared to have more species of algae than small rock pools.

5. Large rock pools were deeper than small rock pools.

The student decided to investigate the relationship between the depth of rock pools and the species diversity of the algae in the rock pools in the mid-shore zone.

The student selected 32 rock pools at random. Approximately half the rock pools were small and half were large. The depth of each rock pool at its deepest point was measured and the number of different species of algae in each rock pool was counted.

(a) State **two** variables that have been standardised in the investigation.

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(b) The results of the investigation are shown in Fig. 1.3.

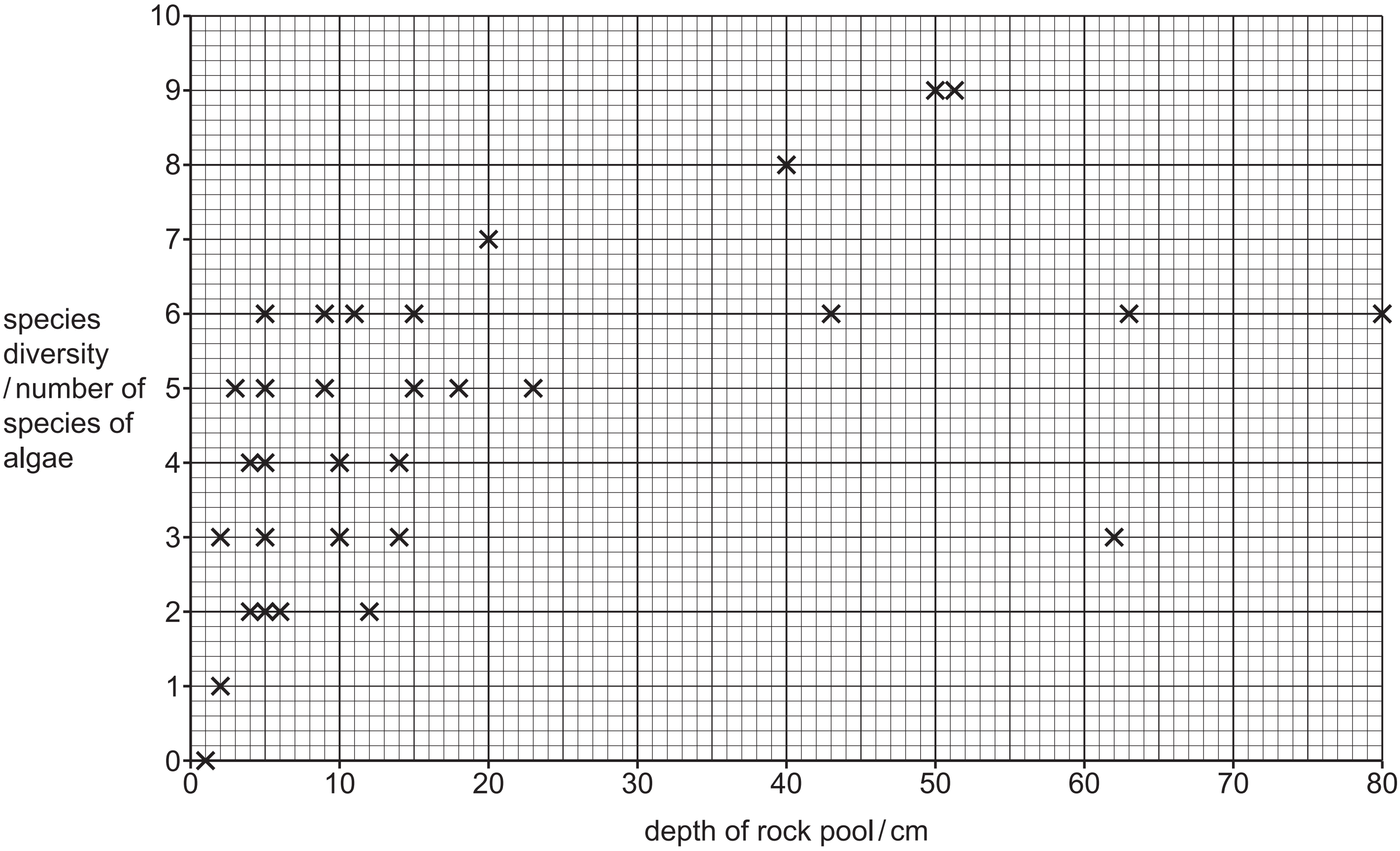

Fig. 1.3

The student used the Spearman's rank correlation to analyse the data in Fig. 1.3.

(i) State a null hypothesis for this investigation.

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.... [1]

(ii) The student calculated the Spearman's rank correlation coefficient (r_s) as 0.628.

Table 1.1 shows some of the critical values for the Spearman's rank correlation test.

Table 1.1

number of pairs of measurements	**critical values**	
	***p* = 0.05 (5%)**	***p* = 0.01 (1%)**
30	0.362	0.467
31	0.356	0.459
32	0.350	0.452
33	0.345	0.446
34	0.340	0.439

Discuss, with reference to Table 1.1, the conclusions that can be made from the analysis of the data collected by the student.

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(iii) State **one** reason why Pearson's linear correlation coefficient is **not** appropriate for analysing the data shown in Fig. 1.3.

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(c) One important feature of scientific reports is that they provide enough information for other researchers to repeat each investigation.

Explain why it is difficult for researchers to repeat this investigation of species diversity in rock pools from the information provided.

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(d) The student noticed that part of the rocky shore had **no** rock pools. The student observed that the species of algae were not distributed equally on this part of the rocky shore from the LWM to the HWM.

Describe an investigation to find out how the distribution **and** abundance of the different species of algae varies on a rocky shore with **no** rock pools from the LWM to the HWM.

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

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[Total: 16]

2 Abscisic acid (ABA) is a plant hormone that influences the growth and development of plants.

Salicylic acid (SA) is a plant hormone that interacts with other plant hormones, such as ABA, to influence growth and development in plants.

Scientists investigated the effects of ABA and SA on shoot growth in seedlings of rice, *Oryza sativa*.

The scientists germinated some rice grains and divided the young seedlings into four batches, **A** to **D**, each containing 9 seedlings of the same length. The seedlings were put into trays containing a seedling growth medium. The shoots in each batch of seedlings were sprayed once with a different solution:

batch **A** – water
batch **B** – $2\,\mu mol\,dm^{-3}$ ABA
batch **C** – $2\,\mu mol\,dm^{-3}$ ABA + $1.0\,mmol\,dm^{-3}$ SA
batch **D** – $1.0\,mmol\,dm^{-3}$ SA

The seedlings were then put into a growth chamber with constant conditions of light, temperature and humidity. The length of the shoot on each seedling was measured one day after spraying and five days after spraying.

Fig. 2.1 shows two seedlings taken at random from each batch five days after being sprayed.

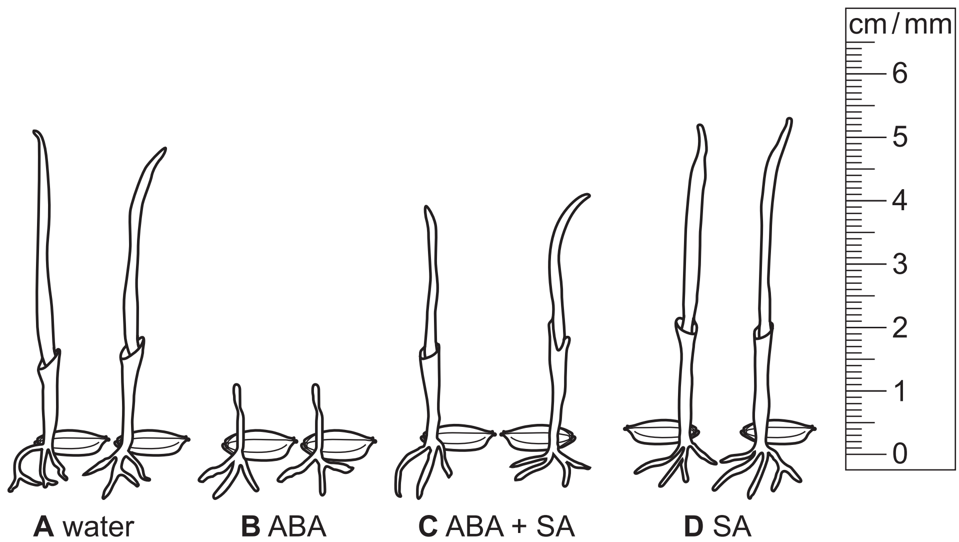

Fig. 2.1

The mean results of the investigation are shown in Fig. 2.2.

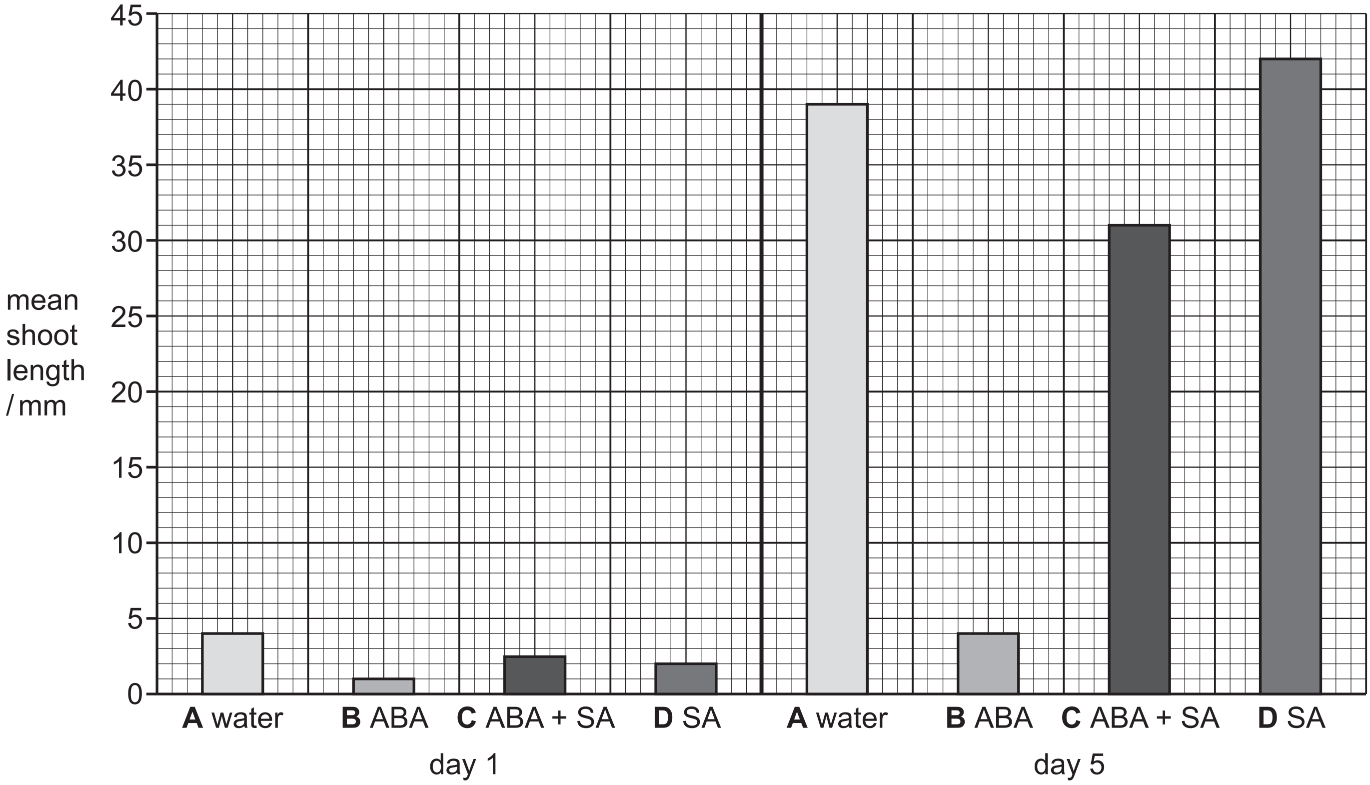

Fig. 2.2

(a) Seedlings do not always grow straight.

Suggest how the measurements of shoot length of the rice seedlings can be made as accurately as possible.

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(b) There were nine seedlings in each batch.

The standard deviation for the length of seedlings in batch **D** (sprayed with SA only) at day 5 is 5 mm.

The formula for calculating standard error (SE) is:

$$\text{SE} = \frac{s}{\sqrt{n}} \qquad s = \text{sample standard deviation} \qquad n = \text{sample size (number of observations)}$$

The formula for calculating the 95% confidence interval (95% CI) is:

$$95\%\ \text{CI} = \bar{x} \pm (2 \times \text{SE}) \qquad \bar{x} = \text{mean}$$

(i) Calculate the 95% CI for batch **D** (treated with SA only) at day 5.

95% CI = ... mm [1]

(ii) The values for 95% CI were used to add error bars for batches **C** and **D** at day 5. These error bars did not overlap. State what can be concluded from this.

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(c) Use the information in Fig. 2.2 to suggest **and** explain the effects of ABA and SA on the growth of the rice seedlings over five days.

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(d) The scientists delivered the plant hormones to the rice seedlings by spraying the shoots.

A student suggested that the rice seedlings could take up ABA and SA in the roots and transport the hormones to tissues in the shoot to give similar results to those in Fig. 2.2.

Outline a method to test this suggestion.

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Question 2 continues on page 12

(e) ABA and SA are reported in the scientific literature to be involved in the control of the mitotic cell cycle.

Cyclin-dependent kinases (CDKs) are enzymes involved in the control of the mitotic cycle. The gene *CDKB2* codes for one of these kinase enzymes.

Genes *KRP4* and *CycD6* code for proteins that regulate the activity of CDKs.

The scientists investigated the effect of ABA and SA on gene expression.

Microarrays were used to measure the relative quantities of mRNA produced by transcription of the three genes, *CDKB2*, *KRP4* and *CycD6*, in the cells of the seedlings that were sprayed by ABA and SA.

The relative quantity of mRNA produced is a measure of the level of gene expression.

Fig. 2.3 shows the effects of ABA alone, SA alone and ABA and SA combined on the expression of the three genes.

Error bars show **standard deviation** (n = 3).

(i) Complete Table 2.1 to show how the expression of the three genes is affected by the presence of ABA alone and SA alone, shown in Fig. 2.3.

Use **only** these descriptions to complete the table:

large increase **small increase** **large decrease** **small decrease** **no change**

Table 2.1

gene	**effect on gene expression**	
	ABA only	SA only
CDKB2		
KRP4		
CycD6		

[3]

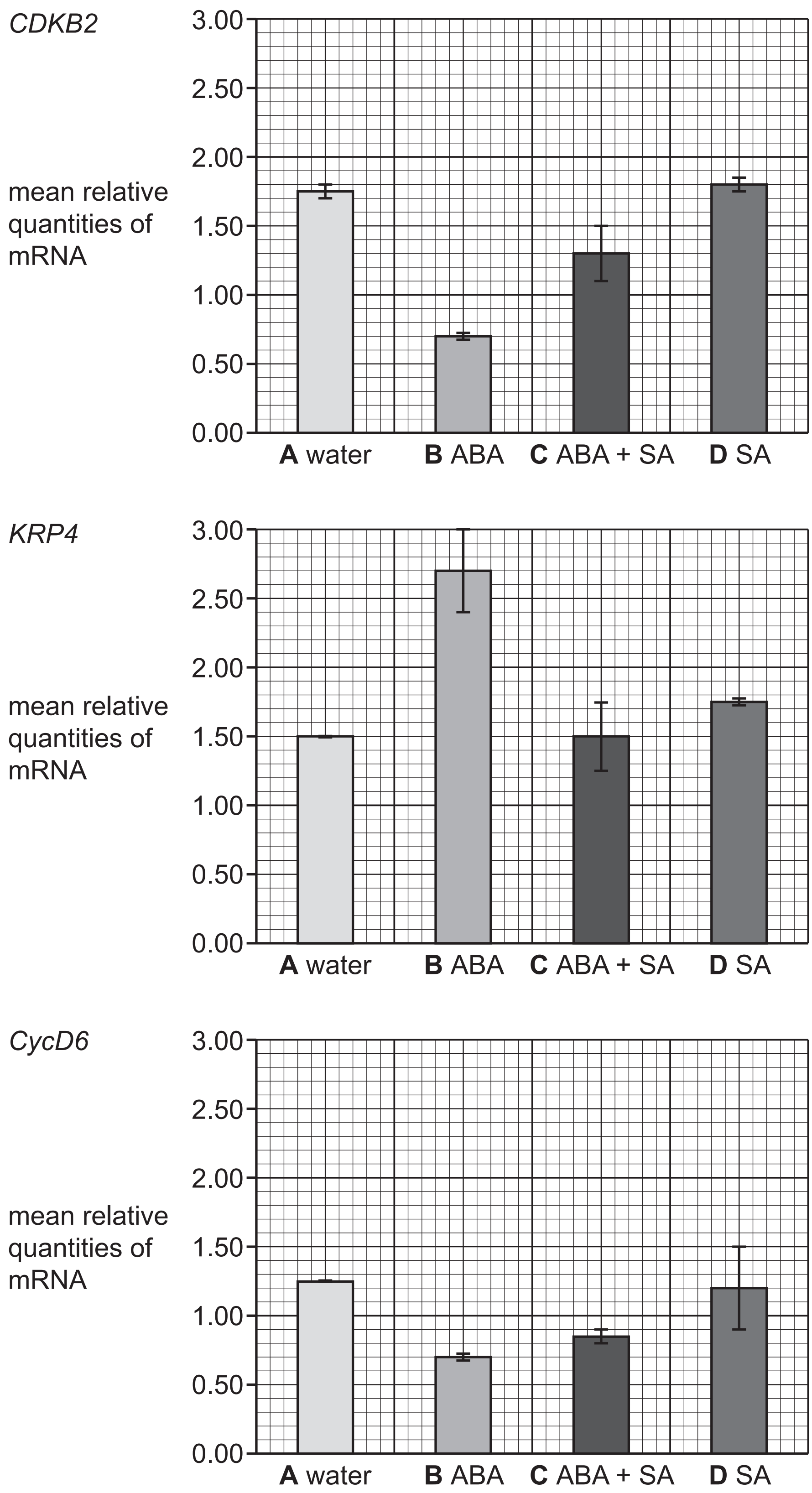
CDKB2
mean relative quantities of mRNA
3.00
2.50
2.00
1.50
1.00
0.50
0.00
A water
B ABA
C ABA + SA
D SA
KRP4
mean relative quantities of mRNA
3.00
2.50
2.00
1.50
1.00
0.50
0.00
A water
B ABA
C ABA + SA
D SA
CycD6
mean relative quantities of mRNA
3.00
2.50
2.00
1.50
1.00
0.50
0.00
A water
B ABA
C ABA + SA
D SA

Fig. 2.3

(ii) Fig. 2.3 also shows the results of spraying the seedlings with the mixture of ABA and SA (batch **C**) on the expression of the three genes.

The scientists made two conclusions about the effects of the mixture of ABA and SA (batch **C**) on the expression of the genes *KRP4* and *CycD6*.

Conclusion 1: SA counteracts the stimulation of gene expression of *KRP4* by ABA.

Conclusion 2: SA does not reverse the effect of ABA on gene expression of *CycD6*.

State **and** explain whether the evidence from Fig. 2.3 **fully supports**, **partially supports** or **does not support** each of these conclusions.

conclusion 1 ....

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conclusion 2 ....

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[2]

[Total: 14]

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