Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6151467701

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2020**

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 **12** pages. Blank pages are indicated.

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1 **(a)** Some students decided to find the respiratory quotient (RQ) of germinating pea seeds.

Pea seeds germinate best at temperatures between 13 °C to 18 °C.

Table 1.1 shows the main biological molecules in pea seeds that could be used to release energy for seed germination.

Table 1.1

biological molecule	g per 100 g of dry mass
carbohydrate	68
protein	25
fat	1

(i) Predict the RQ value for these seeds in aerobic conditions.

..... [1]

The students used the respirometer shown in Fig. 1.1.

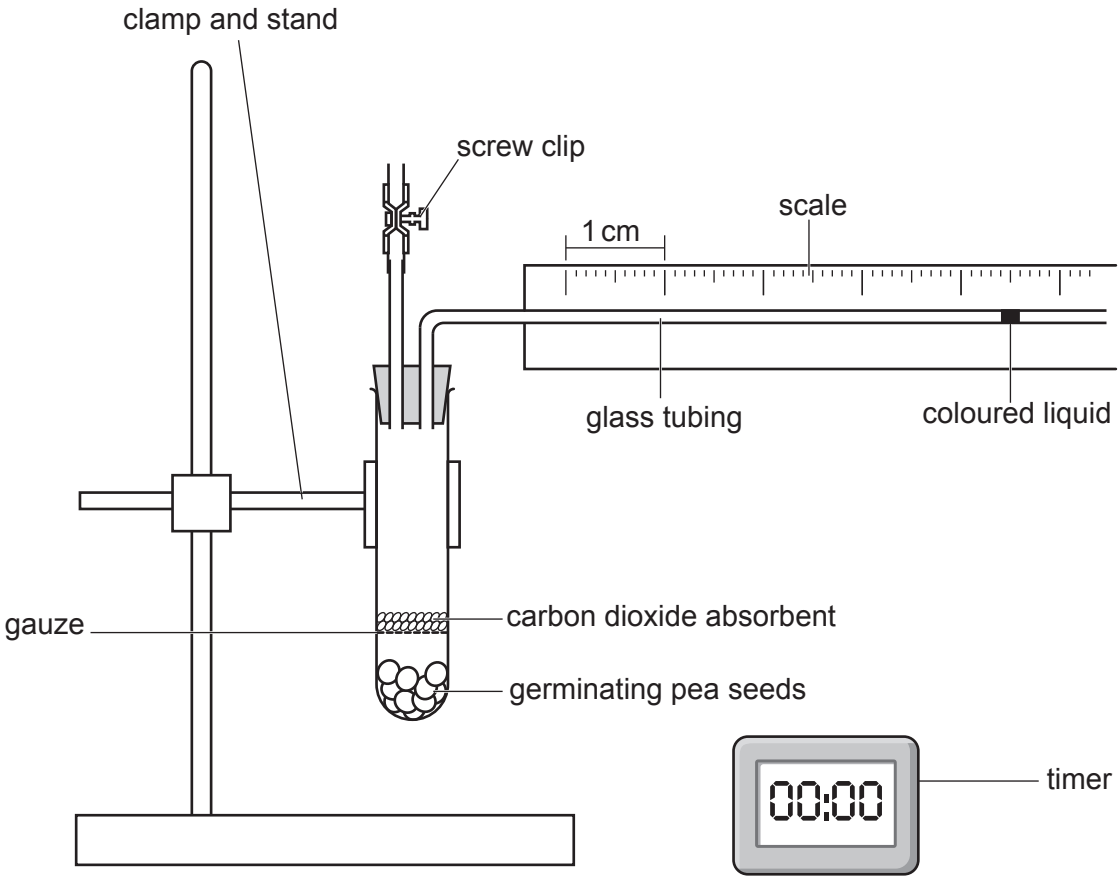


Fig. 1.1

(ii) Describe how the students could set up the respirometer **and** use it to make the measurements needed to calculate the RQ of germinating pea seeds.

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

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(b) Describe how the students should process their results to find the volumes of gases needed to calculate the RQ of germinating pea seeds.

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..... [3]

(c) **(i)** The students predicted that peas could also respire in anaerobic conditions, producing alcohol and carbon dioxide.

Outline how the students could use the respirometer in Fig. 1.1 in anaerobic conditions to find out if their prediction was correct.

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..... [3]

(ii) Table 1.2 shows the distance moved by the coloured liquid in anaerobic conditions in five different trials.

Table 1.2

trial	1	2	3	4	5
distance moved / mm	25	38	21	27	23

The students calculated a mean from the results in Table 1.2. They did not include one of the results in their calculation.

Identify the result that the students did not use **and** explain why they did not use it.

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..... [1]

[Total: 15]

2 The cotton bollworms, *Helicoverpa armigera* (old world bollworm) and *Pectinophora gossypiella* (pink bollworm), are insect pests of cotton.

Adult cotton bollworms are moths. The adult female moths lay eggs on cotton plants. The eggs hatch into larvae. The larvae feed on cotton plants, causing extensive damage and reduction in yield.

Fig. 2.1 shows a mature cotton fruit (cotton boll) from an uninfested plant.

Fig. 2.2 shows a cotton bollworm inside a developing cotton boll.



Fig. 2.1

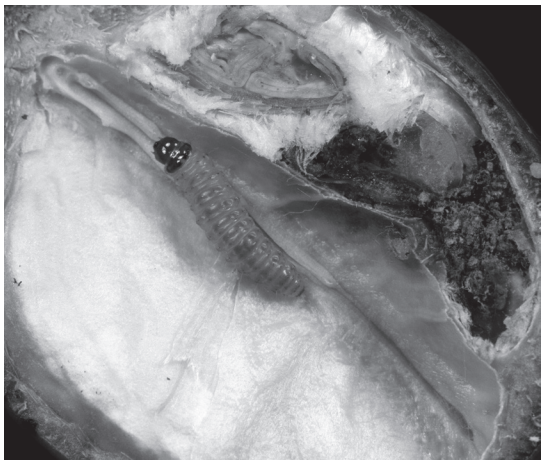


Fig. 2.2

A gene, *cry1Ac*, from the bacterium *Bacillus thuringiensis* (Bt), can be inserted into the cotton genome to produce 1 *cry* gene Bt cotton.

- 1 *cry* gene Bt cotton produces the protein Cry1Ac, which is toxic to some species of bollworm.
- This toxicity gives cotton plants some resistance to cotton bollworm.

An additional gene, *cry2Ab*, can be inserted into the cotton genome with *cry1Ac*. This produces 2 *cry* gene Bt cotton.

- 2 *cry* gene Bt cotton produces two different proteins, both toxic to cotton bollworm.

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(a) Bt cotton was first introduced into India in 2002.

Table 2.1 shows the types of Bt cotton grown from 2005 to 2009. The table also shows pesticide use over the same period of time.

Table 2.1

year	total cotton planted / millions of hectares	Bt cotton planted / millions of hectares		percentage of Bt cotton in total cotton crop	pesticide use on bollworm / tonnes
		1 *cry* gene Bt cotton	2 *cry* gene Bt cotton		
2005	8.9	1.30	0.00	14.6	6454
2006	9.1	3.65	0.15	41.8	2923
2007	9.2	5.74	0.46	64.5	1201
2008	9.2	5.56	2.04	82.6	653
2009	9.6	3.58	4.82	87.5	500

(i) A trend is a change over time.

Describe **three** trends shown by the data in Table 2.1.

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..... [3]

(ii) Suggest an explanation for the relationship between growth of Bt cotton and pesticide use on bollworm.

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..... [1]

(b) Since 2009, the number of hectares used to grow cotton has risen to 12.5 million. More than 90% of this cotton is Bt cotton.

Resistance to the protein Cry1Ac has been observed in some species of bollworm since 2005. In India resistance of the bollworm to both Cry1Ac and Cry2Ab has been observed since 2015.

(i) Predict **and** explain the effect of resistance on cotton yield, if the planting of Bt cotton continues to increase.

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(ii) Experimental observations have shown that planting rows of non-Bt cotton between rows of Bt cotton slows the spread of resistance.

Suggest why this pattern of planting can slow the spread of resistance.

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..... [2]

(c) Research has been carried out to develop a new type of insect-resistant cotton.
This uses a different type of toxic protein, Vip3, which has been isolated from *B. thuringiensis*.

The gene, *vip3AcAa*, which codes the toxic protein Vip3AcAa, has been inserted into the cotton genome.

The effectiveness of the new type of insect-resistant cotton has been tested on two different types, **A** and **B**, of the bollworm *H. armigera*. Both types are resistant to Cry1Ac.

1. 20 leaves were cut from each of three types of cotton plants:
   non-Bt, Bt *cry1Ac* and Bt *cry1Ac* + *vip3AcAa*.
2. Each of the 60 leaves was placed in a separate glass tube with a lid.
3. Larvae of type **A** were placed on each leaf.
4. Steps 1–3 were repeated using type **B** larvae.
5. All the tubes were kept in a temperature-controlled room.
6. The effectiveness of Vip3AcAa was assessed by calculating the percentage of dead bollworm larvae on each type of leaf.

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

independent variable .....

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dependent variable .....

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[2]

(ii) Suggest **one** variable that should be standardised in this investigation.

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..... [1]

(iii) Non-Bt cotton plants and Bt *cry1Ac* cotton plants were included as controls in this investigation.

Explain why it is necessary to include these plants in this investigation.

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..... [2]

Question 2 continues on page 10

Table 2.2 shows the results of this investigation.

Table 2.2

type of cotton	mean percentage of dead bollworm larvae ± *s*	
	resistant type **A**	resistant type **B**
non-Bt	40.00 ± 6.07	29.00 ± 4.43
Bt *cry1Ac*	41.00 ± 7.21	38.00 ± 3.82
Bt *cry1Ac* + *vip3AcAa*	69.00 ± 3.42	67.00 ± 3.79

s = standard deviation

(iv) The researchers concluded that:

1. The presence of the toxin Vip3AcAa may cause a statistically significant increase in the number of deaths of Bt-resistant larvae.

2. The toxin Vip3AcAa may be equally effective in controlling both types of Bt-resistant larvae.

Explain how the data in Table 2.2 support these conclusions.

conclusion 1 .....

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conclusion 2 .....

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[2]

(d) Research has shown that the toxin Vip3AcAa is also effective against Bt-resistant types of *P. gossypiella* (pink bollworm).

Suggest a further investigation that could be carried out to find out if Bt *cry1Ac* + *vip3AcAa* cotton is more effective than Bt *cry1Ac* cotton in controlling pink bollworm.

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..... [1]

[Total: 15]

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