Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/53**

Paper 5 Planning, Analysis and Evaluation **May/June 2025**

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.

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1 *Drosophila melanogaster* is a species of fruit fly.

Fig. 1.1 shows a female fruit fly and a male fruit fly. A typical fruit fly is 3 mm in length.

Fig. 1.1

Scientists have studied the inheritance patterns of many genetic traits in fruit flies.

To carry out genetic crosses with fruit flies:

- a specimen tube is prepared with food for the fruit flies, as shown in Fig. 1.2
- adult male and female fruit flies are added to the specimen tube to allow mating to take place
- the specimen tube is kept in warm conditions for several days
- the eggs laid by female fruit flies develop into pupae
- adults are removed from the specimen tube before pupae mature into adult fruit flies
- offspring emerge as adult flies 10-15 days after eggs are laid.

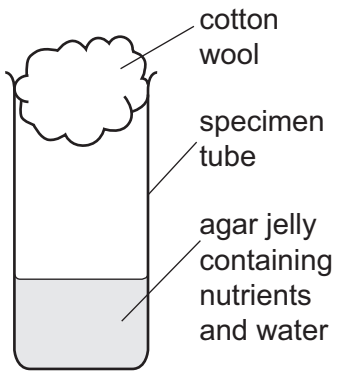

Fig. 1.2

One of the genetic traits studied in fruit flies is eye colour. The normal (wild type) eye colour of *D. melanogaster* is red.

Eye colour in *D. melanogaster* is controlled by several genes, including two genes that are located on separate chromosomes, **A/a** and **D/d**.

- Allele **A** is dominant to allele **a**.
- Allele **D** is dominant to allele **d**.

Table 1.1 summarises eye colour in *D. melanogaster* for these two genes.

Table 1.1

eye colour phenotype	genotypes
red	AADD, AaDD, AaDd, AADd
brown	AAdd, Aadd
scarlet (bright red)	aaDD, aaDd
white	aadd

(a) A student was provided with two populations of fruit fly:

- brown-eyed fruit flies with genotype AAdd
- scarlet-eyed fruit flies with genotype aaDD.

In each population, males and females were provided in separate specimen tubes.

The student decided to carry out two genetic crosses.

The first cross used fruit flies from the initial populations to produce offspring that are heterozygous for each of the two genes (double heterozygotes).

The second cross used the double heterozygotes produced from the first cross.

To carry out the genetic crosses, the student was provided with standard laboratory equipment and:

- specimen tubes containing food
- a chemical to anaesthetise the flies – this chemical, when given at a particular dose, makes the flies immobile for more than 30 minutes
- small brushes for sorting immobile flies without harming them.

(i) Identify a hazard in this investigation **and** state a risk associated with the hazard **and** state **one** precaution that the student should take.

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(ii) Describe a method the student could use to carry out:

- the first cross using fruit flies from the initial two populations to produce double heterozygotes (genotype AaDd)
- the second cross using the double heterozygotes produced from the first cross
- an analysis of the offspring phenotype ratio from the second cross.

The description of your method should be set out in a logical way and be detailed enough for another person to follow.

The method should include a description of how offspring phenotypes would be identified.

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(iii) Predict the ratio of offspring phenotypes from the cross between parents that are heterozygous for the two genes (AaDd).

You may use this space for any working.

ratio .....

phenotypes.....

[2]

(b) After crossing double heterozygotes (genotype AaDd), the student recorded the numbers of offspring in each of the four phenotypic groups.

The student used a chi-squared (χ^2) test to analyse these data.

The null hypothesis for this χ^2 test was:

There is no difference between the expected and observed numbers of offspring in each phenotypic group.

The calculated value of χ^2 was **4.798**.

The student compared **4.798** to the values in Table 1.2.

Table 1.2

degrees of freedom	probability level (*p*)		
	0.10	**0.05**	**0.01**
1	2.706	3.841	6.635
2	4.605	5.991	9.210
3	6.251	7.815	11.345
4	7.779	9.488	13.277
5	9.236	11.070	15.086

Using Table 1.2 and the calculated value of χ^2 of **4.798**, state **and** explain what the student can conclude about the results.

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[Total:13]

2 Echidnas are mammals that live in Australia and New Guinea.

Fig. 2.1 shows an echidna.

Fig. 2.1

Scientists analysed the milk produced by female echidnas and identified a protein that they named EchAMP. The scientists predicted that EchAMP may have antibacterial properties.

The scientists tested the effect of EchAMP on the bacterium *Escherichia coli*.

1. 100 *E. coli* cells were added to each well on a cell culture plate with 96 wells.
2. A treatment solution that contained EchAMP was added to each well on the plate.
3. A chemical that causes living *E. coli* cells to fluoresce was added to each well.
4. The plate was incubated at 37°C.
5. Every hour for 7 hours, the fluorescence emitted by the *E. coli* on the plate was recorded as a measure of *E. coli* population growth.
6. Steps 1–5 were repeated eight times.

The scientists also carried out two control experiments.

- A negative control experiment repeated the procedure (steps 1–6), but the treatment solution did not contain EchAMP.

- A positive control experiment repeated the procedure (steps 1–6), but the treatment solution contained an antibiotic called bacitracin instead of EchAMP.

(a) Identify the **independent** variable in this investigation.

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(b) The scientists standardised the temperature and the initial number of *E. coli* cells.

State **two other** variables that the scientists should standardise in this investigation.

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(c) **(i)** Explain why the scientists included the negative control experiment in their investigation.

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(ii) Explain why the scientists included the positive control experiment in their investigation.

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(d) Some of the results are shown in Table 2.1.

Table 2.1

time / hours	mean fluorescence / arbitrary units (au)		
	EchAMP	**negative control**	**positive control**
0	10	10	10
1	11	11	11
3	15	15	15
6	20	35	20
7	100	140	70

(i) Use Table 2.1 to complete the graph in Fig. 2.2 by:

- plotting the three results at 7 hours
- adding axis labels
- completing the key.

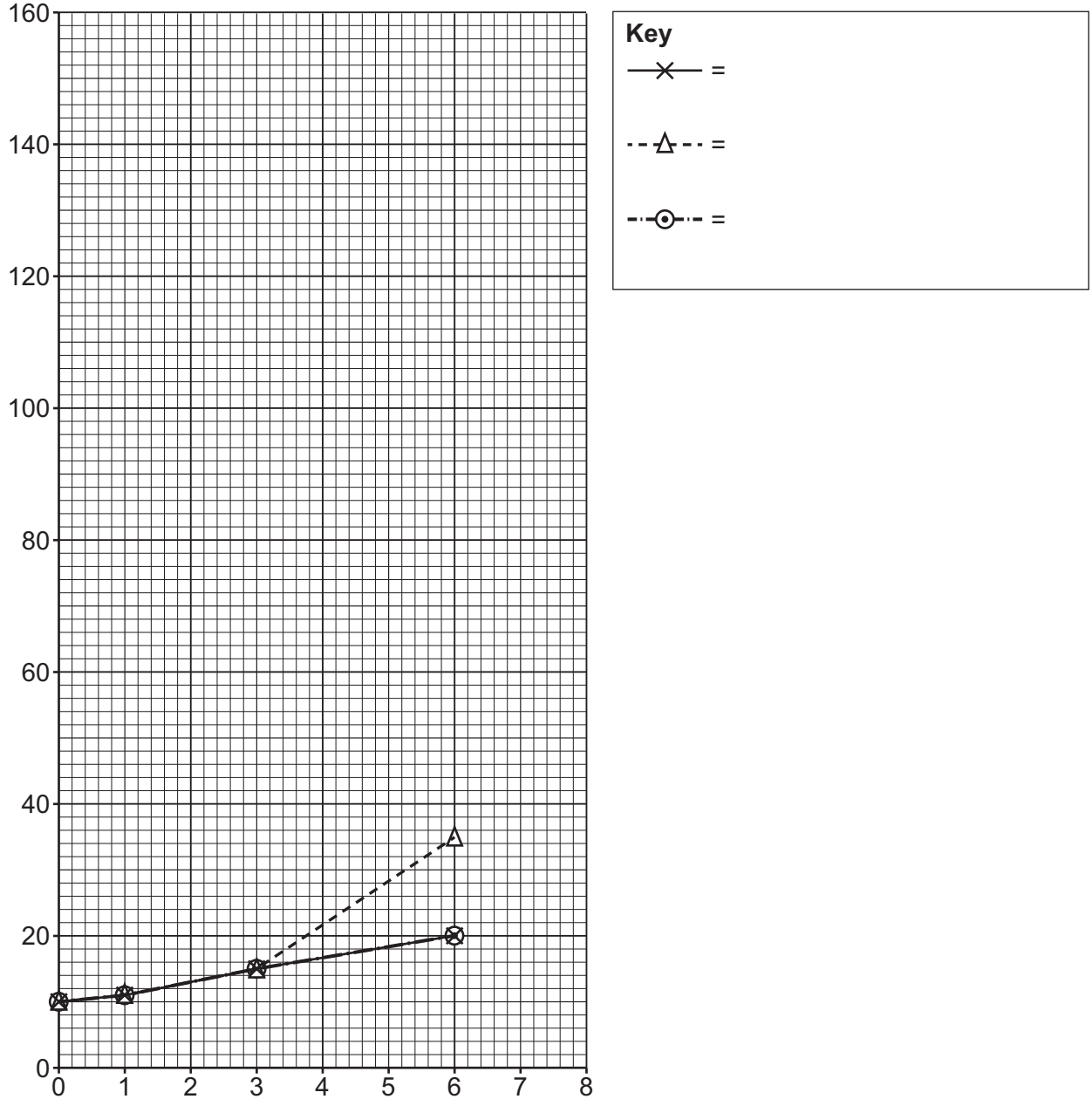

Fig. 2.2

[2]

(ii) Use Table 2.1 and Fig. 2.2 to compare the effect of EchAMP and bacitracin on the population growth of *E. coli*.

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(e) The scientists used *t*-tests to analyse the results.

The scientists compared the fluorescence emitted by *E. coli* after seven hours when exposed to:

- the negative control
- EchAMP.

(i) State a null hypothesis for this *t*-test.

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(ii) For *E. coli* exposed to the negative control, after seven hours:

- the mean of nine fluorescence measurements was 140 au
- the sample standard deviation was 8 au.

For *E. coli* exposed to EchAMP, after seven hours:

- the mean of nine fluorescence measurements was 100 au
- the sample standard deviation was 10 au.

The formula for calculating a *t*-test is:

$$t = \frac{\left|\bar{x}_1 - \bar{x}_2\right|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

key to symbols

$\bar{x}$ = mean

s = sample standard deviation

n = sample size (number of observations)

Calculate a value of *t* for these data.

Show your working and state your answer to **four** significant figures.

t = ... [3]

(iii) The *t* value calculated by the scientists was significant.

After reading the scientific paper published by the scientists, a student wrote the conclusion:

EchAMP would make a good treatment for bacterial infections in the human digestive system.

Suggest **four** reasons why this conclusion might **not** be valid.

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