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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

* 5 1 8 0 9 5 6 9 4 2 *

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **May/June 2024**

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. Any blank pages are indicated.

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1 Tree plantations are areas where trees are planted for a particular purpose. Some tree plantations increase the supply of wood for construction and fuel. In many plantations, fast-growing, alien tree species are planted.

Undergrowth is found in and around plantations, increasing plant biodiversity. Undergrowth is mainly made up of indigenous (native) small plants and shrubs.

Fig. 1.1 shows part of a plantation of eucalyptus trees.

Fig. 1.1

Bangladesh has many tree plantations as part of a national tree-planting programme.

Two fast-growing, alien tree species planted in Bangladesh are acacia, *Acacia auriculiformis*, and eucalyptus, *Eucalyptus camaldulensis*.

Acacia and eucalyptus are considered to be invasive species as they outcompete indigenous tree species such as sal tree, *Shorea robusta*, and mango, *Mangifera indica*.

Scientists carried out an investigation into the biodiversity of plant species in the undergrowth in plantations of alien trees compared with the undergrowth in plantations of indigenous trees.

The hypothesis that the scientists tested was stated as:

The undergrowth in plantations of alien tree species will have a lower biodiversity of plant species than the undergrowth in plantations of indigenous tree species.

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

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For the investigation, plantations were selected within the same region of Bangladesh with the same environmental conditions.

- Three plantations of each tree species were selected: acacia, eucalyptus, sal tree and mango.
- A plot measuring 36 m by 36 m was studied within each plantation.
- For each plot, belt transects were used to collect the data needed to determine Simpson's index of diversity (*D*).

For each type of plantation, Simpson's index of diversity (*D*) was calculated for the plant species in the undergrowth.

Each plot was studied in April, July and November.

(ii) Identify **two** variables the scientists standardised in this investigation.

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(b) The scientists used belt transects to investigate the undergrowth of each plot.

Describe how you could use belt transects to collect the data needed to determine Simpson's index of diversity (*D*) of the undergrowth in each of the plots.

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

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Table 1.1 shows the Simpson's index of diversity (*D*) values the scientists obtained for the different plantations during April, July and November.

Table 1.1

month	Simpson's index of diversity (*D*) for undergrowth plant species in plantation			
	acacia	eucalyptus	sal tree	mango
April	0.90	0.87	0.94	0.90
July	0.86	0.86	0.94	0.86
November	0.87	0.83	0.94	0.88
mean	0.88	0.85	0.94	0.88
± *s*	±0.02	±0.02	±0.00	±0.02

s = standard deviation

(c) State **and** explain whether the data in Table 1.1 support the hypothesis:

The undergrowth in plantations of alien tree species will have a lower biodiversity of plant species than the undergrowth in plantations of indigenous tree species.

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In China, a different group of scientists investigated whether the roots of invasive plant species produce chemicals that have an effect on the growth of other plants.

The scientists prepared an extract of the roots of staghorn sumac, *Rhus typhina*. Staghorn sumac is an invasive plant species.

The scientists prepared a stock solution of the root extract with a concentration of 10 mg cm^{-3}. The scientists then used the stock solution to prepare solutions with different concentrations of root extract.

(d) **(i)** Describe how the scientists could use the stock solution to prepare **50 cm^3** of solutions of the root extract with concentrations of 2.5 mg cm^{-3} and 7.5 mg cm^{-3}.

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In some regions of China, marigold plants, *Tagetes erecta*, are grown commercially.

In the investigation into the effect of staghorn sumac root extract on the growth of marigolds, the scientists carried out the procedure described in step 1 to step 5.

step 1 Prepare five containers, each with five marigold plants grown from seed.

step 2 Add 20 cm^3 of distilled water to one of the containers. This is the control.

step 3 Add 20 cm^3 of the root extract concentrations to the other four containers, so that each container has a different concentration of root extract.

step 4 Repeat step 2 and step 3 each day for 60 days.

step 5 After 60 days, remove the marigold plants from the soil and untangle the roots. Measure the length of the longest root for each plant.

The scientists replicated this procedure twice and calculated the mean maximum root length for the control and for the root extract concentrations.

The results are shown in Table 1.2.

Table 1.2

root extract concentration / $mg\,cm^{-3}$	**mean maximum root length after 60 days / mm**
control	163.0
2.5	153.2
5.0	156.4
7.5	152.0
10.0	141.6

(ii) Using the data in Table 1.2, calculate the percentage change in the mean maximum root length between the control and the roots treated with 10 $mg\,cm^{-3}$ root extract concentration.

Show your working and record your answer to 3 significant figures.

percentage change ..... [3]

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(e) A student suggested that this investigation could be improved.

With reference to the method used and the data in Table 1.2, state **and** explain **three** ways to improve confidence in the results.

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(f) To investigate the effect of the different root extract concentrations on the diversity of the microorganisms in soil, the scientists:

- took samples of soil from each of the containers
- identified and counted the number of species of microorganism present in the samples
- calculated the Simpson's index of diversity (*D*) values for the species of microorganism in each of the soil samples.

State **two** variables the scientists should have standardised when taking the soil samples.

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2 Tumours may be described as benign or malignant. Malignant tumours can lead to greater complications for the person with the tumour.

Early identification of tumours, particularly malignant tumours, is important for effective treatment. Benign tumour cells and malignant tumour cells can look similar when viewed using a light microscope.

Some scientists wanted to develop a diagnostic test to identify tumour cells as benign or malignant. The scientists investigated whether the diameter of the cell nucleus could be used to identify the type of tumour cell as benign or malignant.

The scientists used a light microscope with a calibrated eyepiece graticule to measure the diameter of the nuclei of stained tumour cells.

Fig. 2.1 shows a photomicrograph of stained tumour cells viewed using a light microscope.

An eyepiece graticule was placed across the nucleus of one of the tumour cells.

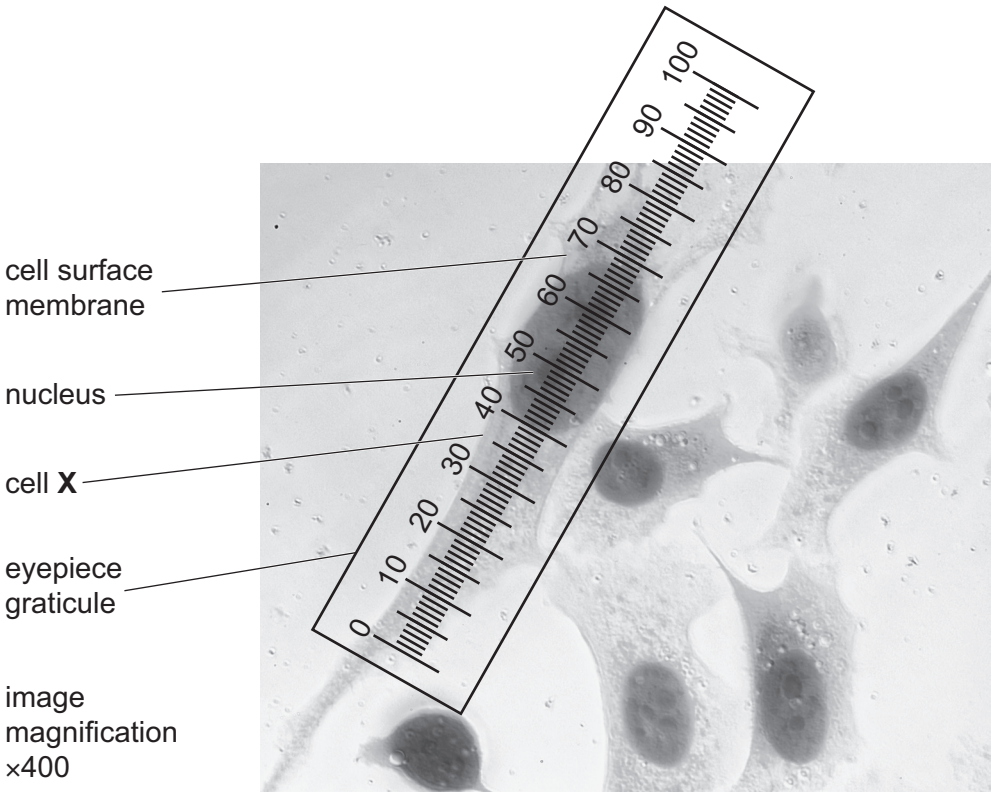

Fig. 2.1

The calibration of the eyepiece graticule scale is:

one eyepiece graticule division = 320 nm

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(a) Use the calibration of the eyepiece graticule scale to calculate the actual diameter of the nucleus of cell **X**, shown in Fig. 2.1.

Show your working and state your answer in μm.

actual diameter of the nucleus of cell **X** = ... μm [3]

(b) For the investigation into whether the diameter of the nucleus could be used to identify the type of tumour cell, tumours of the thyroid gland (an endocrine gland) were used.

For the diagnostic test the scientists carried out a procedure using two different stains.

step 1 50 people diagnosed with benign tumours and 24 people diagnosed with malignant tumours were selected.

step 2 A sample of tumour cells was removed from the thyroid gland of each person.

step 3 The cells were stained with either Papanicolaou stain (Pap) or haematoxylin and eosin stain (H&E).

step 4 Samples were viewed using a light microscope with a magnification of ×400.

step 5 In each sample, the diameters of 100 nuclei were measured.

step 6 The measurements were made by one of the scientists who did not know the type of tumour cell they were measuring.

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Table 2.1 shows the results of the investigation.

Table 2.1

category	mean nuclear diameter / μm	standard deviation / μm	standard error / μm
total benign cells (50 people) 5000 cells:	7.3	±0.8	±0.011
• Pap-stained cells (41 people) 4100 cells	7.3	±0.7	±0.011
• H&E-stained cells (9 people) 900 cells	7.2	±1.0	±0.033
total malignant cells (24 people) 2400 cells:	9.0	±0.6	±0.122
• Pap-stained cells (18 people) 1800 cells	9.0	±0.7	±0.016
• H&E-stained cells (6 people) 600 cells	8.8	±0.5	±0.020

(i) Suggest how the scientists can standardise the method of measuring the diameter of the 100 nuclei in step 5, so that valid comparisons can be made between benign and malignant tumour cells.

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(ii) Identify **one** variable that the scientists have standardised in step 1 to step 6, **other than** details of the method of measurement of the nuclei.

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(iii) The scientists used a *t*-test to compare the mean nuclear diameter of the Pap-stained cells and the H&E-stained cells in Table 2.1.

State a null hypothesis for the *t*-test.

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(iv) The *t*-value the scientists calculated had a probability (p) value greater than 0.25 ($p > 0.25$).

State **one** conclusion that can be made about the effect of using the two stains, Pap and H&E, on the mean nuclear diameter of the cells.

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(v) State **and** explain **one** conclusion that can be made from the data in Table 2.1 when comparing the results for the 5000 benign cells and the 2400 malignant cells.

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(vi) At the end of the investigation, the scientists evaluated their procedure and results. They identified some disadvantages of using the procedure as a diagnostic test.

Suggest **and** explain **two** disadvantages of this procedure as a diagnostic test.

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[Total: 11]

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