Cambridge Assessment International Education

Example Responses – Paper 5

Cambridge International AS & A Level Biology 9700

For examination from 2022

Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge International AS & A Level Biology 9700.

This booklet contains responses to all questions from June 2022 Paper 51, which have been written by a Cambridge examiner. Responses are accompanied by a brief commentary highlighting common errors and misconceptions where they are relevant.

The question papers and mark schemes are available to download from the School Support Hub.

9700 June 2022 Question Paper 51

9700 June 2022 Mark Scheme 51

Past exam resources and other teaching and learning resources are available from the School Support Hub.

Question 1

1 A group of students investigated two habitats: dense woodland and open grassland.

- Trees are the dominant plants in woodland. The trees form a canopy under which flowering herbs, small shrubs and grasses grow.
- Grasses are the dominant plants in grassland. The grasses and small flowering plants form a continuous ground cover with only a few small shrubs present.

Fig. 1.1 shows photographs of the two areas.

Fig. 1.1

The students decided to compare the adaptations for reducing water loss in the plants growing in each area.

The students suggested the following hypothesis:

The density of stomata will be higher in plants found in the woodland habitat than in the grassland habitat.

(a) **(i)** State the independent **and** dependent variables in this investigation.

independent variable type of habitat

dependent variable density of stomata [2]

The students collected leaves from a number of different plant species in each area. To study the density of stomata on leaves, impressions of the epidermis can be made using clear varnish.

- One surface of each leaf is painted with a thin layer of varnish.
- The varnish is left to dry.
- Clear sticky tape is applied to the leaf over the varnished area, to make a leaf impression.
- The tape and varnish are removed and stuck to a microscope slide.
- The leaf impression on the slide is viewed using a microscope.

Fig. 1.2 shows the microscope image of one leaf impression prepared in this way.

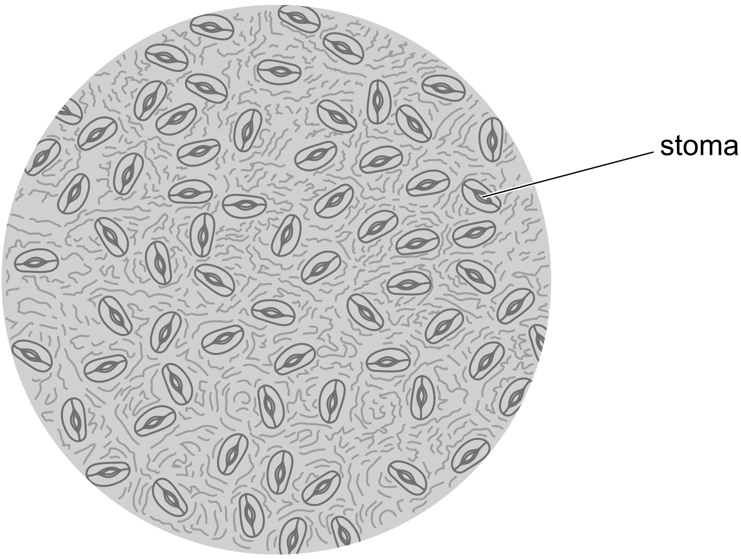

Fig. 1.2

(ii) State the measurements that the students need to make to determine the stomatal density in Fig. 1.2.

The students must measure the diameter of Fig. 1.2 as well as the number of stomata.

Examiner comment

- A common incorrect response was that the area of Fig. 1.2 should be measured. It was important to remember that 'area' is not measured directly; a mention of diameter or radius (of Fig. 1.2) was required to achieve marking point 1.
- Candidates that gave reference to πr^2 are encouraged to describe the meaning of formula symbols.
- Centres are encouraged to review the use of these terms of measurement in their teaching of microscopy.

(iii) Calculate the stomatal density in Fig. 1.2.

Space for working.

$$\text{density} = \frac{\text{number of stomata}}{\pi r^2} \qquad \text{density} = \frac{69}{\pi(36.5)^2}$$

stomatal density = 0.0165 mm^{-2} [2]

(iv) Describe how the students could gather data to compare the stomatal density of plants growing in the woodland and the grassland habitat.

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

You should **not** repeat details of the method for making the leaf impressions.

The students will use random sampling in both the grassland and woodland habitat by laying down two measuring tapes and using a random number generator to give coordinates for sampling.
Five leaves should be taken from the same species of plant in both habitats.
Leaves should be the same age and using the same magnification for all impressions are standardised variables.
Using the microscope, the students should count the number of stomata in the field of view.
The experiment in both habitats should berepeated twice more, and a mean stomatal density calculated. Gloves should be worn in case the students have allergies to plants. [6]

Examiner comment

- The ecological focus of this investigation was challenging, and a variety of field work is encouraged to give familiarity with a range of techniques.
- Candidates needed to first address how to collect the leaves to be used in the investigation by a random or systematic sampling. This was awarded marks when a suitable method was explained such as using a random number generator to find coordinates or collecting leaves at regular intervals along a line.
- Candidates are encouraged to select at least five values for the independent variable, in this case by collecting at least five leaves from both habitats.
- Candidates needed to list at least three variables which should be kept the same in the investigation, otherwise they would affect the dependent variable. Valid control variables included the ‘age of the leaf’ or the ‘position on the plant’ that the leaf was taken from. The ‘age of the plant’ was not a valid control variable, as old plants will have young leaves. It would also not be possible to standardise the size of leaves growing in the different habitats.

- The rest of the investigation was laboratory based, although as instructed in the question, candidates were not expected to repeat details of the method for making leaf impressions. Careful reading of the question is encouraged to avoid unnecessary writing.
- Some candidates attempted to control variables such as temperature, light intensity, and pH; this was not necessary as they do not affect stomatal density. Instead, candidates should control the leaf surface viewed and the magnification of the microscope. Very low and very high magnifications would not work, as there would be either too many or too few stomata visible within the field of view.
- Candidates needed to describe how the dependent variable is measured clearly. In this investigation, using the microscope to view and actively count the stomata.
- Most candidates successfully suggested repeating the experiment in each habitat at least twice and calculating a mean. Use of the correct scientific terminology was required in this context, using 'mean' not 'average'.
- No investigation is totally without risk, so stating that this investigation involved no risks or needed no precautions was not awarded any marks. Outlining the hazard, risk, and appropriate mitigation is required for investigations. For example, plants may cause allergies, so therefore wear gloves / mask.

(b) The students found a published investigation on the effect of light intensity on stomatal density in the species *Lycopersicon esculentum*.

Two plants of *Lycopersicon esculentum* were selected. One was grown in high light intensity and the other was grown in low light intensity.

The results are shown in Table 1.1.

Table 1.1

leaf number	**high light intensity**			**low light intensity**		
	number of stomata $\times 10^3$		leaf area / cm^2	number of stomata $\times 10^3$		leaf area / cm^2
	upper surface	lower surface		upper surface	lower surface	
1	1634	3131	496	18	1277	160
2	1482	5072	509	10	906	115
3	1865	6365	637	14	1398	171
mean	1660	4856	547	14	1194	149

(i) Calculate the percentage decrease in mean leaf area for leaves grown in low light intensity compared with those grown in high light intensity.

Your answer should be expressed as a whole number.

$$\frac{149 - 547}{547} \times 100 = -73\%$$

.......................−73....................... % [1]

(ii) The scientists who carried out the published investigation concluded that:

plants grown in higher light intensity have higher stomatal density **only** on the upper surface of the leaves compared to plants grown in lower light intensity.

Evaluate whether or not the data in Table 1.1 supports this conclusion.

The data supports this conclusion as the mean stomatal density on the upper surface of the leaves is higher for high light intensity compared to the upper surface at low light intensity.

For example, the stomatal density on the upper surface at high light intensity is 3035 cm^{-2} whereas the stomatal density on the lower surface is only 94 cm^{-2}.

However, the data does not support this conclusion as no statistical test was carried out and only one species of plant was investigated, so this conclusion cannot be supported for all plants.

[3]

[Total: 16]

Examiner comment

- The tabulated data and suggested conclusion in this question needed to be read very carefully.
- The command word 'evaluate' required a response on both sides of the argument. Some candidates restricted their answers to only 'support' or 'not support' the conclusion; this meant their answers were unable to achieve full marks.
- Several candidates referred to the number of stomata on the surfaces of leaves; such references were not specific to the conclusion presented.
- Reading the table headings carefully in Table 1.1 was required to calculate the stomatal density of the leaf surfaces by dividing the number of stomata by the leaf area. Correct calculations of stomatal density could then be used to provide data and additional credit for either side of the evaluation.
- Centres are encouraged to teach candidates in making clear 'for' and 'against' statements as part of their evaluation.

Question 2

2 Human immunodeficiency virus (HIV) is an example of a virus that spreads from other animals to humans where it causes disease.

Fig. 2.1 shows a chimpanzee, *Pan troglodytes troglodytes*. Chimpanzees can carry the simian immunodeficiency virus (SIV) which is similar to HIV.

It is thought that chimpanzees who carry antibodies for SIV do not become ill if infected with HIV.

This has been investigated by scientists developing potential vaccines for HIV.

Fig. 2.1

Tests were carried out to see if antibodies against SIV present in chimpanzees bind to HIV antigens.

Test strips were prepared which contained several different HIV antigens.

When samples are applied to the test strip a line will appear in the control region. If the sample contains antibodies to the HIV antigens present on the strip, additional lines will also appear.

Samples of chimpanzee faeces were collected from a number of sites in Gabon in central Africa.

The faecal samples were prepared and then applied to the test strips.

(a) **(i)** Suggest why the investigators collected faecal samples from chimpanzees rather than plasma samples.

No harm will be done to the chimpanzees by collecting faecal samples.

.... [1]

(ii) Suggest a method for preparing the faecal samples before applying them to the test strips.

The samples should be made into a liquid by adding water to them and then filtered to remove any undissolved material.

[2]

(iii) The scientists collected 608 faecal samples from 224 individual chimpanzees.

Suggest a laboratory method that could be used to identify whether two faecal samples belong to the same individual or not.

Gel electrophoresis could be used.

[1]

Samples from humans and chimpanzees were applied to the test strips.

1. Plasma samples from humans who are infected with HIV (HIV+)
2. Plasma samples from humans who are not infected with HIV (HIV–)
3. Faecal samples from chimpanzees who are infected with SIV (SIV+)
4. Faecal samples from chimpanzees who are not infected with SIV (SIV–)

The results are shown in Fig. 2.2.

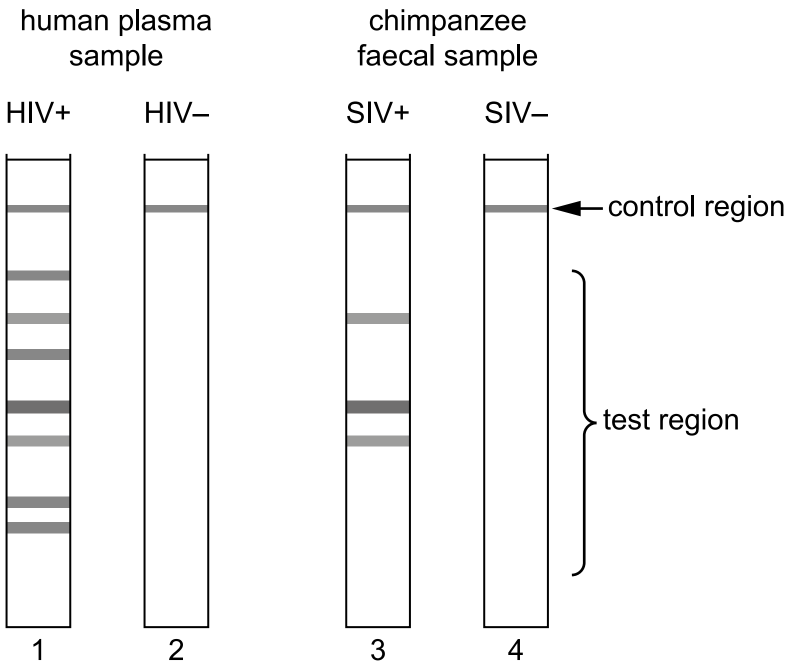

Fig. 2.2

(b) Suggest conclusions that can be drawn from the results shown in Fig. 2.2.

Both HIV- and SIV- did not contain antibodies for the HIV antigens on the strip as no lines are shown. The SIV+ chimpanzee contains antibodies to the HIV antigens on the strip. There are three lines which are in the same location for the SIV+ chimpanzee and the HIV+ human. [3]

Examiner comment

- When asked to suggest conclusions, candidates are encouraged to compare across two or more data sets to achieve high marks.
- Precise and correct use of biological terminology is essential for questions on the immune system, and centres are encouraged to practice the use of such terms in unfamiliar contexts.
- Take care to be unambiguous. Candidates often noted that the lines / bands on Fig 2.2 were matching for HIV+ and SIV+ individuals; however, a clear statement that 3 lines match was required.

(c) HIV infection may lead to HIV/AIDS which, if left untreated, may cause death. The effects of SIV infection in chimpanzees are usually less severe.

A group of scientists investigated the effect of SIV infection on the life expectancy of a population of chimpanzees living in the wild.

- The population of 94 chimpanzees was observed for a nine-year period.
- The ages of all the chimpanzees in the population were estimated.
- The chimpanzees were observed each day.
- The numbers of dead and absent chimpanzees were recorded each day.
- Faecal samples of all the chimpanzees in the population were tested for SIV antibodies.

The results of the investigation are summarised in Table 2.1 and Fig. 2.3.

Table 2.1

SIV status	original number of chimpanzees in population	number of chimpanzees who died or disappeared during the study
SIV–	77	11
SIV+	17	7

The percentage of chimpanzees of each age remaining in the population are represented in Fig. 2.3.

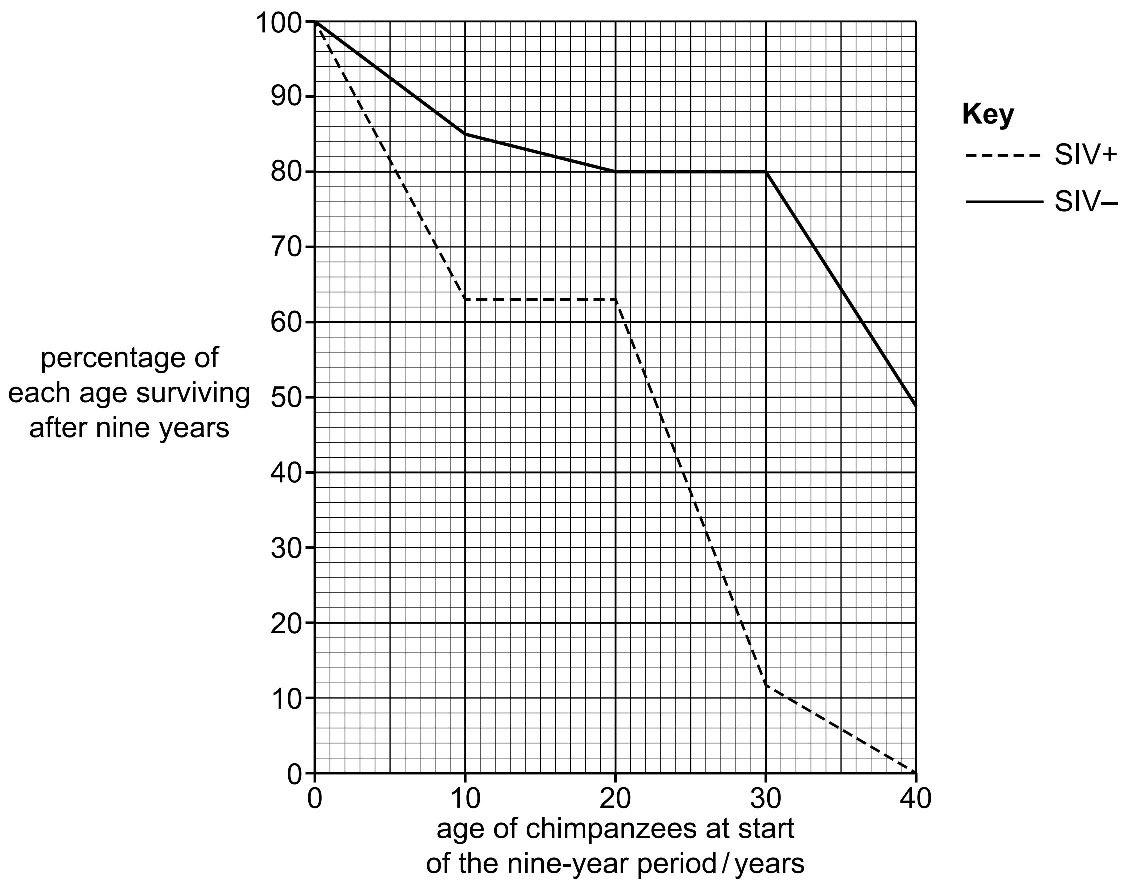

Fig. 2.3

(i) Fig. 2.3 presents the results of the investigation as the percentage of chimpanzees surviving at each age.

Explain the advantages of presenting the results of this study as percentages.

Percentages allow valid comparisons to be made when the initial number of chimpanzees in each group is different.

[2]

Examiner comment

Candidates are encouraged to fully develop their line of reasoning and be scientific in their terminology. In this question, candidates often stated that calculating the percentage of chimpanzees surviving made comparisons easier or more accurate; this was not creditworthy. Those candidates that suggested that the comparisons would be valid, or fair were able to gain the first marking point.

The investigators concluded that chimpanzees infected with SIV die at an earlier age than uninfected chimpanzees.

The investigators decided to test their conclusion statistically.

(ii) State a null hypothesis the scientists could make before carrying out their statistical test.

There is no difference in the age of death between chimpanzees that are SIV+ and SIV–

[1]

Examiner comment

- Candidates should consider first whether the data being compared is continuous or categorical to determine the correct wording of the null hypothesis.
- Centres are encouraged to practice writing null hypothesis in a range of different experimental contexts.
- Reading the question carefully to determine which data are being compared is essential to be able to construct the null hypothesis appropriately.

(iii) The investigators carried out their statistical analysis and found that they could reject the null hypothesis at $p < 0.05$.

Explain what is meant by the term $\boldsymbol{p < 0.05}$.

P<0.05 is the probability at which the critical value is chosen at the appropriate degrees of freedom. It means that there is a less than 5% probability that the results are due to chance. [2]

Examiner comment

- Precision with statistical terminology was required and gaining full marks on this question proved challenging.
- Less successful responses were either too vague to be awarded full marks, or were unsure of the difference between chance and probability when interpreting data.
- As well as using the results of chi-squared tests and t-test together with the relevant probability tables, candidates should consider the reasons for the steps taken in statistical analysis.

(iv) Suggest why the data presented in Fig. 2.3 may not be an accurate representation of the effect of SIV infection on the life expectancy of the chimpanzees.

The deaths in Fig 2.3 may not all be due to SIV, but may be due to other reasons, for example predation or other diseases. In addition, the ages of the chimpanzees were estimated, so may not be accurate.

[2]

Examiner comment

- Candidates who noticed that the death of chimpanzees may not be due to SIV were awarded marks; and for full marks they could give specific examples of these other reasons such as hunting, predation or malnutrition.
- Candidates should use the information in the question strand for assistance when faced with the ‘suggest’ command word to help them formulate a valid criticism of the data.

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