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A LEVEL

Examiners' report

BIOLOGY B (ADVANCING BIOLOGY)

H422

For first teaching in 2015

H422/03 Summer 2024 series

Version 1

Contents

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate answers is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from OCR.

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Paper 3 series overview

H422/03 assesses candidates on their knowledge and understanding of the practical components of the specification, Advanced Level GCE Biology B. It is one of three examination papers for the qualification.

This paper uses structured questions, both short answer and extended response, to test:

- candidates' knowledge and understanding practical outcomes and subject content from the entire specification
- candidates' ability to apply their knowledge to new practical contexts and to solve problems and perform calculations
- candidates' ability to analyse data, interpret scientific information and evaluate information and data accordingly.

This unit has a higher weighting for practical skills marks which cover planning skills, data analysis, interpretation of data and application of knowledge and understanding. To that end, candidates who have greater opportunities to develop practical skills through consistent and regular practical work are more able to develop these skills and perform at a higher level.

As with previous sessions, the June 2024 paper had questions set in new contexts and required candidates to demonstrate their ability to recall practical procedures as well as construct outline practical procedures. To do well in this unit candidates need to be able to recall and develop their own practical experiences to the new contexts.

Practical work should be integrated into the programme of study of Advancing Biology. Where candidates had opportunities to extensively experience practicals in laboratory situations, this clearly allowed them to answer questions on this paper more confidently. In this specific examination paper, this was noted in questions relating to microscopy and the extended Level of Response questions. Candidates are more likely to be able to demonstrate competency in these areas when they are routinely and consistently provided with practical experience during their learning journey.

Assessment and competency of the Common Practical Assessment Criteria (CPAC) are an integral of Practical endorsement and essential for the specification requirements. Centres must ensure that they provide sufficient practical opportunities for candidates to undertake assessments of all practical skills components. It should also be noted that it is essential that candidates are able to develop their understanding of the theory of practical activities as well as any procedures, as outlined in the specification, which may not be possible to replicate in a school laboratory e.g. electrophoresis. Centres are reminded that any practical activities carried out during lessons can provide candidates with opportunities to develop both practical skills and theoretical understanding.

Support and guidance with practicals and developing a positive practical experience can be found on 'Teach Cambridge' as well as the 'Positive about Practical' site.

There are also supporting documents available for teachers and candidates:

- OCR practical skills handbook
- OCR maths skills handbook
- Practice PAG materials

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Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• were confident in manipulating data to perform calculations such as the Hardy-Weinberg equation and Simpson's Diversity Index • could recall key steps in practical procedures relating to DNA purification, separation and visualisation • could develop an appropriate method to investigate the difference in core body temperature between two groups of people with different statuses for a specified medical condition • could interpret data and identify limitations of the data collection process • accurately produce biological drawings that represented the photomicrograph, rather than draw theoretical images • suggest appropriate units for the measurement of translocation.	• were unable to demonstrate precise biochemical structure of ATP, DNA and tRNA • did not show workings in calculations preventing examiners being able to credit some marks for intermediate working when their final answer was incorrect • confused the process of PCR and DNA purification • confused the procedure to measure blood pressure and pulse rate • could recall the principle of degenerate code but found it difficult to link this to the impact of different types of mutations • showed confidence in generic safety considerations for dissections • were confident in describing the trend shown by the data but less confident in the use of appropriate key terms relating to correlations and the strength of the correlation • described the process of random sampling rather than how to set up a transect across the ecological site.

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Question 1 (a)

1

(a) ATP, DNA and tRNA are molecules that have some similarities but several differences in structure.

The table lists structural features of ATP, DNA and tRNA.

Use ticks (✓) to indicate the structural features that are present in ATP, DNA and tRNA.

Structural feature	ATP	DNA	tRNA
Contains adenine			
Contains ribose			
Has hydrogen bonds within its molecular structure			

[3]

Candidates did not perform well on this question, often appearing to assume that DNA contained ribose and failing to recognise that tRNA contained hydrogen bonds within its structure.

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Question 1 (b)*

(b)* Different methods are used to study DNA.

Outline the methods you would use to:

- purify DNA from plant tissue by precipitation
- separate the DNA into fragments using gel electrophoresis
- visualise the DNA bands once they have been separated.

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..... **[6]**

A significant number of candidates were unable to recall and describe the outline steps for purifying DNA. Many described the process of purification of DNA incorrectly by referring to the use of PCR and/or focusing on the process of centrifuging a tissue sample to form a pellet of DNA. Some candidates demonstrated detailed knowledge of the use of different buffers in electrophoresis. However, several candidates did not focus on the command word of the question and instead of outlining procedural steps they described how DNA is actually separated during the process e.g. due to size of the fragments and the charge on the phosphate group, rather than the procedural steps.

Misconception

Candidates confused the process of DNA purification with PCR.

OCR support

The delivery guide on Gene technologies offers ideas and resources that can be used during teaching to support with the delivery of this topic.

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Question 2 (a)

2 A rare disease is defined as a disease that affects less than 0.05% of a population.

(a) NGLY1 deficiency is a rare disease caused by mutation in the *NGLY1* gene.

People with NGLY1 deficiency produce faulty N-glycanase 1, which is an enzyme that removes abnormal proteins.

Symptoms of NGLY1 deficiency include weak muscle tone and delayed development of speech and motor skills.

Several different mutations in the *NGLY1* gene are known to cause NGLY1 deficiency. Two of these mutations are:

- a substitution mutation of cytosine (C) to thymine (T) that causes relatively mild symptoms
- a deletion mutation of C that causes severe symptoms.

Suggest why the deletion mutation of C causes more severe symptoms than the substitution mutation.

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..... **[2]**

Several candidates correctly recalled that the genetic code is degenerate but then could not relate this to the context of the question. Many did not appreciate that if the same amino acid was substituted as a result of a single base mutation then the polypeptide chain, and hence protein, would be unaltered and to that end it would not cause **any** symptoms. Higher performing candidates correctly recognised the impact of the deletion mutation resulting in a frame shift and consequently impacting on a larger number of amino acids. Few candidates then related this to the alteration of the active site of the enzyme thus making it unable to break down abnormal proteins.

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Question 2 (b) (i)

(b) A student researches NGLY1 deficiency and obtains secondary data for the prevalence of the disease.

The student discovers that:
- NGLY1 deficiency is a recessive genetic disease
- 75 people in the world had been diagnosed with NGLY1 deficiency in 2022
- the world population in 2022 was 7 880 000 000.

(i) Using the secondary data obtained by the student and the Hardy–Weinberg principle, estimate the number of people in the world that were heterozygous carriers of a mutant *NGLY1* allele in 2022.

Use the equations:

$p^2 + 2pq + q^2 = 1$
$p + q = 1$

Give your answer to **4** significant figures.

Number of heterozygous carriers in the world = ... **[3]**

Some candidates showed confidence and competence in calculating '2pq' and then determining this fraction of the whole population to gain 2 marks. Most candidates, however, were unable to calculate 'p' or 'q' correctly with many incorrectly rearranging the 2 formulae.

Calculation:

Proportion of people in the word with NGLY1 = 75/7880000000 = $9.95177665 \times 10^{-9}$

$q^2 = 9.95177665 \times 10^{-9}$

$q = \sqrt{(9.95177665 \times 10^{-9}} = 0.00009755904$

$p + q = 1$

p = 1 - 0.00009755904 = 0.99990244

Proportion of people in the word that are heterozygous (2pq) = 0.000195098

0.000195098 x 7 880 000 000 = 1537372

to four significant figures = 1537000

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Misconception

Many did not recall that 2pq is the proportion of heterozygotes in the population. Centres are encouraged to provide sufficient opportunities for candidates to practice the manipulation of data to determine 'p' and 'q' values and then to determine numbers of populations which are likely to be homozygous dominant, homozygous recessive and/or heterozygous.

Question 2 (b) (ii)

(ii) Suggest **two** reasons why the use of the Hardy–Weinberg principle might **not** give an accurate estimate of the number of people in the world who are carriers of a mutant *NGLY1* allele.

1 .....

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2 .....

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[2]

Many candidates correctly recalled the assumptions made by the Hardy-Weinberg principle with common answers referring to random mating and immigration. Those referring to mutations did not always specifically refer to new mutations occurring, in this context.

Question 2 (c)

(c) The effect of NGLY1 deficiency on muscle tissue has been studied by dissecting muscle tissue and observing it under a microscope.

Describe **two** safety precautions that should be taken when dissecting muscle tissue.

1 .....

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2 .....

.....

[2]

The most common answers here were the reference to the use of (non-latex) gloves and when cutting to cut away from the body to minimise the risk level. Some candidates incorrectly referred to the use of aseptic techniques.

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Question 2 (d)

(d) Suggest why few clinical trials are carried out to test treatments for rare diseases.

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..... **[1]**

Many candidates lacked clarity and detail in their answers to this question either referring generically to the high cost of clinical trials or the idea of few people available to participate in the trials. Candidates should look to refer to the stages of clinical trials that require human participants and the impact of cost-benefit to the pharmaceutical company itself.

Question 2 (e)

(e) In 2022, the government of the UK announced a rare diseases action plan, which outlined ways to improve the diagnosis and treatment of rare diseases.

The use of information technology is viewed as an important tool in the future diagnosis and treatment of rare diseases.

Explain how information technology **and** research into the human genome could be used in the diagnosis and treatment of rare genetic diseases.

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..... **[2]**

Most candidates found this question difficult with few gaining full marks. Those that scored one mark mainly did so by referring to the use of information technology to generate large databases of genomic sequences. Very few candidates referred to the variations in SNPs being used to diagnose rare diseases or the knowledge of SNPs being used to develop drugs to specifically target those mutations/sequences.

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Question 3 (a)*

3 Hypothyroidism is a condition in which a person produces lower concentrations of the hormone thyroxine than normal. Thyroxine affects metabolic rate and has a role in the control of body temperature. Hypothyroidism causes a variety of symptoms.

(a)* During an investigation, a group of students plan to compare the core body temperature of people with hypothyroidism with people who do not have hypothyroidism.

Describe an experimental plan that would allow the students to collect enough data to be able to complete this investigation.

Your answer should include a method to measure core body temperature and a description of an appropriate statistical test with which to analyse the data.

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..... **[6]**

Some candidates wrote clear, detailed plans for their method and used sufficient numbers of subjects to collect sufficient data and provided details of an appropriate statistical test for the data. However, a significant number of candidates did not recognise that the question was asking them to compare the core body temperature between two groups of people, with and without hypothyroidism. Many assumed that the independent variable was not the presence or absence of the medical condition but the environmental temperature. Thus, they described changing the room temperature to generate five different conditions and consequently did not answer the question posed.

Candidates who did not achieve Level 3 usually did not mention appropriate details of safety considerations when designing a human physiology investigation.

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Exemplar 1

Your answer should include a method to measure core body temperature and a description of an appropriate statistical test with which to analyse the data.

Variables (HT)
Independent – Have 1 group of people with hypothyroidism, and 1 group of people without hypothyroidism.
Dependent – The tympanic temperature of each of the people.
Controls – The same age of the people, similar BMI of the people, the same time of day for measurements, the same sex of the people, the same point in the menstrual cycle for women.
Method – Ensure all participants have given consent first.
1. Have 2 groups of people, 1 group of 25 males with hypothyroidism, and 1 group of 25 males without hypothyroidism.
2. Measure their core body temperature using the tympanic, inner ear measurement and a thermometer. This is the most accurate as the inner ear shares a bloodstream with the hypothalamus.
3. Repeat at least a further 2 times, on different days at the same time of day, calculating mean results and standard deviation. [6]

Extra answer space if required.

Statistics – Use an unpaired t-test to test for a significant difference in the mean core temperature between individuals with hypothyroidism, and those without. 48 degrees of freedom is used, at p=0.05.
Safety – If any people become unwell and experience severe hypothyroidism symptoms seek medical attention immediately.
Control experiment – Use another 25 males without hypothyroidism measuring their core ~~temp~~ body temperature.

The exemplar was well structured with details on how to carry out the method and an appropriate statistical test analysis. The exemplar scored 6 marks.

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Question 3 (b) (i)

(b) Hypothyroidism can affect blood pressure.

(i) Describe how to use a sphygmomanometer to measure the blood pressure of a person.

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..... **[4]**

Most candidates generally answered this question well.

Misconception

A common misconception, especially amongst the lower performing candidates, was that the use of the sphygmomanometer is used with the stethoscope to listen for the 'lub-dub' sounds of the heartbeat. These candidates confused the measurement of blood pressure with heart rate.

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Question 3 (b) (ii)

(ii) A person with hypothyroidism compares their blood pressure measurements with a friend who does not have hypothyroidism.

- The person with hypothyroidism has measurements of $\frac{134}{82}$ mmHg.
- The person without hypothyroidism has measurements of $\frac{119}{80}$ mmHg.

Explain what conclusions can be made from these measurements about the effect of hypothyroidism on blood pressure **and** describe the limitations of this comparison.

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..... **[4]**

Some candidates did not comment on the differences in the systolic **and** diastolic pressures in the two individuals but simply referred to the blood pressure, as a whole, being higher in the individual with hypothyroidism.

Question 3 (c)

(c) Hypothyroidism can affect the concentration of red blood cells in a person's blood.

State a method that could be used to measure the concentration of red blood cells in a person with hypothyroidism.

..... **[1]**

This question was well answered across the cohort.

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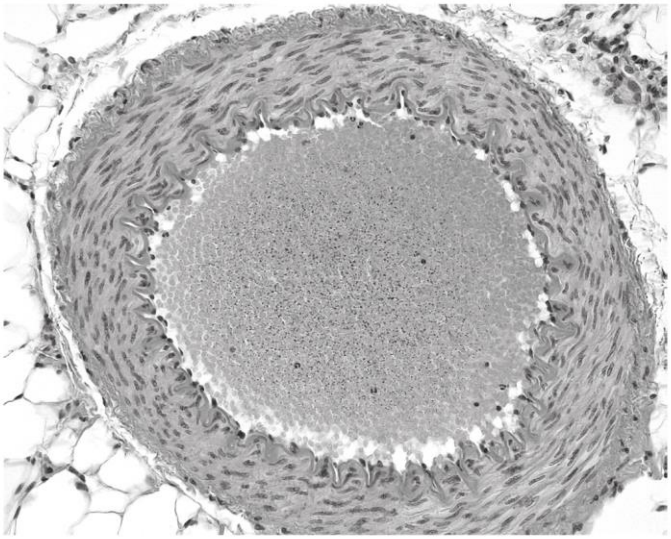
Question 3 (d)

(d) One effect of thyroxine on the cardiovascular system is to cause the dilation of arteries.

This is a photomicrograph of an artery.



Draw a plan diagram of the artery in the space below.

On your diagram, label the lumen and the muscle layer of the artery.

[3]

Few candidates gained full marks in this question. Most lost the second mark point for failing to draw an accurate representation of the artery as shown in the photomicrograph. Another common error was to failure to draw label lines with a ruler and horizontally.

OCR support

The Biological Drawing skills handbook can be shared with candidates when practising drawing of photomicrographs or when looking at specimens under the microscope. The learner's checklist table can also be used as to self-assess their drawings, during practical wo, classwork and/or homework.

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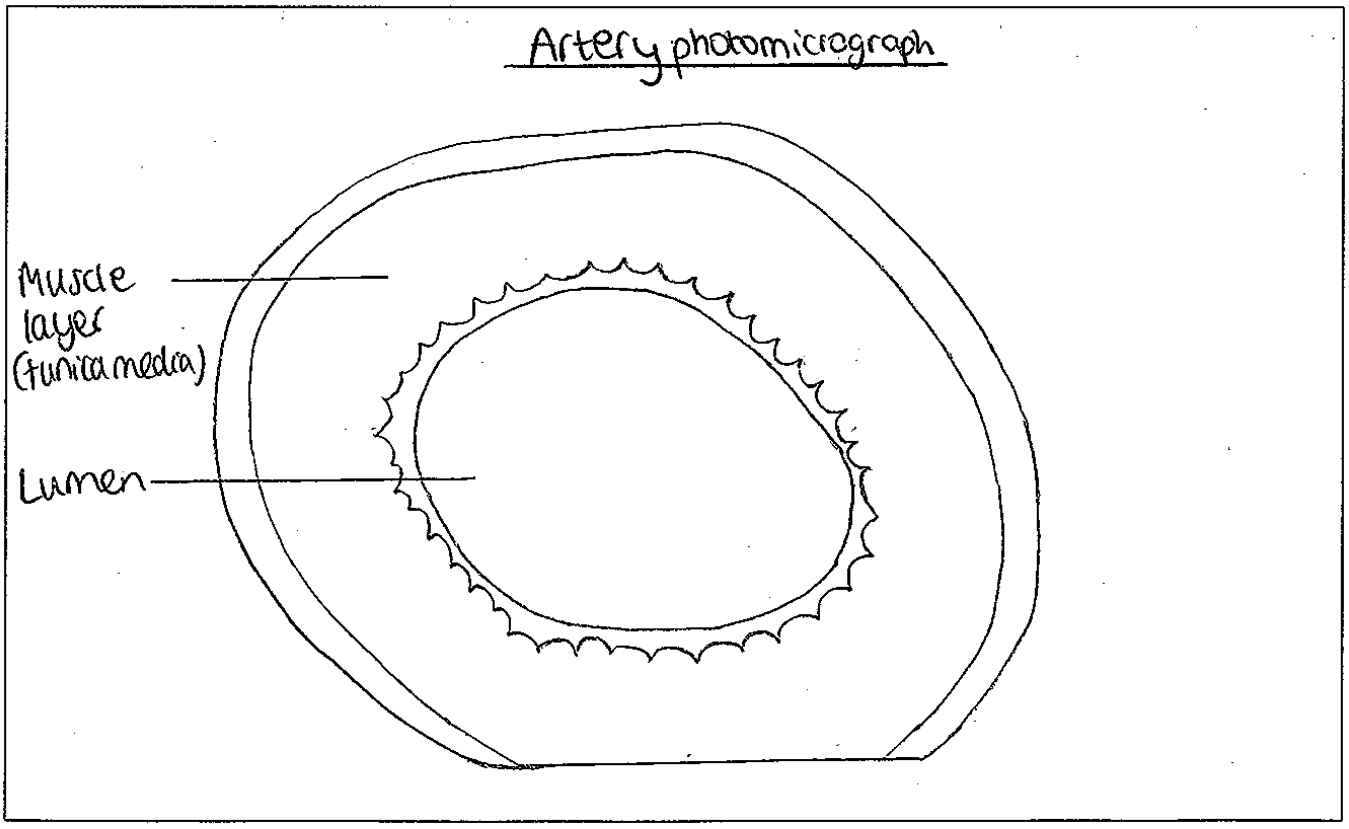
Exemplar 2



The candidate has made an accurate drawing that depicts only the shape and features of the artery as shown in the figure. Many candidates drew a full circular cross section of the artery which prevented the awarding of the second mark point. The candidate's drawing also fills more than 50% of the available space provided and has the 2 label lines drawn with a ruler touching the specific area (lumen and muscle layer). These drawing skills can be practiced using photomicrographs provided on the internet, for example from the Histology Guide website.

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Question 4 (a) (i)

4 Aphids are insects that feed on fluid from phloem sieve tubes of plants.

(a) Scientists studied the genetic diversity of six populations of melon aphid, *Aphis gossypii*.

The scientists used two measures of genetic diversity:

1. percentage of polymorphic loci
2. heterozygosity, which is the proportion of individuals that have two different alleles for a particular gene, averaged over many loci.

The scientists analysed the same 6280 gene loci for each aphid.

The results are shown in the table.

Population	Number of aphids sampled	Percentage of polymorphic loci	Heterozygosity
A	10	25.96	0.180
B	10	69.43	0.153
C	10	78.54	0.172
D	9		0.178
E	7	60.78	0.214
F	10	28.57	0.180

(i) The scientists observed more than one allele at 4936 gene loci for the nine aphids from population **D**.

Calculate the percentage of polymorphic loci in population **D**.

Percentage = ... **[2]**

Many candidates gained full marks. However, some did not give their answer to two decimal places to match the data in that column. Some candidates incorrectly rounded their answer and others were unsure how to calculate the percentage of polymorphic loci.

Calculation:

$$\text{proportion of polymorphic gene loci} = \frac{\text{number of polymorphic gene loci}}{\text{total number of loci}}$$

Proportion of polymorphic gene loci = 4936/6280 = 0.785987

To calculate percentage = 0.785987 x 100 = 78.5987

Rounding up to 2 decimal places to be consistent with the rest of the data in the table = 78.60 (Practical skills handbook – Appendix 5)

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Question 4 (a) (ii)

(ii) Evaluate whether the method used by the scientists allows an accurate comparison of genetic diversity in the six populations.

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..... **[3]**

Many candidates recognised that not only were a large sample of loci studied but also the same specific loci were studied in each population. Most also recognised that there was only a small sample size of aphids in each population.

Question 4 (b)

(b) Aphids are used in experiments to measure the rate of translocation in phloem tissue.

Suggest appropriate units for the rate of translocation in phloem tissue.

..... **[1]**

Few candidates gained this mark; many giving inappropriate units for the likely volume of assimilates (dm^3 or mm or mol dm^{-3}) and others inappropriate units for the time duration (yr^{-1}).

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Question 4 (c) (i)

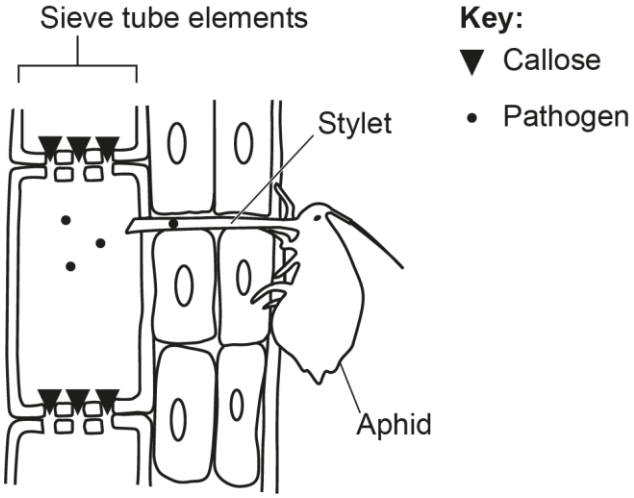
(c) An aphid feeds on a plant by inserting their stylet (a tube-like mouthpart) into a phloem sieve tube.

Pathogens can also pass through the stylet from the aphid to the phloem sieve tube.

Plants have evolved many different adaptations as defences against these pathogenic infections.

One defence adaptation is the production of callose, a type of polysaccharide, when infection is detected.

The diagram shows the deposition of callose in a plant in response to pathogenic infection after aphid feeding.



(i) Discuss whether the production and deposition of callose would have a significant impact on the mass of starch this plant is able to store in its sinks.

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..... **[3]**

This question required candidates to apply their knowledge of translocation to a new context. Few candidates referred to the idea of mass flow or used the term translocation. A few candidates correctly referred to the idea of many phloem sieve tubes and other potential routes for the assimilates to be moved to the sink(s). Some candidates incorrectly wrote about starch being moved in the phloem.

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Question 4 (c) (ii)

(ii) A scientist plans to compare the concentration of callose in the phloem tissue of two groups of plants of the same species:

- plants that have not had aphids feeding on them
- plants that have had aphids feeding on them in order to infect them with pathogens.

Describe **two** potential problems that the scientist will need to consider in order to take valid measurements in this investigation.

1 .....

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2 .....

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[2]

Several candidates did not read the question carefully and consequently referred to using plants of the same species. As this was quoted in the stem of the question no credit could be given for this. Other candidates gave less successful responses referring to problems with the aphids feeding or not feeding at all.

OCR support

Several candidates appeared uncertain in the term 'valid' and instead gave answers using terms such as accurate and reliable. A useful resource for all teachers and candidates is the Language of Measurement in Biology document.

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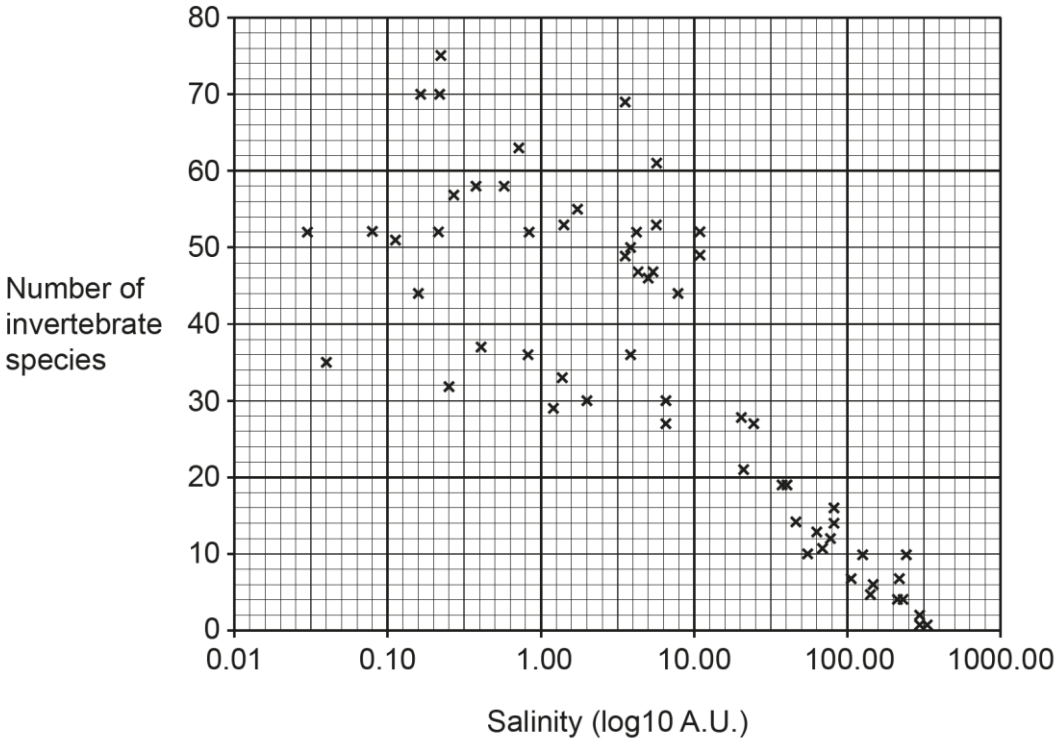
Question 5 (a) (i)

5 Human activities such as agriculture and urbanisation have resulted in an increase in salinity (the concentration of salts) in rivers and lakes.

(a) Western Australia contains many saltwater wetlands. In some cases, human activity has changed the salinity of these saltwater wetlands.

Scientists studied how the salinity of saltwater wetlands affects the number of invertebrate species present. They measured salinity and the number of invertebrate species in each wetland.

The graph shows the results of the study.



(i) Describe the results shown in the graph.

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..... **[2]**

Most candidates could accurately describe the trend shown in the graph although not all used the term correlation. Only a few candidates could identify the difference in the strength of the correlation before and after 10.00 log10 A.U. Some candidates incorrectly referred to the number of invertebrates causing a change in the salinity levels.

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Question 5 (a) (ii)

(ii) One of the scientists plans to investigate how the number of plant species changes across one of the saltwater wetlands.

Outline how the scientist could measure the number of plant species across the saltwater wetland.

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..... **[3]**

Few candidates gained full marks in this question with a large number focussing on how to generate a random number and random sample site rather than using a transect across the wetland. Several candidates also referred to using tape measures to form 2 axes to then sample at random sites which is not appropriate in this context. Another common mistake was for candidates to refer to determining the percentage cover of plants and/or determining the abundance of organisms in the quadrats rather than only counting the specific number of different species present. Very few candidates referred to using a photographic or dichotomous key for the purpose of accurate identification of the different plant species.

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Exemplar 3

Using systematic sampling, creating a transect across the saltwater wetlands, and placing a quadrat at intervals along the transect* to count the number of plant species within the quadrat. allows scientist to see how number of species changes along transect.

* for example every 5km **[3]**

The candidate has correctly proposed the use of a transect across the wetland area. Many candidates proposed the use of random sampling, but this could result in samples only being collected from one area of the wetland and not **across** the saltwater wetland. The use of systematic sampling would remove bias of sampling. Importantly, this candidate has also noted that the question asks for the number of different species of plants to be determined. Many candidates incorrectly assumed the question asked for the abundance (number) of each of the plant species to be obtained. This answer could be improved further by referring to the use of a dichotomous or photographic identification key to ensure each individual plant species was identified correctly.

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Question 5 (b) (i)

(b) Another scientist sampled the species of fish present in a brackish lake, which has salinity that is higher than freshwater but lower than seawater.

The table shows the results of the sampling in the brackish lake.

Species	n	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
A	3	0.071	0.005
B	5	0.119	0.014
C	3	0.071	0.005
D	10	0.238	0.057
E	19	0.452	0.204
F	2		
		Σ =	

(i) Calculate Simpson's Index of Diversity.

Use the formula: $D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$

n = number of individuals of each species present in the sample
N = total number of all individuals of all species

Simpson's Index of Diversity (D) = ... **[3]**

Most candidates were able to calculate the Simpson's Index of Diversity accurately. A common mistake was to give the answer as the sum of the values in the last column, failing to then deduct this value from one.

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Question 5 (b) (ii)

(ii) A different group of scientists had sampled the fish species in the same lake 20 years earlier.

This group of scientists calculated a *D* value of 0.709.

Using your answer from **(i)**, state what conclusion can be made about how the biodiversity of fish species has changed over the 20-year period.

.....

.....

..... **[1]**

Many candidates simply stated that the biodiversity had increased and did not recognise that the increase was only small. Some candidates misread the question and incorrectly referred to a (slight) decrease in the biodiversity, even though they had the correct answer in Q5bi.

Question 5 (b) (iii)

(iii) Suggest why the comparison between the two values of *D* might not be valid.

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..... **[1]**

Common answers for this question were the idea that data could have been collected in different seasons or via different methods. Some candidates referred to the potential impact on of human activity such as water pollution from fertiliser/pesticide run-off.

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