

## Examiners' report

A LEVEL

# BIOLOGY B

## (ADVANCING BIOLOGY)

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**OCR Level 3 Advanced GCE in Biology B  
(Advancing Biology)**

**H422**

For first teaching in 2015

**H422/03 Summer 2025 series**

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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 responses 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 [Teach Cambridge](#).

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## Paper 3 series overview

H422/03 assesses content from the entire A2 specification focusing on the practical elements of the specification in a 60-mark written paper. To perform well candidates, need a good factual understanding of practical and mathematical skills as well as evaluative and analytical skills. Candidates who did well showed good examination technique, responding appropriately to command words and instructions. Candidates who did less well showed limited recall of content relating to practical learning outcomes and were less confident with mathematical skills. Many candidates performed less well on questions requiring application of knowledge, for example Question 4 relating to quantitative PCR.

Candidates are encouraged to use the additional lined answer pages where needed rather than write in the page margins. It is also recommended that candidates check carefully that they have numbered their answers correctly when using additional lined pages, this was often not the case which hinders the marking process.

Examiners reported a significant decrease in legibility in candidates writing this session, despite the procedures in place to make sure that examiners read all scripts. Although, examiners will never penalise candidates for a bad handwriting, marks will not be awarded if the handwriting is completely illegible, even after being reviewed by multiple examiners.

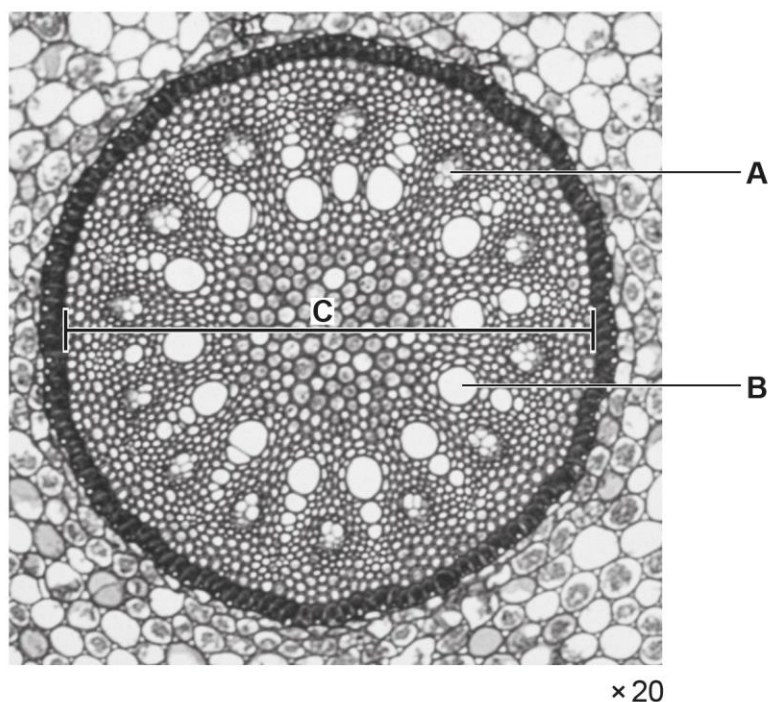
Candidates must make sure that their writing is clear and legible at all times. There was also a noticeable increase in the number of unofficial short-hand notations being used such as 'w/' and 'w/o' and 'bcs' which are not appropriate for formal examinations.

| Candidates who did well on this paper generally:                                                                                                                                                                                                                                                                                                                                                                                      | Candidates who did less well on this paper generally:                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>gave detailed methods and included details of how to work safely and how to analyse the data obtained</li> <li>demonstrated a good understanding of the difference in hazards and risks</li> <li>could extract and use data from graphs accurately</li> <li>applied their knowledge to new situations</li> <li>demonstrated a good understanding of p-values and statistical tests.</li> </ul> | <ul style="list-style-type: none"> <li>were unable to distinguish between cell types and tissues</li> <li>did not interpret command words correctly, for example describing data when the command word was to explain the data</li> <li>gave methodology details which were not required</li> <li>proposed temperature ranges which were unsuitable for the nature of the investigation</li> <li>found it difficult to apply their knowledge of PCR to new contexts.</li> </ul> |

## Question 1 (a) (i)

1 Two functions of the roots of plants are to take up water from the soil and to store starch.

(a) The photomicrograph shows a transverse section of a root in a monocotyledonous plant.



(i) The cells labelled **A** and **B** are two different types of cell in the vascular tissue of the root.

Identify the types of cell labelled **A** and **B**.

**A** .....

**B** .....

[2]

This question was not answered well, with the majority of candidates giving the answer phloem for **A**. Phloem is the correct **tissue**, but the question asks for the names of the **cells**. Therefore 'sieve tube element' would have been the appropriate answer. Similarly, the cell indicated by B is a 'xylem vessel'. However, candidates who wrote 'xylem' (i.e., as in 'xylem cell' – the word 'cell' was already stated in the question) were given a mark, because B is a cell within the xylem tissue. Students should make sure that they distinguish between tissues (phloem and xylem) from cells (phloem sieve tube elements and xylem vessels).

### Assessment for learning



It is better to use actual photomicrographs when identifying the tissues in a root, rather than using representations of the stem which sometimes might be misleading. These can be used to develop practical skills such as drawing low power plans with appropriate labels and annotations.

### Question 1 (a) (ii)

- (ii) The diameter of one region of the root is represented by the line **C** in the image.

The magnification used to produce the image was  $\times 20$ .

Calculate the actual diameter of **C**.

Give your answer in mm.

Diameter = ..... mm [2]

This question was answered well by the majority of candidates. Those that did not gain full marks usually measured the diameter inaccurately. Occasionally candidates did not give their final answer in millimetres.

*Calculation:*

image diameter = 68 mm

Actual diameter = image diameter/ magnification

$68 / 20 = 3.4$  mm

### Question 1 (a) (iii)

- (iii) One risk when dissecting plant tissues, such as roots, is the potential for injury when using sharp instruments.

State **one other** health and safety risk that should be considered before dissecting plant tissues.

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

Some candidates gave generic safety considerations such as wearing safety goggles, which were not given as these are not **risks** but mitigations.

#### Assessment for learning



Students could be encouraged to identify hazards, levels of risks and mitigations for in class practicals. This could be in the form of a table included in practical work being assessed for their practical endorsement.

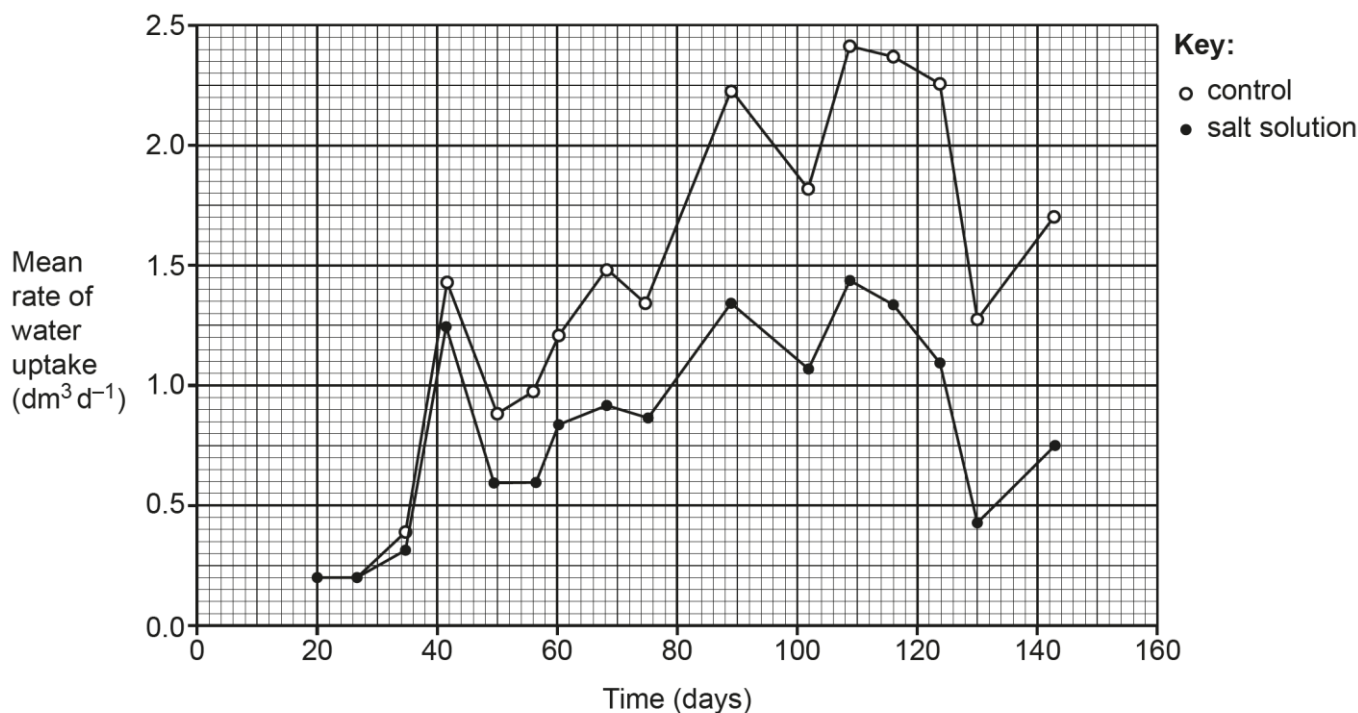
## Question 1 (b) (i)

- (b) A scientist investigates how the rate of water uptake by roots is affected by the presence of salt (NaCl) in the surrounding soil.

This is the method they use:

- Grow 110 tomato plants in pots of soil in a greenhouse.
- Add  $50 \text{ mmol dm}^{-3}$  salt solution to the soil of 55 plants, every day.
- The other 55 plants are a control group.
- Calculate the rate of water uptake per day ( $\text{dm}^3 \text{ d}^{-1}$ ) by the roots of each plant.

The results of the investigation are shown in the graph.



- (i) State how the group of control plants would be set up differently to the group of plants given salt solution **and** explain the purpose of this control group.

.....

.....

.....

..... [2]

Most candidates correctly explained the importance of the control plants providing a set of data to enable a comparison to be made, thereby enabling the scientists to determine if the presence of salt affected the mean water uptake. However, only a small number of candidates were able to gain full marks by gaining the other mark point. The most common error was stating that the salt solution would be removed but failing to then also state that the salt solution needed to be replaced by *an equal volume* of distilled water.

### Assessment for learning



It is important to make a clear comparison between what is happening in the control experiment to the outcome of the experiment. This emphasises the importance of practical based activities throughout the course that address such ideas. Other areas which could also be developed in this way include considering how the data might be processed and analysed.

### Question 1 (b) (ii)

- (ii) Calculate the largest percentage difference in water uptake between the plants in the control group and the plants given salt solution.

Use your answer to complete the sentence.

On day ..... the water uptake of the control plants was .....% greater than the water uptake of the plants given the salt solution. [2]

Many candidates were able to identify day 124. However, few candidates gained the mark for correctly calculating the largest percentage difference in water uptake. Some candidates did not gain this mark because they misread the values from the graph, others found it difficult to recall the formula for calculating percentage differences.

### Question 1 (b) (iii)

- (iii) Suggest what conclusions can be made from the results shown in the graph.

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

This question functioned as an effective discriminator. The question asks for conclusions and as such candidates should be cued to give more than one conclusion. Candidates who did not do well described the data, rather than giving conclusions. Students should be encouraged to look for areas where trend lines are the same as well as differences and refer to specific time periods, e.g. from day 20 to day 26 the addition of salt solution had no effect on the mean rate of water uptake.

**OCR support**

When preparing candidates to sit an examination [the assessment story: exploring our question papers](#), may be useful.

Page 12 lists some common command words used in exam questions.

**Question 1 (c)**

**(c)** The roots of plants can store starch in high concentrations.

Outline how the starch concentration of a sample of root tissue could be estimated using colorimetry.

.....

.....

.....

.....

.....

..... [4]

Many candidates scored well on this question. However, a number of candidates were unable to recall the correct reagent to use when testing for the presence of starch. Candidates who performed less well were unable to give details of key steps when using a colorimeter.

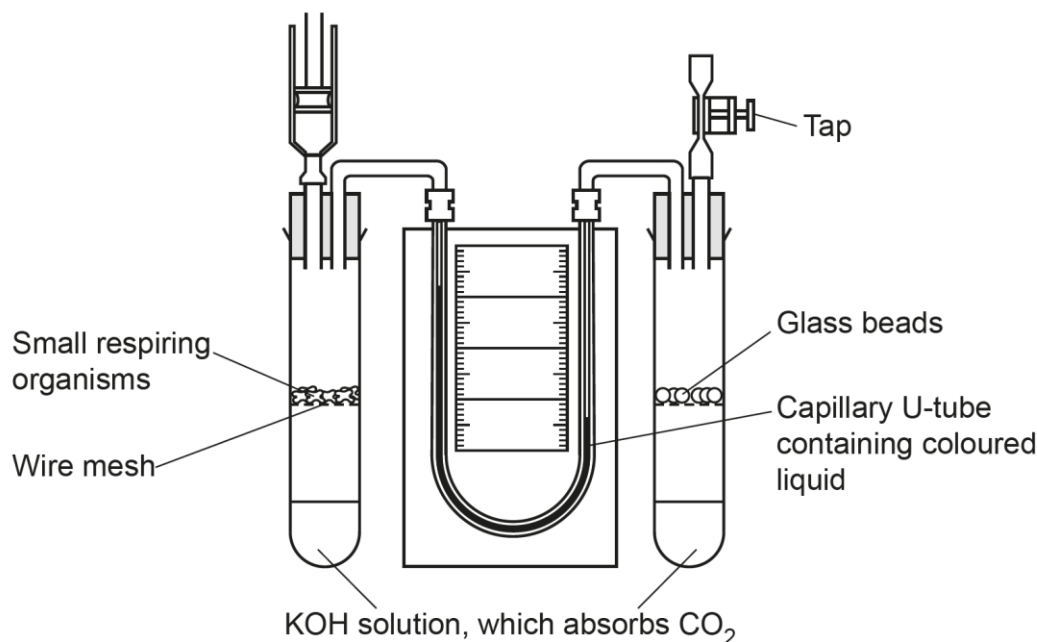
**Assessment for learning**

Details of how to carry out an investigation using colorimetry to determine the concentration of starch can be found [here](#).

## Question 2 (a) (i)

- 2 Respirometers can be used to measure the respiratory quotient and the rate of respiration of organisms.

The diagram shows a respirometer that can be used for these measurements.



The oxygen (O<sub>2</sub>) used by organisms for respiration can be estimated by measuring the distance moved by the coloured liquid in the capillary U-tube over a set time period. The volume of O<sub>2</sub> can then be calculated.

- (a) A student measures the volume of O<sub>2</sub> used and the volume of carbon dioxide (CO<sub>2</sub>) produced per minute in four species of bean.

The results are shown in the table.

| Species of bean | Volume of O <sub>2</sub> used in one minute (mm <sup>3</sup> ) | Volume of CO <sub>2</sub> produced in one minute (mm <sup>3</sup> ) |
|-----------------|----------------------------------------------------------------|---------------------------------------------------------------------|
| <b>A</b>        | 0.063                                                          | 0.050                                                               |
| <b>B</b>        | 0.038                                                          | 0.027                                                               |
| <b>C</b>        | 0.061                                                          | 0.065                                                               |
| <b>D</b>        | 0.072                                                          | 0.052                                                               |

- (i) Describe how the values for the volume of CO<sub>2</sub> produced in one minute would be measured and calculated using a respirometer.

.....

.....

.....

.....

.....

..... [3]

This question discriminated between candidates. Few candidates were able to correctly describe how to use the apparatus and measure the volume of carbon dioxide. Some candidates related the distance moved to the volume of carbon dioxide by recalling the formula to calculate the volume of a cylinder,  $\pi r^2 l$ .

### Question 2 (a) (ii)

- (ii) Calculate the RQ of **species A**, using the values in the table.

RQ = ..... [1]

Candidates answered this question well with some candidates giving answers to 3 decimal points in line with the data in the table. All correctly rounded answers were given.

*Calculation:*

RQ = CO<sub>2</sub> produced / O<sub>2</sub> consumed

0.050 / 0.063

= 0.79

### OCR support



Correctly rounding values is discussed in [maths skills handbook](#) as well as the '[Maths for Biology' resources \(Module 0\)](#).

## Question 2 (a) (iii)

(iii) The student thinks the results for one of the species are anomalous.

State which species has anomalous results **and** explain why the student thinks the results are anomalous.

.....

.....

.....

.....

..... [2]

Candidates often correctly identified C as the anomalous result but did not clearly explain why this was the case. Some candidates gave additional detail to their answer by not only stating that the RQ would be greater than one, but also by calculating the RQ for species C as 1.07.

## Question 2 (b)\*

(b)\* Plan an investigation to test the effect of temperature on the **rate of respiration** in germinating beans and obtain valid results.

You do **not** need to include details of how to set up or use a respirometer in your plan.

.....

.....

.....

.....

.....

..... [6]

This question was answered well by most candidates. Those candidates that achieved Level 3 gave detailed steps of how to use the apparatus at an appropriate temperature range and provided details of how to work safely. Some candidates wrote extensive methods and included details of how to set up the respirometer which were not required. Candidates made good use of the available additional lined pages for their answer.

### Assessment for learning



When preparing for questions on practical methodology it is useful to write each stage on a separate line, cut out each line and ask candidates to put the steps in the correct order. When demonstrating a procedure before the candidates performing the experiment, show what would happen if you omitted a step so they can see it would not work effectively without that step.

### OCR support



For further support on how to answer Level of Response questions you can use [The Guide to Level of Response Questions](#).

## Exemplar 1

Risk assessment:

1) High Temperatures - could cause burns or scalding - low risk

- use tongs when handling substances going in and out of thermostatically regulated water bath - wash burn under cold water for a few minutes if occurs

2) Allergy to plant material (<sup>germinates from</sup> ~~the~~ beans) - could cause skin irritation

- low risk - wear ~~put~~ non latex gloves when handling plant material -  
~~contact~~ <sup>Professional</sup> seek medical assistance if allergic reaction occurs.

The independent variable in experiment is the range of Temperature

used (10, 15, 20, 25, 30, 35, 40°C). The dependent variable is the

volume of CO<sub>2</sub> ~~produced~~ produced. The control variables are the

surface area or mass of germinating bean (control by measuring using ruler),

species of germinating bean (use same species) and light intensity (do

experiment in same room)

[6]

Extra answer space if required.

For this experiment use a thermostatically controlled water bath

to heat germinating seeds to desired, ensure there are the same number

of seeds in each test tube for each repeat of each temperature

(A note continued at extra page at the end)

2b) Using a respirometer measure the volume of  $\text{CO}_2$  collected in <sup>the</sup> gas in one ~~observed~~ minute and repeat this at least 3 times for each temperature and remove anomalies.

Once mean volume of  $\text{CO}_2$  measured in gas syringe for each temp recorded then divide this by 60 seconds to determine the rate of  $\text{CO}_2$  emission per ~~second~~ <sup>second</sup> and plot a graph to visualise trend and use a statistical test <sup>student's</sup> such as unpaired  $t$  test to determine if difference is ~~the~~ <sup>statistically</sup> significant. For each temperature use a control of glass beads in test tube.

This candidate has provided details of how to work safely. Control variables are concisely and clearly indicated. There are details of how to use the respirometer at a number of temperatures within an appropriate range as well as the intention to collect replicates and analyse the data appropriately. The steps provided would enable the experiment to be reproduced. This response was given a Level 3, 6 marks.

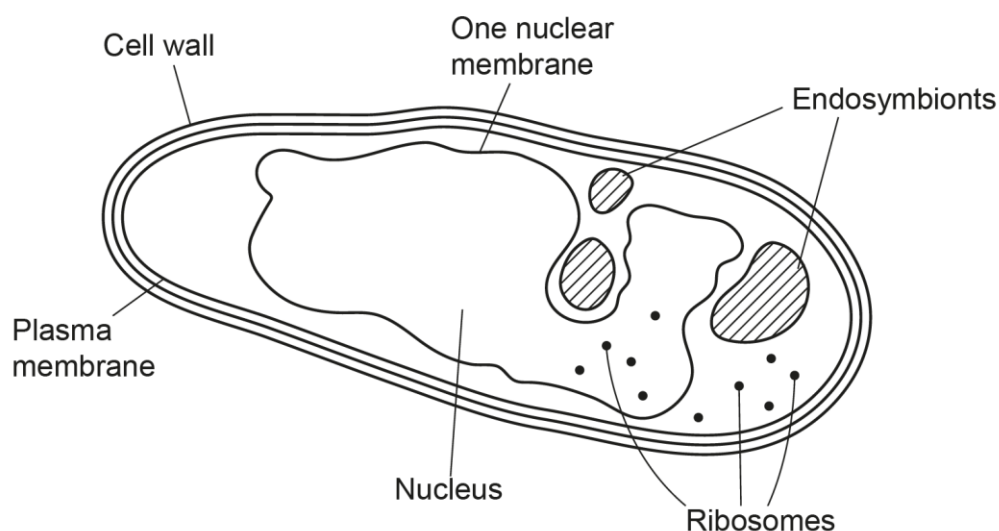
### Question 3 (a)

3 *Parakaryon myojinensis* is a species of single-celled organism that was discovered in 2012.

*P. myojinensis* is unique among species that have been discovered because it has features of both eukaryotes and prokaryotes. It also has features that are neither eukaryotic nor prokaryotic.

A student uses a sharp pencil to draw a *P. myojinensis* cell from an electron micrograph.

A representation of the student's drawing of *P. myojinensis* is shown in the image.



Endosymbionts are organisms that can also be found in some eukaryotic and prokaryotic cells.

(a) State **two** ways in which the student could improve their drawing.

- 1 .....
- 2 .....

[2]

This question was answered well with many candidates gaining both marks. Some marks were lost when describing improvement to label lines by not specifying that the lines should be horizontal **and** ruled/straight. Almost all candidates correctly noted that no shading should be present.

#### OCR support



Details of good biological drawings can be found in the [Biological Drawing Skills Handbook](#).

### Question 3 (b)

- (b) The student concludes that 'although it does not seem to have mitochondria, *P. myojinensis* is more similar to a eukaryote than a prokaryote'.

Discuss the evidence from the image that supports **and** does **not** support this conclusion.

.....

.....

.....

.....

.....

..... [3]

Most candidates were able to refer to the presence of a nucleus as evidence that supports the conclusion that *P. myojinensis* is more similar to a eukaryote. Fewer candidates were able to give evidence that undermined the conclusion.

### Exemplar 2

The image supports this conclusion as there is a large nucleus with some ribosomes in it (possibly suggesting the presence of a nucleolus). There is also a nuclear membrane and plasma membrane. However, the image also contains endosymbionts, which are neither eukaryotic or prokaryotic. Furthermore, organelles that would be present in eukaryotes, like the SER/RER<sup>and</sup> Golgi apparatus are not present in the image (even though it is from an electron micrograph).

This candidate has a well-structured answer, first identifying evidence that supports the conclusion and then evidence that undermines (does not support) the conclusion. This response would have been further developed by referring to the nuclear membrane only having one membrane (whereas eukaryotes have a nuclear envelope made from 2 membranes) and to that end this would be evidence that the *P. myojinensis* is unlike a eukaryote. This answer gained 2 marks.

### Question 3 (c)

- (c) Suggest what the absence of mitochondria indicates about the process of respiration in *P. myojinensis*.

.....

.....

..... [1]

This question was answered well by most candidates with common responses referring anaerobic respiration being the source of ATP.

### Question 3 (d)

- (d) The student is interested in whether the cell wall of *P. myojinensis* is made from peptidoglycan or a different substance.

State how to test for the presence of peptidoglycan in the cell wall of *P. myojinensis*.

.....

.....

.....

.....

..... [2]

Many candidates gave very detailed answers for this question referring to the correct reagents (including the use of a counterstain) and the expected positive colour change in the presence of peptidoglycan. Some candidates incorrectly referred to Biuret reagent.

### Question 3 (e)\*

(e)\* *Rhizobium* species are other examples of single-celled organisms.

Describe how to culture *Rhizobium*, in vitro.

Your answer should include steps that would reduce the risk of contamination of the culture.

.....

.....

.....

.....

.....

..... [6]

This question was a discriminator with candidates who performed well overall giving details of the procedure from the initial stages of obtaining a source of the bacteria from a root nodule from a leguminous plant through to the incubation of the agar plate at an appropriate temperature. Often candidates gave muddled answers, incorrectly referring to zones of inhibition which are not relevant. Candidates who reached Level 3 identified steps which would reduce the risk of contamination which were specific to the procedure, rather than generic safety such as wearing goggles and wearing lab coats. Some candidates gave detailed descriptions of working aseptically and incubation procedures, e.g. incubating at 25°C with plates stored upside down (to reduce condensation falling onto the agar).

## Question 4 (a)

4 Mutations in some genes are associated with an increased risk of developing cancer.

(a) The table lists three genes associated with cancer: *Myc*, *p53* and *Ras*.

Complete the table by putting a tick (✓) in the appropriate box or boxes on each line to show whether a gene has the feature.

| Feature                                                            | <i>Myc</i> | <i>p53</i> | <i>Ras</i> |
|--------------------------------------------------------------------|------------|------------|------------|
| A mutation that causes a loss of function that can lead to cancer. |            |            |            |
| It is a proto-oncogene.                                            |            |            |            |

[1]

Few candidates gained this mark with a large number giving the complete opposite to the expected answers. Examiners did note that candidates were much better at giving clear ticks and less hybrid cross/ticks being seen.

## Question 4 (b) (i)

- (b) The polymerase chain reaction (PCR) can be used to detect alleles that are associated with cancer.
- (i) Complete the table to show the temperatures used in the three stages of a PCR cycle and the processes that occur at each temperature.

| Temperature (°C) | Process                                                |
|------------------|--------------------------------------------------------|
| .....            | Separation of DNA strands                              |
| 55               | .....<br>.....                                         |
| .....            | DNA polymerase attaches nucleotides to the new strands |

[2]

Most candidates gained the mark for the first column giving temperatures within the allowed ranges for the 1<sup>st</sup> and 3<sup>rd</sup> stage of the process. Less candidates gained the mark for the process description. Many candidates give responses which were too vague such as 'joining' or 'nucleotides lining up'. This stage is where the process of annealing between the free DNA-nucleotides and exposed DNA-polynucleotide strand occurs.

## Question 4 (b) (ii)

- (ii) In theory, the number of DNA molecules can increase exponentially during PCR.

Calculate the theoretical maximum number of DNA molecules that could be present after 15 cycles of PCR, assuming that the process started with one DNA molecule.

Give your answer as a  $\log_{10}$  value.

Number of DNA molecules = ..... [2]

This question discriminated between candidates. While most candidates were able to determine that 32678 molecules would be present ( $2^{15}$ ) few could then give this as a  $\log_{10}$  value. This should be calculated by  $\log(32678)$  giving an answer of 4.514. Candidates could then self-check their answer by  $10^{4.514}$  to confirm the answer would then give (close to) 32678.

### Question 4 (b) (iii)

- (iii) Suggest **one** reason why the theoretical maximum number of DNA molecules might **not** be achieved.

.....

.....

..... [1]

This question was answered well with many candidates suggesting there may be a shortage of free DNA-nucleotides.

### Question 4 (b) (iv)

- (iv) A version of PCR known as quantitative PCR (qPCR) is used to detect alleles that are associated with an increased risk of cancer.

qPCR involves:

- extracting mRNA (transcribed from the target allele) from a cell
- converting the mRNA to complementary DNA (cDNA)
- conducting PCR on the cDNA sample using *Taq* DNA polymerase, allele-specific primers and fluorescent probes.

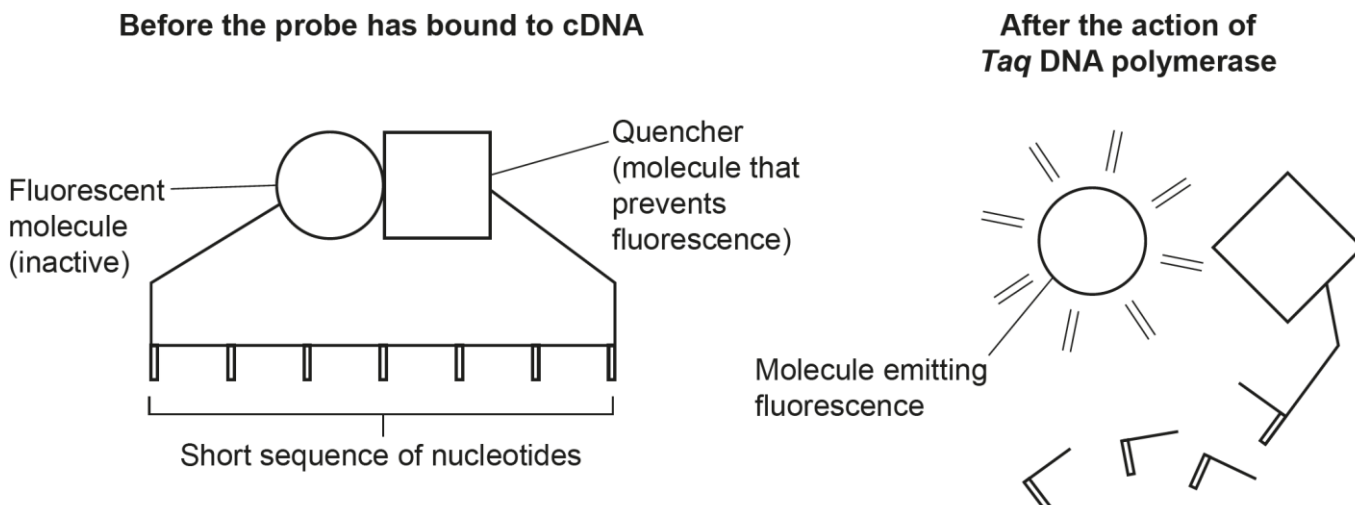
State the name of the enzyme that converts mRNA to cDNA.

..... [1]

While many candidates correctly recalled the enzyme, reverse transcriptase, some common misconceptions were noted. For example, DNA-polymerase, DNA-ligase.

## Question 4 (b) (v)

(v) The diagram shows a fluorescent probe used in qPCR.



Suggest how fluorescent probes can be used in qPCR to estimate the concentration of cDNA derived from a cancer-associated allele.

.....

.....

.....

.....

..... [2]

Few candidates gained both marks on this question. Candidates needed to apply their knowledge of PCR to the quantitative version of the procedure. While some candidates correctly stated that the level of fluorescence would be proportional to the quantity of cDNA present, many incorrectly referred to the use of flow cytometry to count the number of cells/alleles. Some candidates recognised that the probe would have complementary base sequences to the cDNA derived from the cancer-associated allele.

### Question 4 (c) (i)

(c) Electrophoresis is another technique that can be used to detect cancer-associated alleles.

*CYP17* is a gene that has been linked to some cancers.

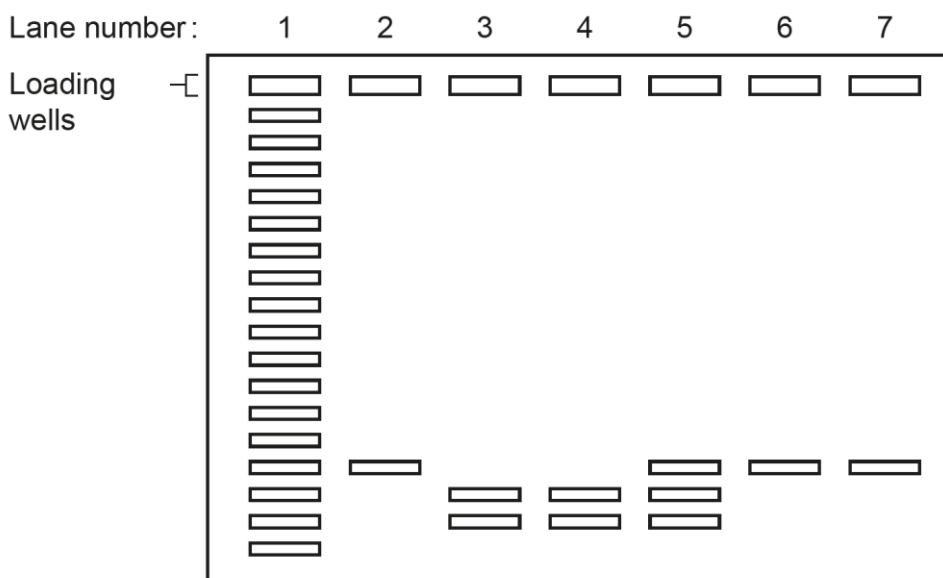
- The normal *CYP17* allele does not increase the risk of cancer.
- A mutant *CYP17* allele increases the risk of some cancers.

Restriction enzymes are used to produce fragments of the *CYP17* alleles for analysis in electrophoresis.

Restriction enzymes:

- produce one fragment when the normal *CYP17* allele is present
- produce two smaller fragments when the mutant *CYP17* allele is present.

The diagram shows the results of electrophoresis of DNA samples from 6 people. Lanes 2 to 7 in the diagram show only DNA fragments from *CYP17* alleles.



(i) Samples containing DNA fragments are placed in the loading wells of the electrophoresis box before beginning electrophoresis.

State **one other** substance that should be added to the box before beginning electrophoresis **and** explain the purpose of this substance.

.....

.....

.....

.....

..... [2]

While many candidates identified that a buffer solution would be needed, few were able to explain the role of the buffer. Some detailed answers were seen referring to the loading buffer which enables the DNA sample(s) to be loaded and the movement of the DNA fragments to be visualised as it migrates through the agarose gel. Many candidates referred to the addition of fluorescent markers and the use of UV-light which was not relevant to the question as this refers to the identification process which takes place **after** electrophoresis. Another common answer was to suggest that 'gel' or 'agarose' was needed. However, this was not awarded as the stem of the question states that the samples of DNA were added into the loading wells, thereby indicating the agarose gel was present.

### Question 4 (c) (ii)

(ii) State **and** explain the purpose of the DNA fragments in lane 1 in the diagram.

.....

.....

.....

.....

..... [2]

Good answers referred to both the addition of a DNA ladder, or samples of DNA with known lengths and the reason for this. Few candidates gained the explanation as answers often simply referred to the ability to make comparisons. Details of what was being compared was needed such as the comparing the distance the DNA samples had moved compared to the distances the fragments in the DNA ladder had moved. Likewise, comparisons could be made between the sizes of the DNA samples and sizes of the fragments in the DNA ladder.

## Question 4 (c) (iii)

(iii) State the lane numbers that indicate:

- a genotype that is homozygous for the normal *CYP17* allele
- a genotype that is homozygous for the mutant *CYP17* allele.
- a heterozygous genotype for the *CYP17* gene

Homozygous normal .....

Homozygous mutant .....

Heterozygous .....

[2]

This question was answered well by the majority of candidates with most gaining 2 marks. The homozygous normal genotype would have only had one single band, hence potentially being lane 2, 6 and 7. The homozygous mutant genotype would have two bands, one for each fragment being shorter in length and hence travelling further down the gel; thus resulting in lanes 3 and 4 being correct. The heterozygous genotype would then have 3 bands representing the 3 fragments and so being lane 5.

## Question 5 (a)

- 5 Scientists analysed the effect of alcohol consumption by parents on the risk of a child being born with microcephaly.

Microcephaly is defined as a head circumference more than two standard deviations below the mean at a particular age.

The scientists obtained information on the number of units of alcohol consumed per week by both parents:

- during the three months before conception
- during the first three months of the mother's pregnancy.

The scientists compared the risk of the newborn baby having microcephaly when parents consumed:

- no alcohol
- more than 5 units of alcohol per week.

They performed statistical tests to test the hypothesis that there was a greater risk of microcephaly when parents consumed more than five units of alcohol per week.

The  $p$  values from the statistical tests are shown in the table.

|                                        | $p$ value                             |                                       |
|----------------------------------------|---------------------------------------|---------------------------------------|
|                                        | Mother consuming<br>>5 units per week | Father consuming<br>>5 units per week |
| Before pregnancy                       | 0.078                                 | 0.048                                 |
| In the first three months of pregnancy | 0.508                                 | 0.246                                 |

- (a) Describe the conclusions that can be made from the  $p$  values in the table.

.....

.....

.....

.....

..... [2]

Few candidates were able to apply their knowledge of  $p$ -values to this context. Often candidates gave the opposite responses to the correct statements. Others incorrectly tried to use the values to deduce percentages. Candidates who did well, correctly recalled that  $p$ -values below 0.05 are considered statistically significant, indicating sufficient evidence to reject the null hypothesis thereby recognising that fathers consuming >5 units of alcohol before pregnancy **significantly** increased the risk of microcephaly, whereas mothers consuming >5 units of alcohol before pregnancy almost no (or almost a) significant risk of microcephaly. It is important that candidates refer to the data provided and not be (possibly) swayed by previous perceptions.

**Assessment for learning**

A p-value can be used to determine the strength of evidence against a null hypothesis in statistical testing. A large p-value, (typically  $p \geq 0.05$ ), suggests that the observed results are not statistically significant, meaning that they are likely due to chance. This would mean that the null hypothesis would not be rejected. Conversely, a small p-value (typically  $p < 0.05$ ) would indicate that the data is unlikely to be caused by chance alone, providing evidence against the null hypothesis. In this case the null hypothesis is rejected.

**Question 5 (b)**

**(b)** Suggest what additional information is needed to increase confidence in the conclusions.

.....

.....

.....

.....

..... [2]

While some candidates gave 2 correct answers some candidates only gave one. Students should be encouraged to use the mark tariff as a guide to the number / detail of response required. Several candidates referred to the sample size but did not qualify this by saying the sample size should be **larger** so that the confidence in the conclusion would be *increased*.

## Exemplar 3

- Whether parents surveyed have any relatives born w/ microcephaly.
- Larger Sample Size
- How much alcohol was consumed by parents.
- Whether alcohol consumption was continuous or sporadic.
- Information regarding parents who consumed between 0 and 5 units of alcohol per week. [2]
- Other risk factors of microcephaly and whether these factors were controlled.
- Age of parents
- How results were obtained → Surveys or analysing blood alcohol levels (people die in Surveys).

This candidate has given a detailed answer and while they have gained full marks there is concern that too much time has been spent on this question. Students should use the mark tariff and the answer space as guides to the level of detail required. This answer gained 2 marks.

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