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Examiners' report

BIOLOGY A

H420

For first teaching in 2015

H420/03 Summer 2024 series

Version 1

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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

H420/03 is one of the three examination units for GCE Biology A. This component assesses content from across all areas of Biology, and links together the different areas within different contexts: some practical, some familiar and some novel. To do well on this paper, candidates need to be comfortable applying their knowledge and understanding to unfamiliar contexts and be familiar with a range of practical techniques. They must also be able to analyse, interpret and evaluate ideas and evidence to be able to reach conclusions and develop and refine practical design and procedures. This, together with the fact it relies on learning and applying knowledge from two years of work, has proved a challenging test for some candidates. However, all questions were accessible to candidates – even though some of the stretch and challenge questions did not score well, and there seemed to be no time issues with completing the examination. The examination produced a good spread of marks, and most candidates attempted all the questions.

Examiners were pleased to see that many candidates used the additional answer spaces provided in the paper, rather than continuing their answers outside the provided lines, and this is something we would encourage all centres to advise their candidates to do.

Centres are advised to encourage candidates to spend a little time reading the question and ensuring that they supply information that relates to and answers the question.

Demand

The paper covered some topics candidates found challenging –application and interpretation of graphs and data, chemiosmosis, cloning and a population calculation from a serial dilution.

Only three questions were seen to be rarely answered correctly (Question 4 (c) (i) – worth 2 marks, Question 4 (c) (ii) – worth 2 marks – (both stretch and challenge), and Question 5 (a) LoR - worth 6 marks). There were similar amounts (and challenges) of evaluation/practical assessment/calculations compared to the paper in 2023.

Overall, the candidates during this session tended to score better on AO1 questions than AO2 or AO3.

Most candidates found the LoR questions quite challenging this session – although this led to a very good spread of marks on Question 3 (c) (ii), the first LoR, which asked candidates to design an experiment to show the effect of temperature on transpiration.

The second LoR (all AO3) which required an ability to apply knowledge of genetic and environment influences on diabetes type 1 and 2 to some data provided from a study, proved very challenging – with many candidates failing to apply the information in the table correctly to draw any valid conclusions. However, much of the rest of the paper was very accessible and scored well.

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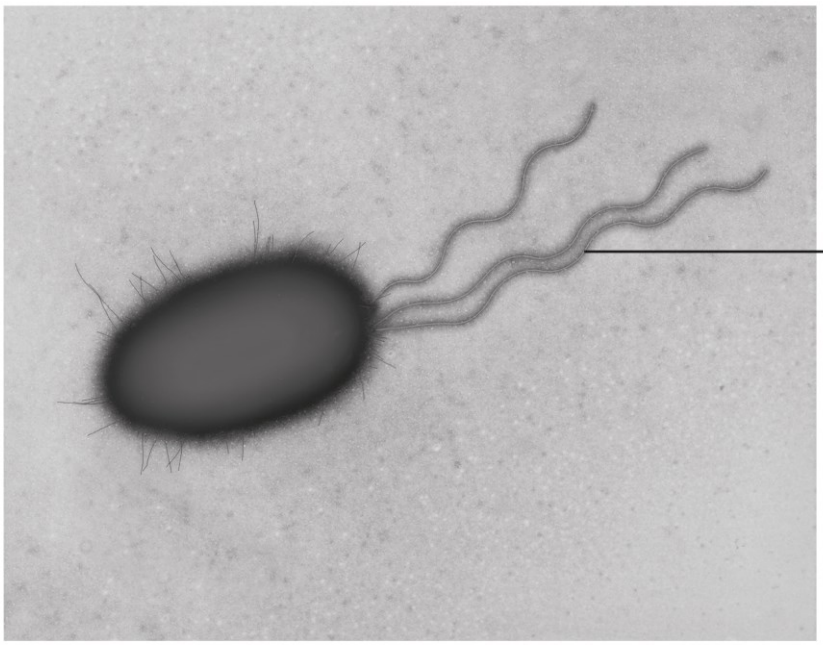
Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• recalled the meaning and definitions of terms accurately • showed mathematical fluency in calculations and interpreting graphs correctly • produced clear, well organised and concise responses to questions • did not repeat too much material from the question stem in their responses • read the question carefully and paid attention to the information and data provided • could interpret information given in diagrams, graphs and tables and use it to answer related questions • were able to extend their responses to follow a process through to describe the logical result of a change in conditions • have a good practical knowledge, with the ability to understand and apply the information given to the questions being asked.	• confused certain key terms such as electroporation and electrofusion • found it challenging to answer mathematical based calculations • left answers unfinished or blank • found it challenging to apply what they had learnt to unfamiliar situations • produced responses which lacked depth, particularly to practical based questions • produced responses which were very wordy and often simply repeated information provided in the stem of the question • found it challenging to interpret and use images and information supplied in the question paper to answer related questions.

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Question 1 (a) (i)

1 *Escherichia coli* is a bacterium that is used widely in scientific experiments and in biotechnology.

(a) This is a transmission electron micrograph of *E. coli*.



(i) Name the structure labelled **A**.

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

The majority of candidates answered this correctly and were able to correctly spell the term flagellum. When there was an incorrect response, it often stated tail, cilia or undulipodium (which is found in eukaryotic cells only).

Question 1 (a) (ii)

(ii) Based on your knowledge, **estimate** the diameter of the *E. coli* cell.

Give your answer in μm.

Diameter = ... μm **[1]**

Most candidates gained this mark, however, a few candidates clearly did not understand the question and tried to calculate a size from the diagram (although no magnification was given) or on occasions stated the answer with the incorrect unit, e.g. nm.

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Question 1 (b) (i)

(b) A student carries out a serial dilution of an *E. coli* culture.

This is the method the student uses:

- Transfer 10 cm^3 of *E. coli* culture to a sterilised test tube from an original culture that has a volume of 50 cm^3.
- Carry out four 10-fold serial dilutions. Each dilution involves transferring 1 cm^3 of culture from one test tube to another test tube containing 9 cm^3 of distilled water.
- Transfer 1 cm^3 of the final 10 cm^3 diluted culture to an agar plate. Evenly spread 1 cm^3 of liquid across the plate using a sterilised spreader.
- Use a micropipette for each transfer.
- Incubate the agar plates for 24 h.
- Count the number of colonies that develop on the plate. Each colony is assumed to develop from a single bacterium.
- Estimate the *E. coli* population in the original 50 cm^3 culture.

(i) Describe **two** improvements to the student's method, **other than** using different equipment, that could improve the accuracy of their population estimate.

1 .....

.....

2 .....

.....

[2]

Good answers tended to describe how the accuracy of the bacterial population estimate could be improved either by reducing the number of transfers (to limit error) or by repeating the plating. Some candidates, although a relatively low proportion, described the importance of mixing at each stage and replacing or sterilising the pipette (or pipette tips). The introduction to the question contained references to sterilisation and general aseptic technique, so these answers, if not specifically in the context of the pipettes, were ignored. Many candidates suggested the experiment should be repeated. This answer was not credited because of the ambiguity: repeating the experiment suggests restarting with a fresh bacterial population rather than carrying out more dilutions with the current culture.

OCR support

OCR's Language of measurement in context: Biology can be used with candidates to support their learning and use of language of measurement terms, such as accuracy.

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Question 1 (b) (ii)

(ii) The student counts 22 colonies on the agar plate.

Calculate the total number of *E. coli* cells in the original 50 cm^3 culture.

Give your answer in standard form.

Total number of *E. coli* cells in 50 cm^3 = ... **[3]**

It was encouraging to see that most candidates attempted the question with many giving the correct answer. Candidates should be encouraged to show their working as credit was available for stages within the calculation (multiply by x5 or x50) and the conversion of their calculated answer to standard form so many still gained 2 marks as ECF. Where candidates were unable to gain marks was for the original conversion being incorrect or the final answer not being given in standard form.

OCR support

Advice on how to make order of magnitude calculations (M1.8) and express results correctly in Standard Form for maths skill M0.2 can be found in the biology mathematical skills handbook.

Question 1 (c)

(c) *E. coli* can be genetically modified to produce useful proteins.

State **two** other reasons why *E. coli* is a suitable microorganism to use in biotechnology.

1 .....

.....

2 .....

.....

[2]

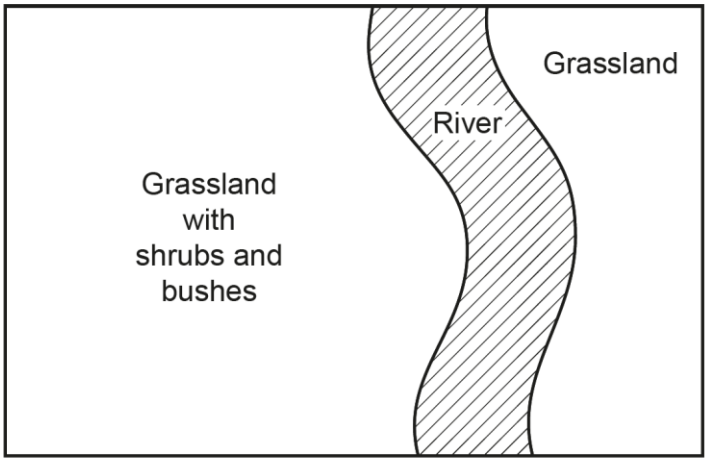
This was generally well answered with most candidates identifying the short life cycle as one reason. Other popular answers were few ethical concerns and the low cost to feed, or the idea that it can be kept at low temperatures which is cheaper. Occasionally candidates did not gain marks with unqualified answers such as 'easy to grow', 'small' or 'cheap' as more supporting information was required.

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Question 2 (a)

2 Species biodiversity is affected by many factors.

(a) A student plans to sample the plant species in the area shown below to assess the area's species biodiversity.



The student plans to:

- use a random number generator to generate 10 coordinates
- sample at each of the 10 coordinates
- use a point quadrat and an identification key to estimate the percentage cover of each species at each coordinate.

Describe **two** improvements to the student's plan **and** explain why they would be improvements.

Improvement .....

.....

Explanation .....

.....

Improvement .....

.....

Explanation .....

.....

[4]

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Many candidates gained marks for describing larger sample sizes, the use of stratified sampling and the use of a frame quadrat as potential improvements to the method. Some candidates explained these improvements in terms of providing better representation of the area or populations. Vague explanations such as 'to improve accuracy' or 'to collect more data' were not credited. A small number of candidates described the use of transects and sampling at different times of year as possible improvements.

Answers that described the use of one transect did not gain credit because this would be less representative than several random samples, partly because it would be restricted to one side of the river. Answers that focused on changes to the method in the river were not credited because these suggestions rely on too much unknown information. For example, if the river is shallow, clear or slow moving, the use of quadrats is plausible. Otherwise, if little plant life is observable in the river, it could be omitted from the sampling.

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Question 2 (b) (i)

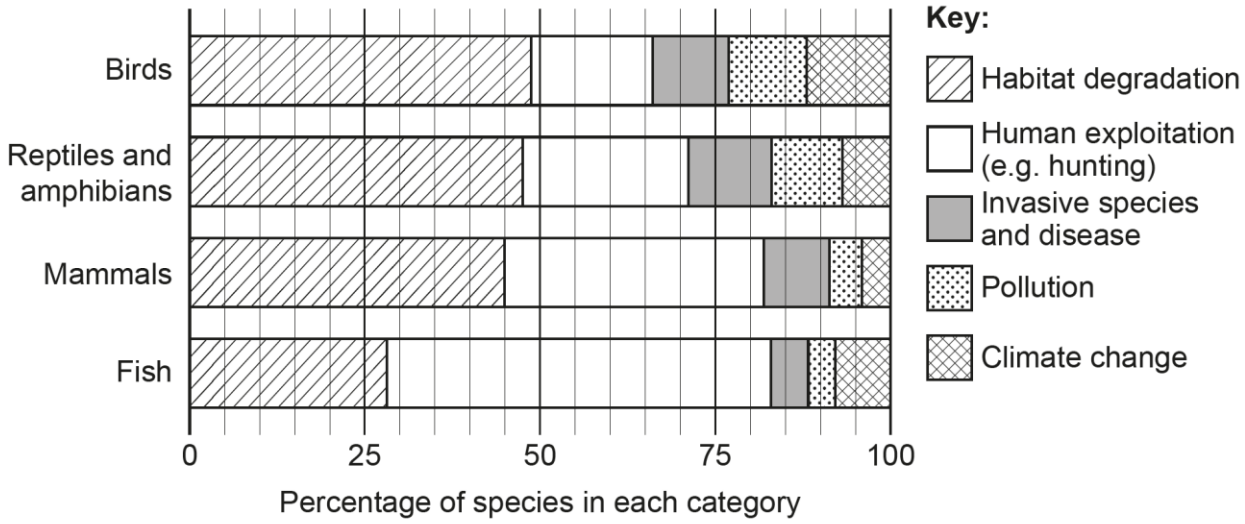
(b) The International Union for Conservation of Nature (IUCN) compiles a list of species and their conservation status, known as the Red List of Threatened Species.

A study in 2016 assessed which factors were threats to populations of animal species.

The scientists carrying out the study selected 3789 species on the IUCN List.

They classified each population into one of five categories, based on the greatest threat to the survival of the population.

The graph shows the results of the study.



(i) Outline the differences between the bird and mammal results shown in the graph.

.....

.....

.....

.....

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

Many candidates were able to gain both marks. A range of different ways of describing greater/smaller threat were accepted, as well as quotes of the percentages if these were qualified in a way that shows the correct trend in the data and as a comparison between mammals and birds, e.g. 'human exploitation has 37% threat in mammals but only 16% in birds'. Candidates who described the difference in habitat degradation needed to say that there was a slightly lower/higher threat or that the percentages were similar. Candidates should be encouraged to comment on the finer detail when describing data so that they pick up on points like this.

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Question 2 (b) (ii)

(ii) A student looking at the graph concluded that 'climate change is not a major threat to species biodiversity'.

Evaluate this conclusion.

.....

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.....

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.....

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

This part of Question 2 proved challenging with few candidates gaining all four marks. There were many responses that focused on the other threats being higher, which did not gain credit. The idea of it being the lowest threat needed to be linked to named groups as this was not true for all the groups of animals. Similarly, it had to be clear that all the groups had a threat below 11-13%. A small number of candidates interpreted the data incorrectly thinking that the climate change values were highest as they went up to 100%. The strongest responses gave points in support and against the conclusion. Very few candidates identified that these species were from the Red List therefore it was not a random sample. However, a greater number realised that climate change would lead to other threats such as habitat loss, or that the impact of climate change will have increased since the data was taken. Many candidates realised that there was no statistical analysis, and some recognised that the study could not be generalised to all animals or that other groups, such as plants were not included. When answering questions of this type it would help candidates to be more succinct in their answers, as there were some quite long responses that filled the answer space while only focussing on a single point.

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Assessment for learning

The majority of candidates were able to pick up some marks on this question, but exam technique could be improved to maximise their success.

The question is effectively asking candidates to 'Evaluate this conclusion: "climate change is not a major threat to species biodiversity"', which happened to be concluded by someone just looking at the graph. When candidates are asked to evaluate, they should aim to find positives and negatives. So as a minimum they should be aiming to make four points here.

Candidates need to not just look at data in the graph, but all the surrounding information to see if the conclusion drawn can be supported or not. The data cannot be analysed without understanding what they represent (i.e. what the researchers considered the principal threat to each population) and the limitations of the method used to collect the data. Therefore, it is important to remind candidates to use all the information linked to the graph when evaluating a conclusion.

The acronym ReBUGG could be used:

Re	read the question
B	box in command words
U	underline key points
G	gauge the number of points needed
G	glance back and read what you have written.

Question 2 (c)

(c) Timber can be produced sustainably to maintain biodiversity in woodland.

Describe **one** way in which timber can be produced sustainably.

.....

.....

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

Nearly all candidates were able to identify a way of producing timber sustainably, coppicing being the one most often described. While in this case the mark could be given for naming the technique, it was pleasing to see that many candidates picked up on the command word and give some description, which allowed the mark to be awarded, even if the technique was not named.

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Question 3 (a)

3 Xylem vessels maintain the transpiration stream by transporting water up plant stems.

(a) The sentences describe the role of meristems in producing xylem vessels.

Complete the sentences using the most appropriate words or phrases.

Meristem cells are located between xylem and ..... tissues in plants. Cells of either of these vascular tissues can be produced when meristem cells divide and ..... .

[2]

The vast majority of candidates achieved both marks for this question. Most identified phloem as the tissue. A very small number of candidates specified a specialised cell within phloem tissue and were not awarded the mark, because they had not acknowledged the word 'tissue' within their answer. The use of 'differentiate' and 'specialise' was equally observed. Typically, those that did not achieve both marks used the terms 'reproduce' or 'replicate' or 'grow' in place of the correct response.

Question 3 (b) (i)

(b) A pair of students dissect the vascular tissue of the primrose plant, *Primula vulgaris*.

(i) State **and** explain **one** safety precaution that the students should take when dissecting the vascular tissue.

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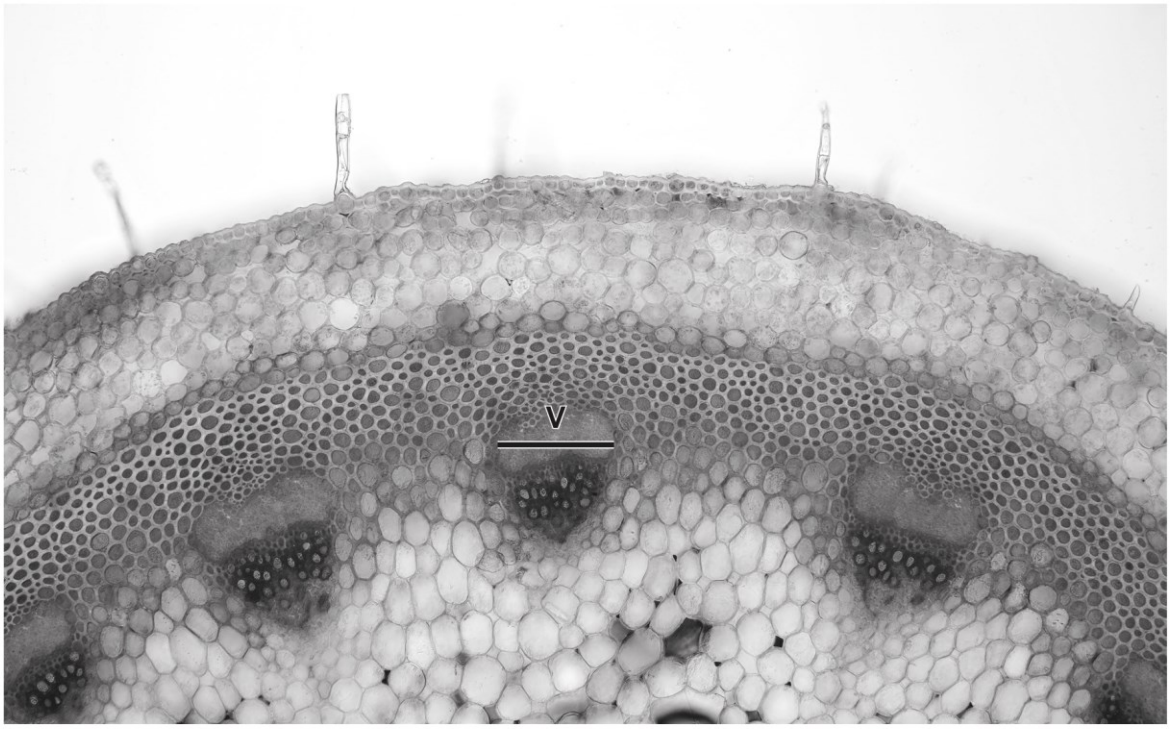
..... **[2]**

Most candidates achieved at least one mark in this question. Many were able to achieve both marking points. This was most often achieved by describing the use of a sharp scalpel (or similar) linked to the risk of cutting themselves. Many described cutting the vascular tissue away from themselves. However, it was less common for those candidates who selected to wear gloves or eye protection to accurately describe an appropriate risk; many responses described the use of gloves or goggles as a measure to reduce cuts, rather than avoid plant material causing irritation or infection.

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Question 3 (b) (ii)

(ii) This is a light micrograph of a transverse section through the stem of *P. vulgaris*.



× 90

The diameter of one of the vascular bundles is shown by the line labelled **V**.

Calculate the actual diameter of the vascular bundle labelled **V**.

Give your answer in mm and to **2** significant figures.

Diameter of the vascular bundle **V** = ... mm **[2]**

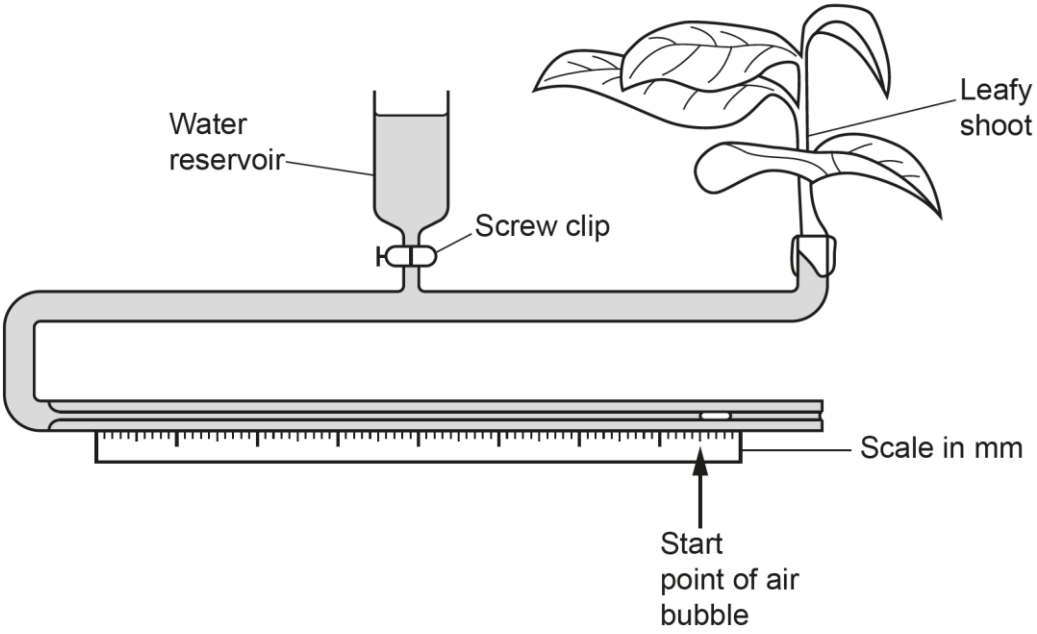
This mathematical calculation posed little challenge to the majority of candidates. The most frequent source of error related to undertaking the initial measurement in centimetres and not correctly converting this unit to millimetres. Occasionally, candidates did not round the response appropriately. An incorrect measurement divided by 90 and correctly rounded to 2 sig figs was awarded 1 mark.

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Question 3 (c) (i)

(c) A scientist plans to investigate the effect of temperature on the rate of transpiration in *P. vulgaris*.

The scientist uses a potometer in their investigation, as shown in the diagram below.



(i) The scientist plans to calculate the rate of transpiration by measuring the distance moved by the air bubble.

The scientist carries out a preliminary trial by measuring the distance moved by the air bubble in 30 minutes at 20 °C.

The bubble moves 18 mm in 30 minutes. The diameter of the capillary tubing in the potometer is 1 mm.

Calculate the rate of transpiration, in $mm^3 h^{-1}$, during this preliminary trial.

Use the formula: Volume of cylinder = $\pi r^2 l$

Rate of transpiration = ... $mm^3 h^{-1}$ **[2]**

Although many candidates achieved both marks for this question, this proved more challenging than Question 3 (b) (ii). Errors were spread across the different steps of the calculation. A reasonable proportion of candidates did not correctly calculate the radius from the provided diameter; others did not square this number before proceeding through the remainder of the calculation. The most common error related to the conversion of 30 minutes into hours: either not converting it (and expressing an answer per 30 minutes) or halving their answer (and expressing an answer per 15 minutes). The response could be

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given to either two or three significant figures to take into account the analogue scale of the potometer provided. However, many candidates inappropriately responded to four significant figures (28.57) and were not able to gain 1 mark. On some scripts, no working was shown and so 1 mark for correctly working out the volume of water lost in 30 minutes, even if the final answer was incorrect, could not be given.

Question 3 (c) (ii)*

(ii)* Describe how the scientist could use the potometer to collect the data needed to assess the effect of temperature on the rate of transpiration in *P. vulgaris*.

Details of how to set up and use a potometer are not needed.

In your answer you should name an appropriate statistical test that could be used to analyse the data.

.....

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.....

.....

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

This level of response question was generally well-attempted by candidates, who demonstrated knowledge of investigative skills developed through their studies. Although many candidates gained credit in line with Level 3, relatively few candidates achieved the communication mark. Despite the question stating that no details of the potometer set-up were needed, a large number of candidates did include this within their responses. Very rarely did candidates suggest an appropriate range of temperatures, with many exceeding 50℃ or going below 10℃. Sometimes only three or four values were suggested (which would be too few to analyse with Spearman's rank correlation coefficient) or candidates didn't give a temperature range at all. Few candidates were able to describe how a change in temperature could be maintained appropriately around the plant within the potometer (e.g. references to using a water bath, which would be inappropriate for a land-based plant, or vague references to using a thermometer). As a result, these candidates would not be able to gain the communications mark. The selection of a Student t-test was commonly seen but was not appropriate for assessing the significance of a correlation between a temperature range (that most candidates chose to include) and the rate of transpiration; it would be appropriate if comparing two temperatures. Many candidates made sound statements relating to undertaking a suitable number of repeats at each temperature and calculating a mean or SD, although some candidates merely stated 'repeat the experiment' which was unclear. The most common controlled variables provided related to the duration of each test, leaf surface area, the light intensity, or humidity. Some answers listed many irrelevant control variables, such as water volume, pH, and carbon dioxide concentration. Few candidates articulated how a variable, such as light intensity, would be controlled.

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Exemplar 1

The distance moved by the air bubble should be ~~calculated~~ measured over 30 minutes at 30°C, 35°C, 40°C, 15°C and 10°C. ~~The~~ The measurement should only begin after the potometer and plant have acclimatised to the new temperature for 15 minutes. ~~The~~ The measurements should be repeated for each temperature 10 times, and the mean and standard deviation of the rate of transpiration should be calculated for each temperature. The rates of transpiration for each temperature should be ranked and Spearmam's rank correlation coefficient can be calculated to determine if there is a positive, negative or no correlation between temperature and rate of transpiration. **[6]**

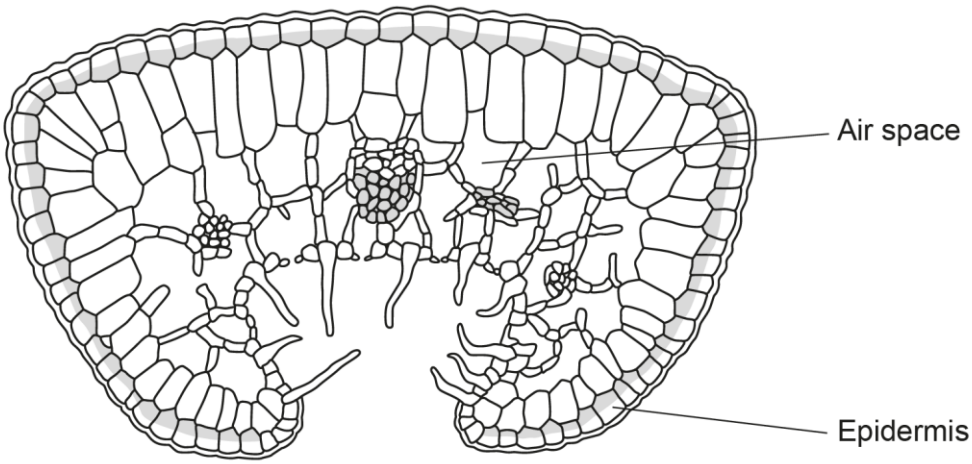
Although the temperatures are listed in an unusual order and are not evenly spaced, this range can be credited as a 'data collected' point. 'Repeated for each temperature' and 'calculate a mean/standard deviation' can also be credited. The answer includes an appropriate statistical test (Spearman's rank). However, there is only one clear control variable (acclimatising for 15 minutes). For Level 3 more than one data collection point is needed (which this answer has), an appropriate statistical test (which this answer has), and more than one control variable point (which this answer does not have). This means that Level 2 is the maximum level that can be awarded. The temperature range given is suitable as is the stats test and the answer does not contain irrelevant information, so the communication mark can be awarded – Level 2, 4 marks.

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Question 3 (d)

(d) Many plants, such as *Erica cinerea* (bell heather), have evolved adaptations to limit water loss by transpiration.

This is a drawing of a leaf of *E. cinerea*.



State and explain how the leaf of *E. cinerea* is adapted to limit water loss by transpiration.

.....

.....

.....

.....

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

Many candidates were able to correctly identify an adaptation of *E. cinerea*. The most frequent correct responses related to a thick waxy cuticle, sunken stomata, and curled leaves. These were often well explained. A noticeable proportion of candidates mentioned a thick epidermis rather than a thick waxy cuticle. Many incorrect responses tried to explain how the air spaces were involved in the reduction of water loss, or their involvement in trapping carbon dioxide for photosynthesis or use in buoyancy in an aquatic plant.

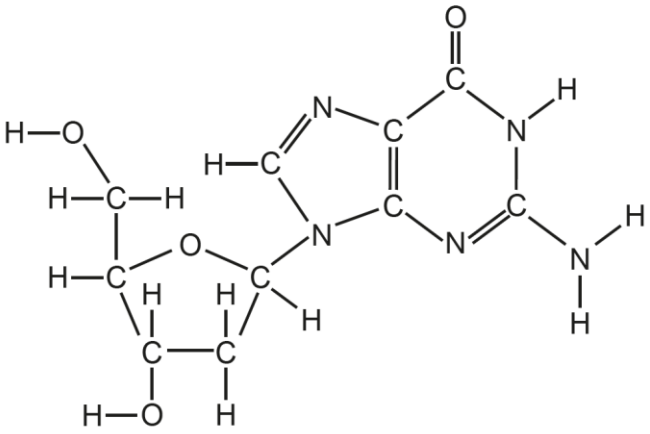
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Question 4 (a)

4 Respiration allows cells to carry out processes such as DNA replication.

(a) Phosphodiester bonds are formed during DNA replication.

The diagram shows a molecule of deoxyguanosine, which consists of deoxyribose bonded to guanine.



Draw **two** circles **on the diagram** around the two parts of the molecule that bond to phosphate when phosphodiester bonds form in DNA. **[2]**

A number of candidates scored 2 on this question for circling the O-H groups or the H atoms on the sugar molecule. Some candidates were unable to be credited marks for including the C atom in their circles, while other candidates circled parts of the guanine molecule.

Question 4 (b)

(b) Outline why cellular respiration is necessary in cells that are carrying out DNA replication.

.....

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

This was well answered by most candidates. Even if they did not give a clear answer as to what the ATP was used for, they could gain the available mark for saying that ATP provides energy or DNA replication requires ATP. Some candidates did not score the mark for this question as they mentioned the use of ATP in protein synthesis, transcription or translation.

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Question 4 (c) (i)

(c) Chemiosmosis is a mechanism that is thought to occur in both respiration and photosynthesis.

(i) Evidence for chemiosmosis during photosynthesis can be demonstrated by:

- isolating chloroplasts from plant cells
- placing the chloroplasts in an acidic solution, in the dark
- shining light onto the chloroplasts in the solution
- measuring the final pH of the solution.

Explain what is likely to happen to the pH of the solution when light is shone on the chloroplasts.

.....

.....

.....

.....

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

This was a challenging question, but a reasonable number of candidates managed to interpret the information provided and explain why the pH of the solution would increase. Some candidates that understood the principles of the process did not gain both marks because they described how the H+ ions would be used inside the chloroplasts without initially explaining that these ions would need to move into the chloroplasts and then into the thylakoid spaces. Other candidates explained that the protons would move from the solution into the chloroplasts, which was credited, but their answer did not state that the protons would move down a concentration gradient by diffusion.

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Question 4 (c) (ii)

(ii) André Jagendorf provided evidence for chemiosmosis in an experiment carried out in the 1960s.

In his experiment, Jagendorf:

- broke open chloroplasts to expose thylakoids, in the dark
- placed the thylakoids into a solution buffered at pH 4 (solution 1)
- after a short time period, transferred some of these thylakoids to a new solution buffered at pH 4 that contained ADP and P_i (solution 2)
- transferred other thylakoids from solution 1 to a new solution buffered at pH 8 that contained ADP and P_i (solution 3).

ATP production was measured in solution 2 and solution 3.

Explain what you would expect to observe in solution 2 and solution 3 after the transfer of the thylakoids.

.....

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.....

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

This was the most challenging question in the examination. Candidates were required interpret the information and make several logical steps to realise that ATP production would occur in solution 3. The majority of candidates suggested that ATP production would be higher in solution 2; the logic of these answers was often that the lower pH and therefore higher H+ ion concentration in that solution had the potential to provide more protons for chemiosmosis. Only the higher performing candidates realised that the initial placement of the thylakoids, in the dark, in a solution of pH 4 would have resulted in a pH of 4 inside the thylakoids. As a consequence, no concentration gradient would have existed across the thylakoid membranes in solution 2 (and no light was present to activate the ETC to allow protons to be pumped into the thylakoids). A concentration gradient would have existed in solution 3, allowing the diffusion of protons through ATP synthase even without the ETC functioning.

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Question 5 (a)*

5 Type 1 diabetes mellitus is characterised by a lack of insulin production. Type 2 diabetes mellitus can involve reduced production of insulin and a decreased response to insulin.

(a)* Scientists analysed the occurrence of diabetes in identical and non-identical twins.

Identical twins have the same DNA. Non-identical twins share approximately 50% of each other's DNA.

The scientists selected 614 pairs of twins in which at least one of the individuals had diabetes: 109 pairs had type 1 diabetes; 505 pairs had type 2 diabetes.

The scientists calculated the percentage probability of an individual having diabetes when their twin has the disease.

The table shows the percentage probability of both individuals in a pair of twins developing either type 1 or type 2 diabetes.

	Percentage probability of both individuals in a pair of twins having the disease	
	Type 1 diabetes	**Type 2 diabetes**
Identical twins	23	34
Non-identical twins	5	16

Explain what conclusions can be drawn from the data in the table about the influence of the environment and genetics on the probability of developing diabetes.

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.....

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

This question included a strong element of stretch and challenge. The data presented to candidates was unusual and from a study that had some limitations. Importantly, the data contradicted some of the understanding many candidates may have about the relative influence of genetics and the environment on the risk of developing diabetes. Therefore, this question was a data analysis and evaluation question rather than requiring prior knowledge of diabetes causes. Candidates that interpreted the data correctly were able to score full marks. However, many candidates attempted to fit their understanding of the causes of diabetes to the data, rather than allowing the data to lead them to conclusions.

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Candidates had to state clearly that the data showed that both type 1 and type 2 diabetes were influenced by both genetics and the environment. More successful candidates recognised that if the only influence was genetic, then all the identical twins would have type 1 or type 2 diabetes.

As the percentage concordance for each type of diabetes was less than 100 but more than 0 for identical twins, there must be an environmental and a genetic influence on each type of diabetes

Some more successful candidates noted that the percentage concordance for identical twins was less than 50 for both types of diabetes, so the dominant influence in both type 1 and type 2 diabetes was environmental.

Others noted that both types of twins had a higher percentage for type 2, concluding that the genetic influence on type 2 was greater than for type 1.

Few candidates identified that the study was unreliable, or conclusions were limited due to flaws in the design. Less successful candidates who attempted to make this point referred to a lack of a control group which did not apply in this study.

Misconception



Many candidates attempted to use the data to support the misapprehension that type 1 diabetes was only influenced by genetics and type 2 only by the environment. In fact, both types of diabetes are influenced by both genetics and the environment.

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Exemplar 2

Both types of diabetes are influenced by environmental factors. Type 1 diabetes is much more likely to occur in identical twins who share all their DNA than in non-identical twins who only share half their DNA (23% in identical vs 5% in non-identical). Type 1 diabetes is very likely to be influenced by genetic factors. However, environmental factors still influence to some degree, as not all identical twins both have type 1 diabetes. Type 2 diabetes is also likely to have a genetic factor as more identical twins (34% both) both have it than non-identical twins (16% both). However, environmental factors play a larger ~~role~~ role because more non-identical twins both have type 2 diabetes than type 1 diabetes (16% vs 5%). Non-identical twins are more likely to share lifestyles than genes, as they were likely brought up similarly. **[6]**

This answer has stated that both types of diabetes have potential genetic and environmental components. These points are scattered throughout the answer, as was often the case with this first conclusion (other conclusions are much more likely to be found as a single statement).The idea that the environment has some influence on type 1 diabetes as not all identical twin pairs have type 1 diabetes is the explanation for this conclusion (i.e. there must be environmental influence as well as genetic as less than 100% of identical twins both have type 1 diabetes) So this answer has both a conclusion and explanation – gains Level 2, 3 marks. The communication mark was not credited because the conclusion was not stated clearly.

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Exemplar 3

From the data in the table, it can be concluded that both type 1 and type 2 diabetes have a genetic link as the % probability of both individuals having the disease is higher in identical twins for both type one and type 2. It may be suggested that type 2 diabetes has a stronger genetic link as there ~~was~~ was a higher probability in non identical twins for ~~type~~ type 2 than type one. However, the sample size for the twins with type 2 was much greater than that of type 1 (505 pairs vs 109 pairs respectively). This means that a causal relationship (direct cause and effect) may not be able to be found due to the difference in sample size. However despite this, it cannot be said that either type 1 or 2 is 100% genetic as if it was, the probability of identical twins both having the disease will also be 100% as they share 100% the same DNA. This means that there must be environmental factors having an effect on the development of diabetes **[6]**

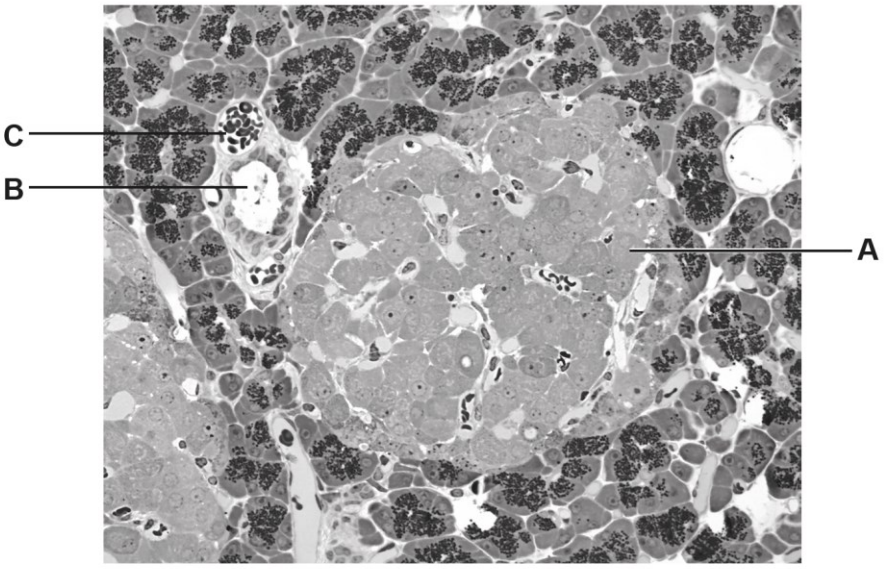
This answer has stated that both types of diabetes have potential genetic and environmental links, but these points are scattered throughout the answer. They go on to state that the diabetes is not entirely genetic as identical twins should be 100% and so has the explanation for this conclusion. They also conclude that genetics has a greater effect on type 2 diabetes as there is a higher probability of both non - identical twins having type 2 diabetes than type 1. Finally, they mention that any conclusions drawn are limited due to the relevant sample sizes of twins with type 1 and 2 diabetes. This is a clear Level 3 answer worth 6 marks.

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Question 5 (b)

(b) Insulin is secreted from cells in the pancreas.

This is a photomicrograph of pancreatic tissue.



Identify the structures labelled **A**, **B** and **C**.

A .....

B .....

C .....

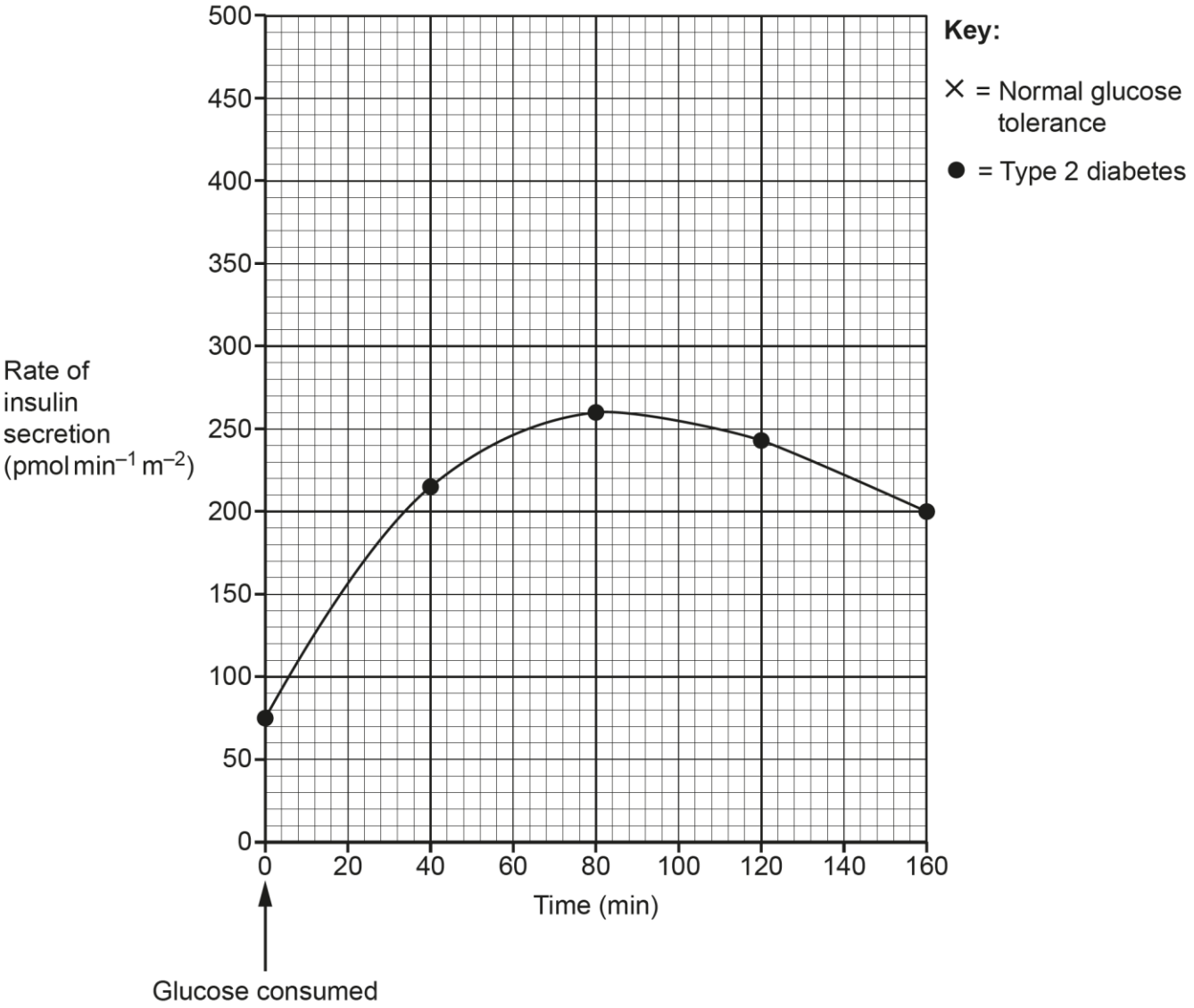
[3]

Most candidates correctly identified A as an islet of Langerhans. Credit was also given if A was identified as an α–cell or a β-cell. More successful answers recognised B as a (pancreatic) duct and C as a blood vessel, or a red blood cell inside the blood vessel. Marks were not gained due to references to the blood vessels being hepatic rather than pancreatic, or for thinking that C was a capillary which was not allowed as it contains too many erythrocytes.

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Question 5 (c)

(c) The graph shows the changes in the rate of insulin secretion in a person with type 2 diabetes after consuming glucose.



The table shows the changes in the rate of insulin secretion in a person with normal glucose tolerance after consuming glucose.

Time (min)	Rate of insulin secretion (pmol min^{-1} m^{-2})
0	60
40	460
80	365
120	299
160	190

Plot the data from the table **on the graph and** draw a line of best fit. **[2]**

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Candidates were required to plot five points and draw a line of best fit. The majority of candidates plotted the points correctly, but the line of best fit was less successful. The line mark was not credited for drawing a straight line instead of a curved one or for sketching the line, so that in places there were two lines. Successful candidates drew a smooth curve which passed through points 1, 2 and 5, and either passed between points 3 and 4 or only touched one or both of them.

Question 5 (d)

(d) The table lists statements about a molecule of insulin.

Complete the table by stating the level of protein structure (primary, secondary, tertiary or quaternary) to which the statement relates.

Statement	Level of protein structure
It consists of two polypeptide chains (A and B) that are linked by disulfide bonds.	
Chain A consists of a sequence of 21 amino acids.	
Chain A contains a disulfide bond between cysteine amino acids.	
Chain B contains both α-helix and β-pleated sheet structures.	

[2]

This was generally well answered. Candidates commonly found the primary structure easiest to identify and tertiary and quaternary the most difficult to distinguish between.

Question 5 (e) (i)

(e) Bacteria can be genetically modified to produce insulin.

(i) State how a plasmid containing the gene coding for insulin can be transferred into a bacterial cell.

.....

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

A variety of methods were accepted for this question. The most common answer was electroporation or heat shock. However, some candidates were unable to be credited the mark for mentioning electrofusion or just a vector on its own with no reference to a virus being used.

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Question 5 (e) (ii)

(ii) Suggest how bacterial cells can be screened to check if they have taken up a recombinant plasmid.

.....

.....

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

Some candidates answered this question correctly by stating the use of marker genes or the use of antibiotic resistance genes added to the plasmid. However, there were a few candidates who mentioned the process of replica plating but with no reference to antibiotic resistance genes and so gained no marks. Many candidates gained no marks for mentioning using fluorescent tags or dyes rather than adding a gene for fluorescence.

Question 5 (f) (i)

(f) In the future, type 1 diabetes could be treated by giving patients new pancreatic β-cells that have been produced in a laboratory from stem cells.

(i) State a feature of stem cells that allows them to be used to produce pancreatic β-cells.

.....

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

Nearly all candidates recognised that stem cells are undifferentiated, with most continuing to say that they could differentiate to form many types of cells, to gain credit.

Question 5 (f) (ii)

(ii) Future treatments for type 1 diabetes may be able to use stem cells from a patient's body to produce new β-cells.

Explain why patients receiving these new β-cells would still need to be given immunosuppressant drugs.

.....

.....

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

This proved to be a demanding question. Very few candidates seemed to notice that the new cells were from the patient, and more candidates referred to autoimmune disease in Question 5 (a) than in this question. Candidates were required to recognise that although the new cells came from the patient, the autoimmune response would need to be suppressed, as their own beta cells were regarded as foreign and therefore were being attacked.

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Question 6 (a)

6 Plants can be cloned and propagated in horticulture and agriculture.

(a) Describe how artificial clones of plants are produced using micropropagation.

.....

.....

.....

.....

.....

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

Generally, a well answered question, with many candidates scoring 4 marks for successfully describing the process of micropropagation. To improve their response, candidates could give details of why a specific nutrient is required or the purpose of the plant hormone applied. Some candidates were not credited the first mark point as they did not mention where the meristematic tissue was being removed from, e.g. Shoot tip. Some candidates incorrectly gave details of taking cuttings; however, many were still able to score one or two marks for using aseptic techniques and transferring the cutting to soil.

Question 6 (b)

(b) Potato plants can be naturally cloned from tubers.

Many diseases can infect potato plants.

State **one** disease that can infect potato plants **and** state the type of pathogen that causes the disease.

Disease .....

Type of pathogen .....

[2]

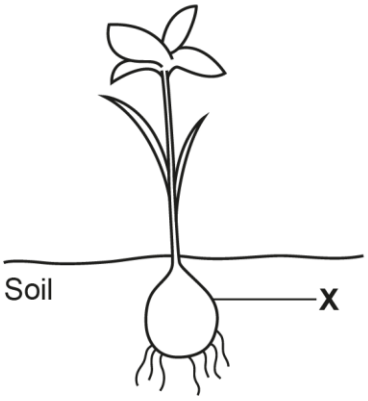
There were several correct possible responses which were mentioned commonly, including ring rot being caused by a bacterium and potato blight being caused by a Protoctista. However, there were also many candidates who were unable to be credited marks as they thought potato blight was caused by a fungus.

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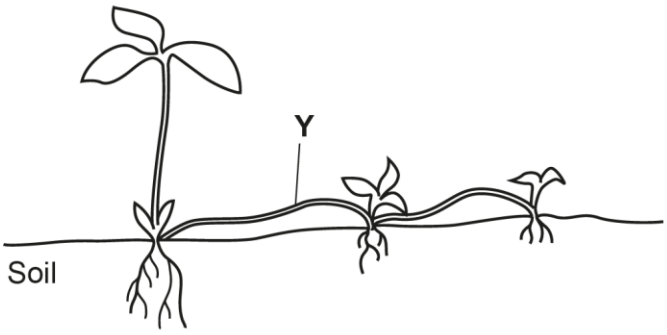
Question 6 (c) (i)

(c) The diagram shows a lily plant and a peppermint plant.

Lily plant



Peppermint plant



(i) State the name of structure **X and** outline how a gardener could produce many cloned plants from structure **X**.

.....

.....

.....

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

Most candidates were able to label structure X as a bulb or tuber. They often did not get the second marking point as they did not mention dividing the bulb before replanting. They often replanted the whole bulb or described taking a cutting from the stem rather than the bulb. Some candidates, perhaps prompted by Question 6 (a), described using micropropagation techniques which would not be appropriate for a gardener to employ.

Question 6 (c) (ii)

(ii) State the name of structure **Y and** describe the process by which a new plant can form naturally from structure **Y**.

.....

.....

.....

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

Several candidates did know that structure Y was a horizontal stem or runner. However, they did not always get the second mark point as they did not mention that the runner grows away from the parent and then forms roots and shoots. Only a few candidates mentioned that the runner between plant dies or withers away.

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Question 3 (b) (ii): Primula stem micrograph, © Marek Mis / Science Photo Library

Question 5 (b): Pancreas tissue micrograph, © Jose Calvo / Science Photo Library

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