OCR
Oxford Cambridge and RSA

Wednesday 19 June 2024 – Morning

A Level Biology A

H420/03 Unified biology

Time allowed: 1 hour 30 minutes

You can use:
- a scientific or graphical calculator
- a ruler (cm/mm)

H420/03

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

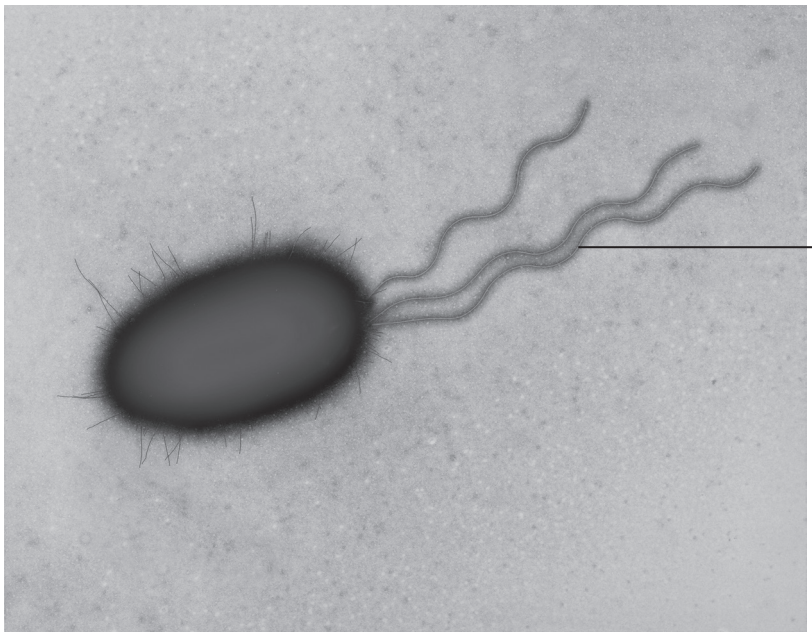
INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

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]**

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

Give your answer in μm.

Diameter = ... μm **[1]**

(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 .....

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2 .....

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[2]

(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]**

(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.

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[2]

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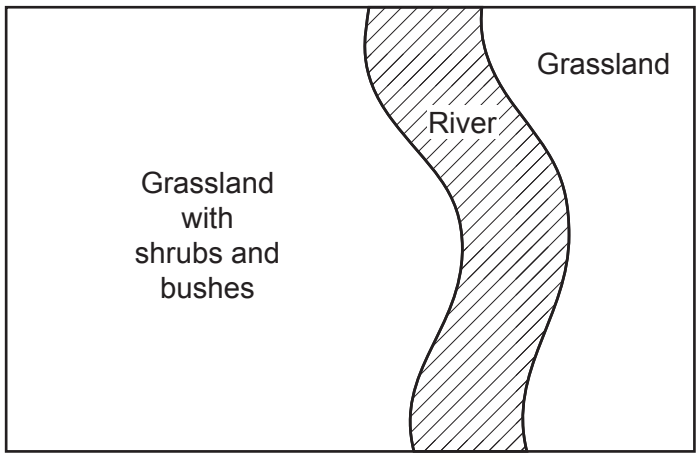
2 Species biodiversity is affected by many factors.

(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 .....

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Explanation .....

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Improvement .....

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Explanation .....

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[4]

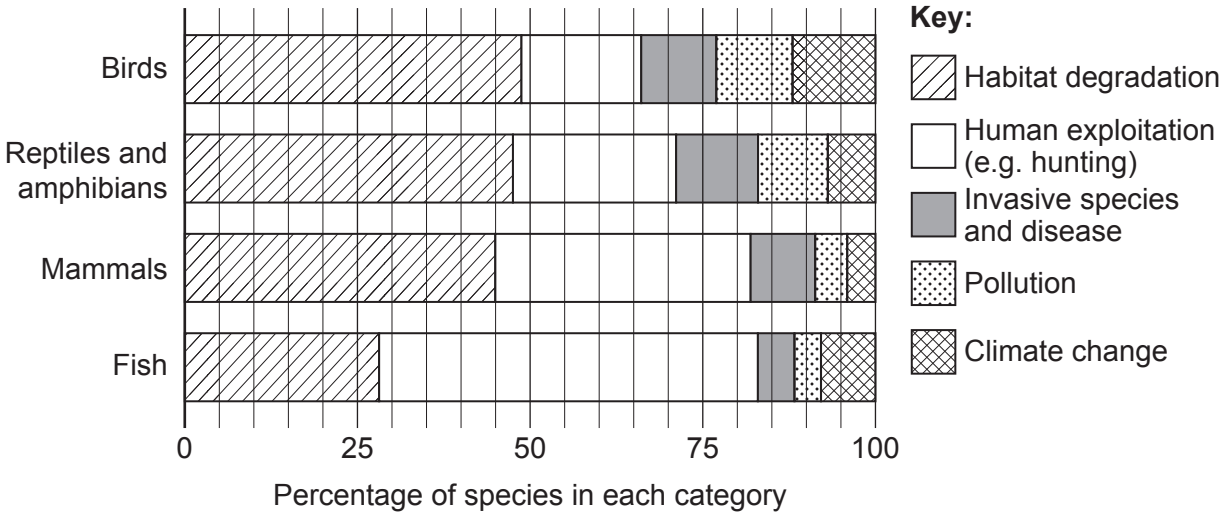
(b) The International Union for Conservation of Nature (IUCN) compiles a list of species and their conservation status, known as the Red List of Threatened Species.

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.

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

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

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

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

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]

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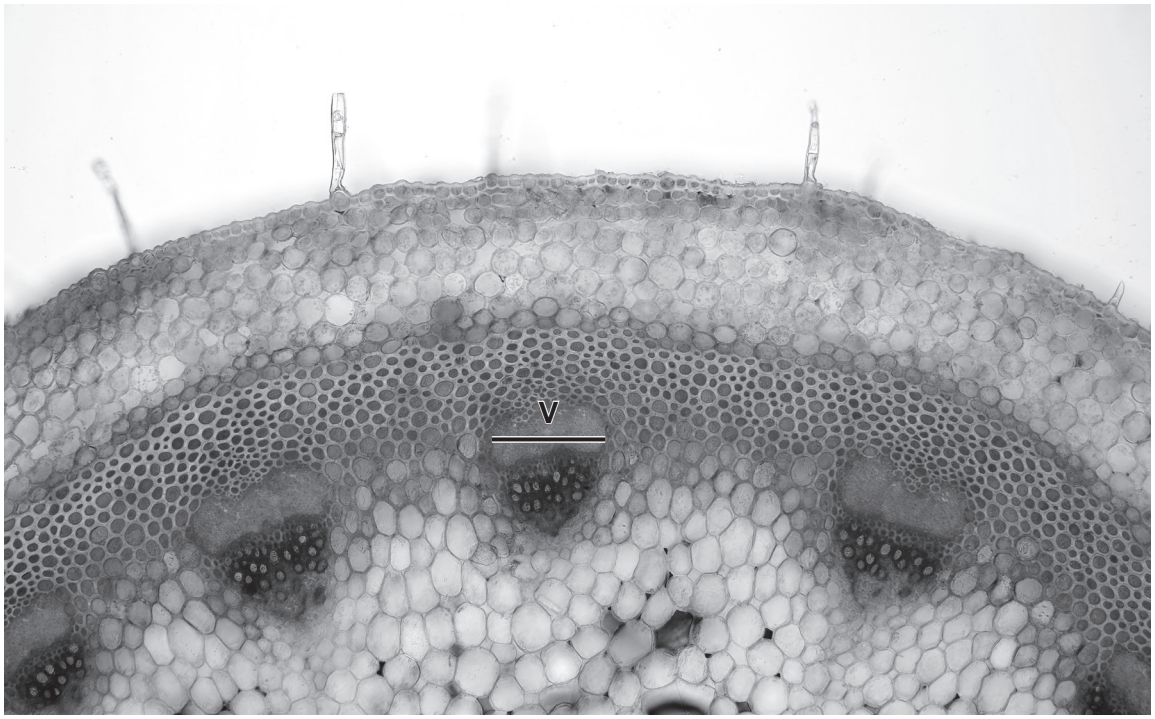
..... **[2]**

(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**.

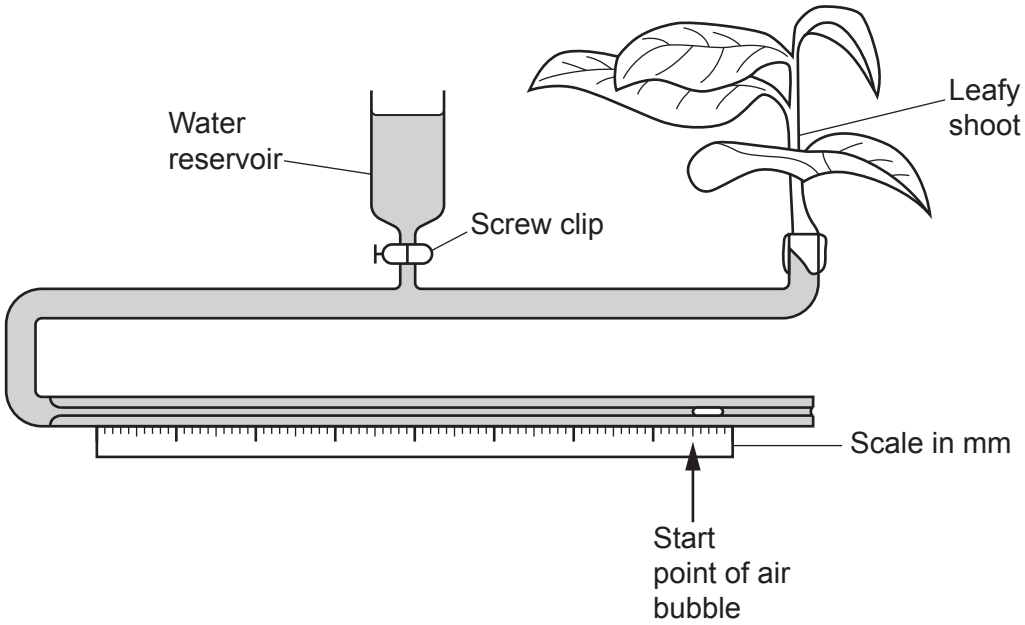
Calculate the actual diameter of the vascular bundle labelled **V**.

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

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

(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]**

(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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Extra answer space if required.

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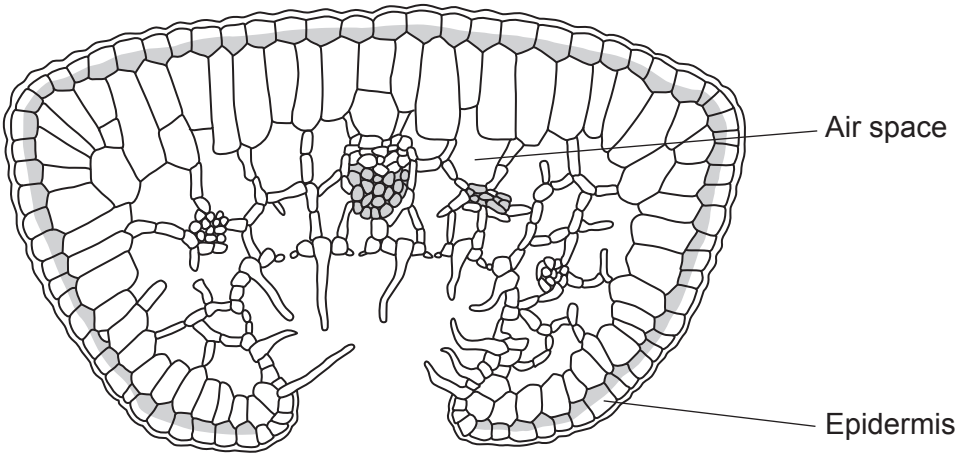
(d) Many plants, such as *Erica cinerea* (bell heather), have evolved adaptations to limit water loss by transpiration.

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.

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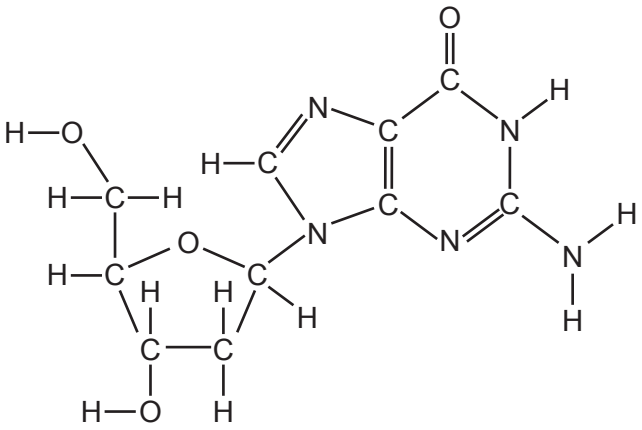
..... **[2]**

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]**

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

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(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.

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

(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]**

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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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Extra answer space if required.

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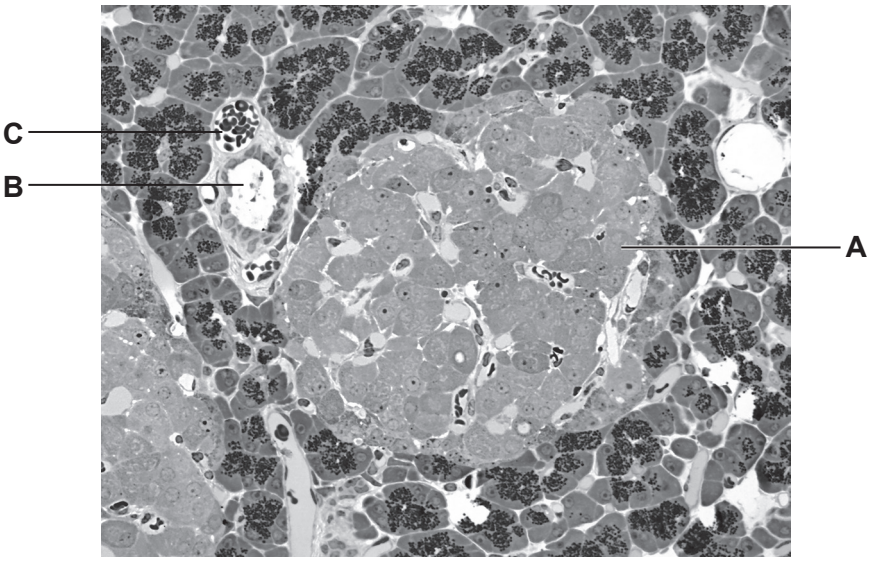
(b) Insulin is secreted from cells in the pancreas.

This is a photomicrograph of pancreatic tissue.



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

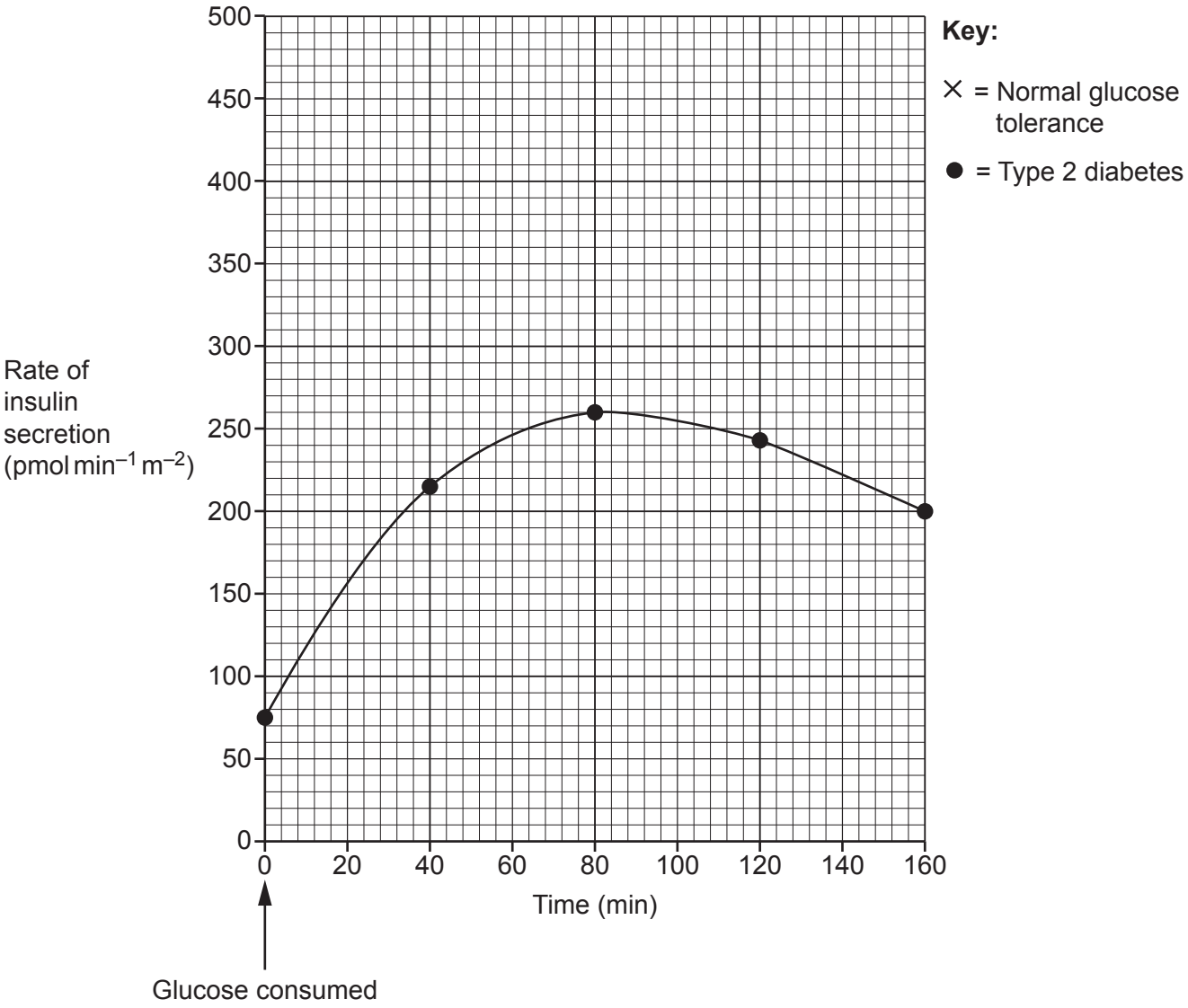
A .....

B .....

C .....

[3]

(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]**

(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]

(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.

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

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

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

(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.

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

(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.

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

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

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

(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.

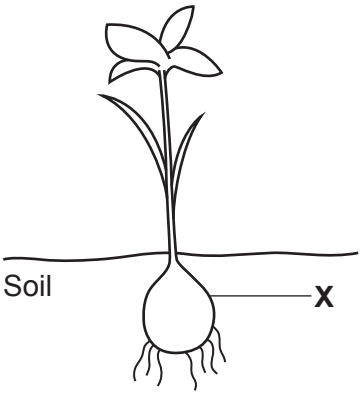
Disease .....

Type of pathogen .....

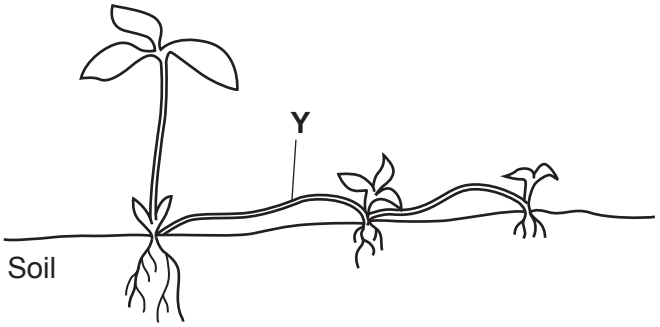
[2]

(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**.

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

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

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

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.