OCR
Oxford Cambridge and RSA

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Wednesday 15 June 2022 – Morning
GCSE (9–1) Biology B (Twenty First Century Science)
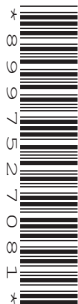
J257/04 Depth in Biology (Higher Tier)

Time allowed: 1 hour 45 minutes

You must have:
• a ruler (cm/mm)

You can use:
• an HB pencil
• a scientific or graphical calculator

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 **90**.
• 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.

Turn over

Answer **all** the questions.

1   The pupil of the human eye changes size in different light levels.

   (a) A diagram of the eye is shown in **Fig. 1.1**.
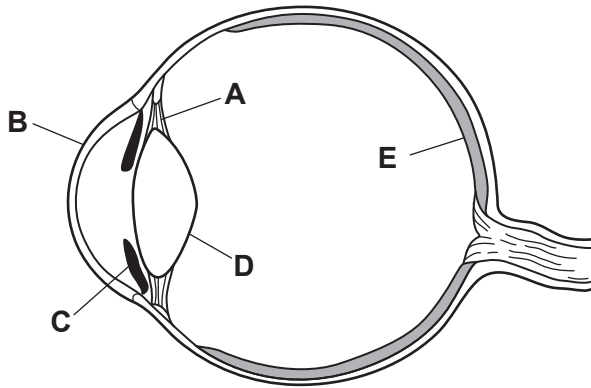
Fig. 1.1

Which structure in the eye changes the size of the pupil?

Tick (✓) **one** box.

A   Ciliary muscles ☐

B   Cornea ☐

C   Iris ☐

D   Lens ☐

E   Retina ☐

[1]

   (b) The pupil changing size is a reflex action that happens in response to light. It uses a reflex arc in the nervous system.

   The pupil reflex arc includes a sensory neuron that connects the eye to the spinal cord.

   State **two other** types of neurons that must be part of the pupil reflex arc.

   1 ....

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

(c) Ali plans to investigate the effect of light brightness on the diameter of the pupil of a person's eye.

The method Ali plans to use is shown in **Fig. 1.2**.

1.   Shine a bright light into the person's eye.
2.   Hold a ruler up to their eye and measure the diameter of the pupil.
3.   Repeat with light at a different brightness.

Fig. 1.2

Ali's teacher says that Ali's method is not safe and could damage the person's eye.

(i) Identify the structure in the person's eye that could be damaged by step **1**, and suggest why the damage would affect the person's vision.

Structure that could be damaged ....

Why this would affect the person's vision ....

....

....
[2]

(ii) Identify the structure in the person's eye that could be damaged by step **2**, and suggest why the damage would affect the person's vision.

Structure that could be damaged ....

Why this would affect the person's vision ....

....

....
[2]

Turn over

(d) A scientist uses a safer method to collect the data as shown in the graph in **Fig. 1.3**.
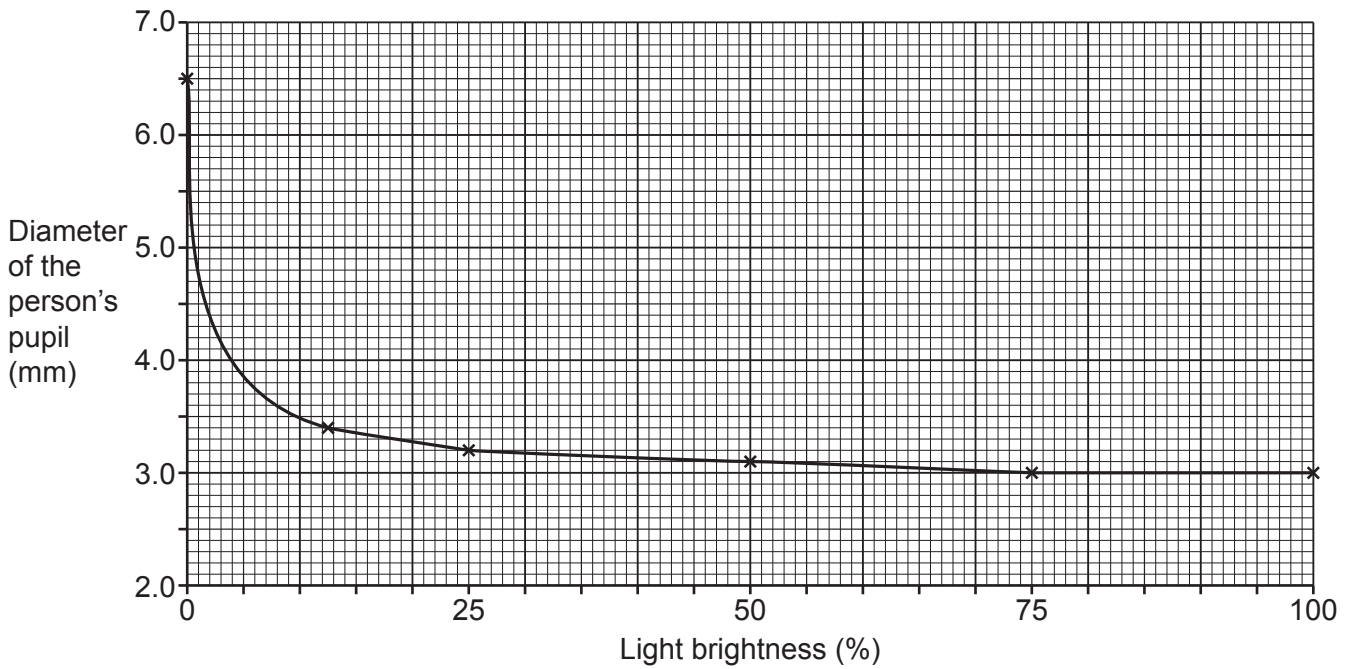
Fig. 1.3

Use **Fig. 1.3** to answer the following questions.

(i) What was the diameter of the person's pupil in complete darkness?

Diameter = ... mm **[1]**

(ii) What would you conclude is the smallest possible diameter of the person's pupil?

Explain your answer.

Smallest possible diameter = ... mm

Explanation ....

....

[2]

(iii) Calculate the rate at which the pupil diameter changed between 25% and 50% light brightness.

Rate = ... mm/% **[2]**

(e)* Describe a method that can be used to collect the data shown in **Fig. 1.3**.
Assume that 100% light brightness is a normally lit room.

In your answer you should describe:

- how you would safely change the light brightness and measure the results

- things you would do or control to make sure the measurements are as accurate as possible.

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.... **[6]**

2 *Elysia* sea slugs are very unusual animals.

(a) The sea slugs eat algae. The slugs take chloroplasts from the algae cells. The chloroplasts stay inside the slugs and continue to work.

Suggest why it is an advantage to a sea slug to have working chloroplasts in its body.

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....

....

.... **[2]**

(b) When a sea slug's body is attacked by predators, its head can separate from the body.

The head continues to live and grows a new body. All of the different tissues and organs for the slug's new body grow from a particular type of cell.

(i) From which type of cell must the slug's new tissues and organs grow?

Put a (ring) around the correct answer.

Gametes   **Meristem**   **Nerve cells**   **Stem cells**

[1]

(ii) Explain how these cells make tissues and organs for the slug's new body.

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.... **[4]**

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3 Gentoo penguins live on islands near South America.

(a) The number of Gentoo penguins on the islands is decreasing.

Suggest **one** factor that could have caused the decrease in the number of Gentoo penguins.

....

.... **[1]**

(b) Scientists used to think all the Gentoo penguins were the same species.

The penguins look very similar to each other. It's very hard to tell them apart just with your eyes.
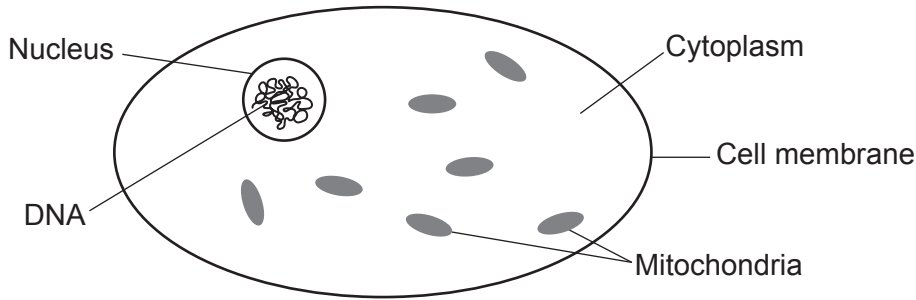
New evidence suggests that there are four different species of Gentoo penguins.

Describe evidence that scientists could have collected from the penguins' cells to show that there are four different species.

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.... **[2]**

(c) The diagram shows a cell from a Gentoo penguin.

The presence of mitochondria shows that this is a eukaryotic cell.

Which other structure shows that this is a eukaryotic cell?

Tick (✓) **one** box.

Cell membrane ☐

Cytoplasm ☐

DNA ☐

Nucleus ☐

[1]

(d) If a cell contains a vacuole, this suggests it could be a plant cell.

State **one other** structure that suggests a cell is a plant cell.

.... **[1]**

(e) The length of a cell is 0.00002 m.

How is the length of the cell written in standard form?

Put a ⟨ring⟩ around the correct answer.

2 × 10^{-5} m   **2 × 10^{-4} m**   **2 × 10^{4} m**   **2 × 10^{5} m**

[1]

(f) The length of a mitochondrion is 3×10^{-6} m.

What is another way to write the length of the mitochondrion?

Put a ⟨ring⟩ around the correct answer.

0.0003 m   **0.00003 m**   **0.000003 m**   **0.0000003 m**

[1]

4 Bacteria can become resistant to antibiotics.

(a) Charlie investigates whether a type of bacteria can grow in different antibiotics.

- Charlie uses aseptic techniques to add a drop of liquid containing the bacteria to the centre of each of four Petri dishes.
- Each Petri dish already contains a different antibiotic.
- The four Petri dishes are incubated for 24 hours.

The appearance of the four Petri dishes after incubation is shown in **Fig. 4.1**.

Bacterial culture

Antibiotic

Petri dish containing antibiotic **A**

Petri dish containing antibiotic **B**

Petri dish containing antibiotic **C**
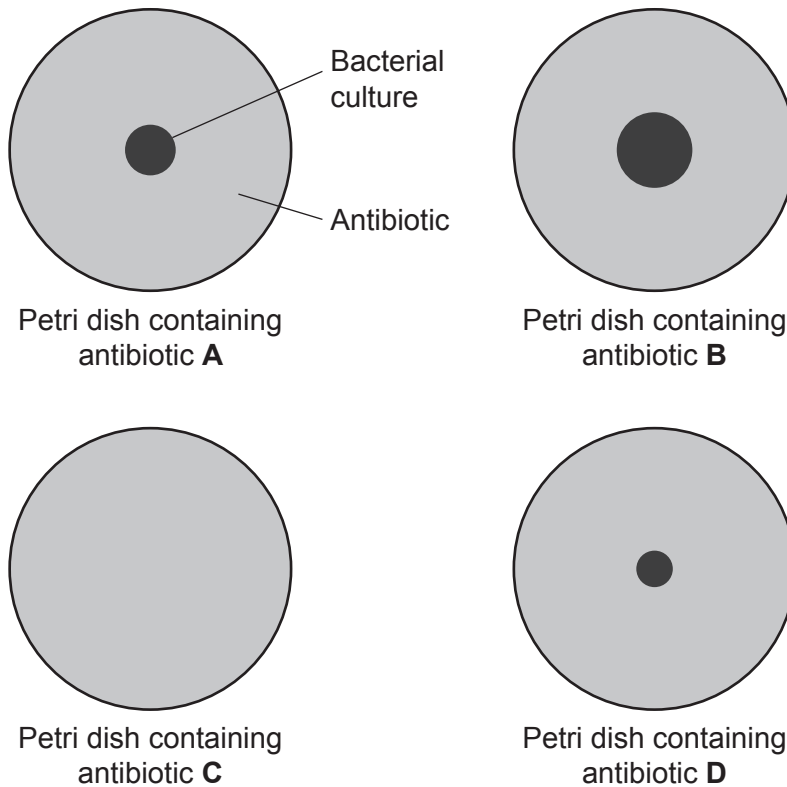
Petri dish containing antibiotic **D**

Fig. 4.1

(i) In the Petri dish containing antibiotic **B**, the bacterial culture has a radius (r) of 5 mm.

Calculate the area of the bacterial culture in this Petri dish.

Use the equation: area = $3.14 \times r^2$

Area = ... mm^2 **[2]**

(ii) Which antibiotic would be the **best** choice to treat a sick patient who was infected with this type of bacteria?

Describe the evidence in **Fig. 4.1** that supports your choice.

Antibiotic ....

Evidence ....

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[3]

(b) **Fig. 4.2** shows the number of infections (rounded to the nearest 100) with antibiotic-resistant bacteria in England over four years.
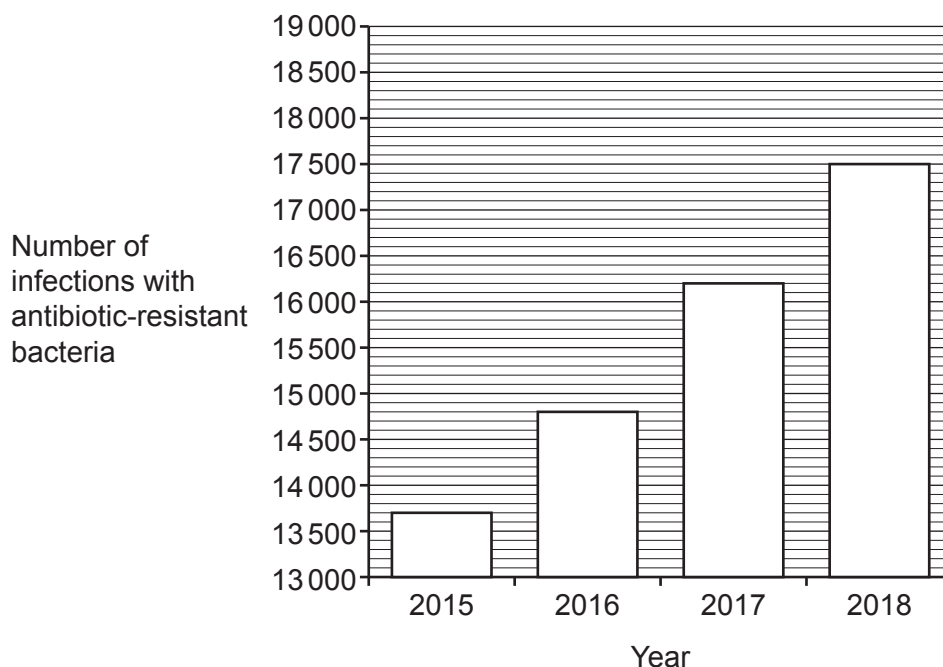

Fig. 4.2

(i) Calculate the percentage increase in the number of infections with antibiotic-resistant bacteria from 2017 to 2018.

Give your answer to **1** significant figure.

Percentage increase = ... % **[3]**

Turn over

(ii) Predict what the number of infections with antibiotic-resistant bacteria might have been in 2019.

Explain your answer.

Prediction ....

Explanation ....

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[3]

(c) A bacterium can become resistant to an antibiotic if it receives a plasmid from another bacterium.

(i) Explain what a plasmid is.

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.... **[2]**

(ii) Explain how receiving a plasmid causes a bacterium to become resistant to an antibiotic.

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.... **[2]**

(iii) Explain how a bacterium could become resistant to an antibiotic **without** receiving a plasmid.

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.... **[2]**

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5 Photosynthesis takes place in plants.

(a) Starch is a carbohydrate that is made when a plant photosynthesises.

Sam investigates the effects of different conditions on the presence of starch in three plant shoots. All three plants are given plenty of water throughout the experiment.

The method Sam uses for the experiment is shown in **Fig. 5.1**.

1. Keep three plant shoots in a dark place for two days.
2. **Test 1:** Cut a small piece of leaf tissue from each plant **A**, **B** and **C**. Test the pieces of leaf tissue for starch.
3. Wrap the leaf of plant **B** in metal foil.
4. Put the leaf of plant **C** inside an open conical flask containing potassium hydroxide solution to absorb carbon dioxide.
5. Keep the three plant shoots in bright light for one day.
6. **Test 2:** Cut a small piece of leaf tissue from each plant. Test the pieces of leaf tissue for starch.

Fig. 5.1

Fig. 5.2 shows the plants during step 5 of Sam's method.
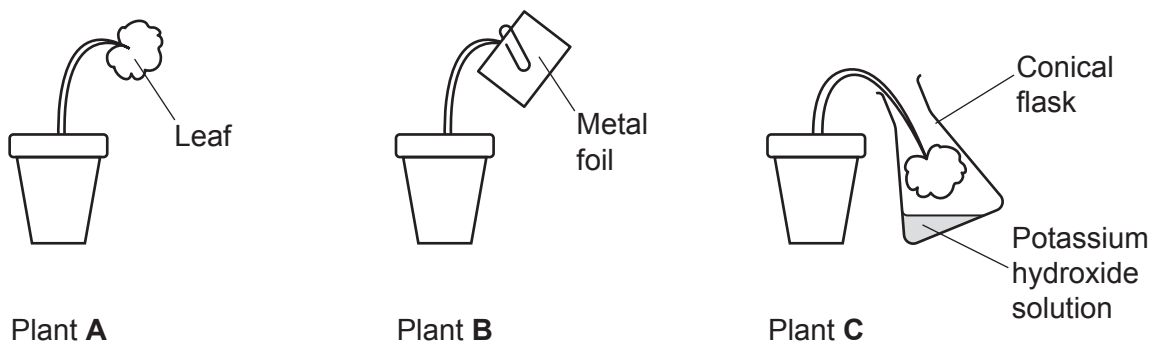
Fig. 5.2

Some of Sam's results are shown in **Table 5.1**.

Plant	Result of test 1	Result of test 2
A	Reagent appeared light brown	
B	Reagent appeared light brown	Reagent appeared light brown
C	Reagent appeared light brown	

Table 5.1

(i) State the name of the reagent used to test for starch.

.... [1]

(ii) Describe a conclusion that can be made from the result of test **2** for plant **B**.

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.... [2]

(iii) Predict the result of test **2** for plant **A**.

Explain your prediction.

Prediction ....

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Explanation ....

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[3]

(iv) Stores of starch can be broken down to make glucose.

Suggest how this helps to explain the result of test **1** for plant **A**.

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.... [2]

(v) Suggest why it is helpful to keep the three plants in the dark for two days at the start of the experiment (step 1).

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.... [2]

Turn over

(vi) Sam predicts that test **2** for plant **C** would show **no** starch was present. However, the test shows that starch **is present**.

Describe **and** explain **one** improvement to their method that would produce the result Sam predicted for test **2** for plant **C**.

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.... **[2]**

(b) A tank of water containing living pondweed is placed next to the window. Pondweed is a plant that lives in water.

Fig. 5.3 shows how the amounts of oxygen and carbon dioxide in the water changes over 24 hours.

Fig. 5.3

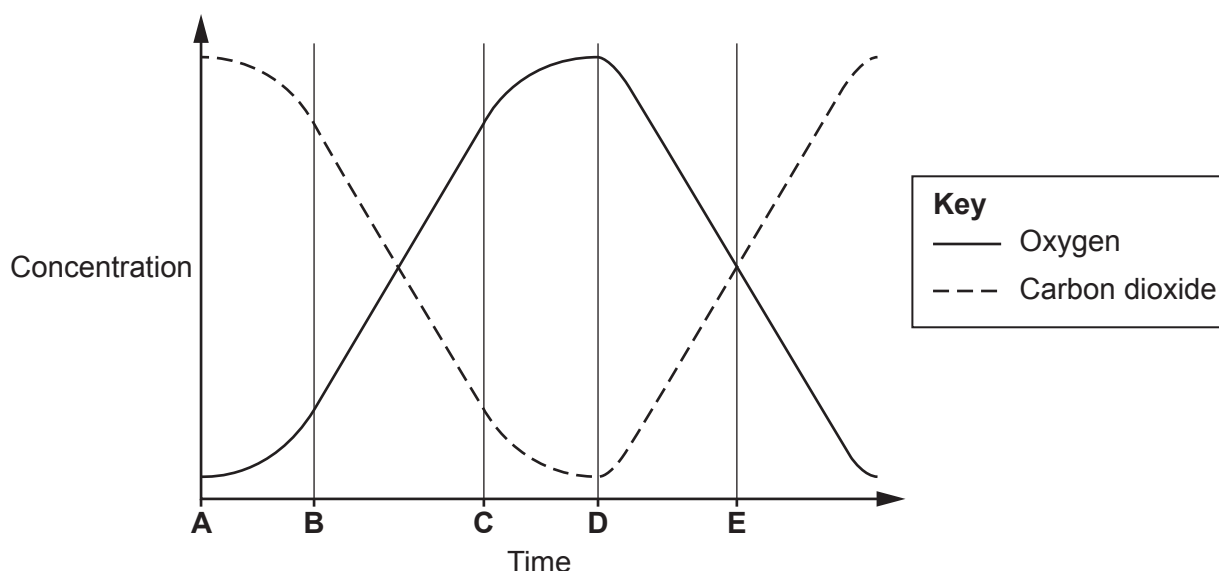Five time points in **Fig. 5.3** have been labelled **A**, **B**, **C**, **D** and **E**.

(i) At which time point were the concentrations of oxygen and carbon dioxide exactly the same?

Time point .... **[1]**

(ii) Between which **two** time points is the line for oxygen represented by the equation $y = mx + c$?

Time points .... and .... **[1]**

(iii)* A student concludes that time point **D** is sunset.

Describe **and** explain how **Fig. 5.3** supports the student's conclusion.

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.... **[6]**

Turn over

6 Plants that grow in soil absorb water and nitrate ions through their roots.

Two cells from the outside edge of a root are shown in the diagram.
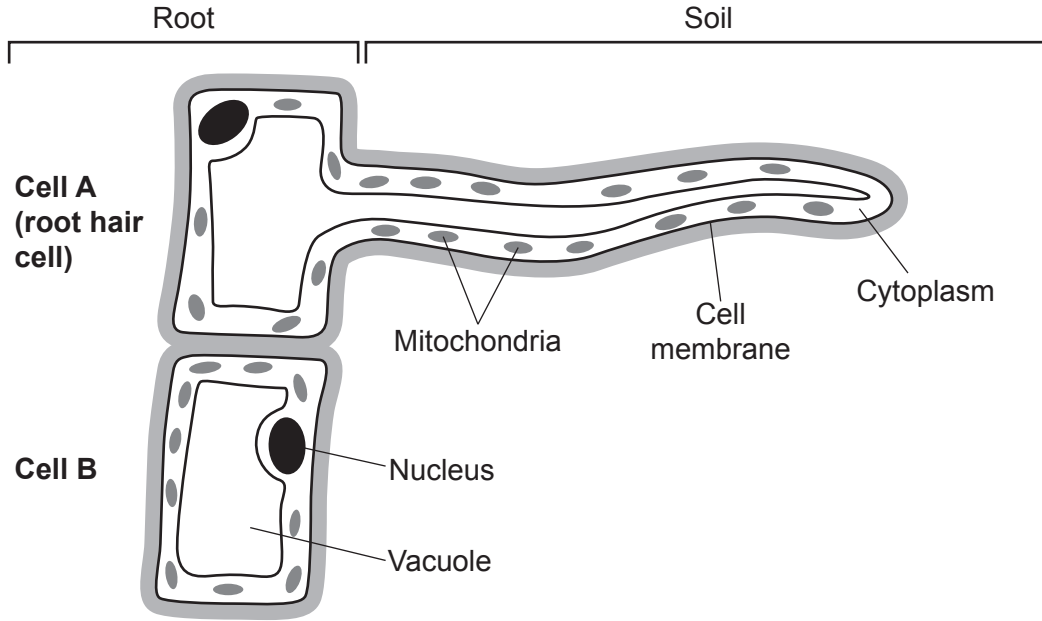
(a) Which statement explains why the cell membrane of the root hair cell is described as "partially permeable"?

Tick (✓) **one** box.

Both water molecules and nitrate ions can diffuse through the membrane. ☐

Neither water molecules nor nitrate ions can diffuse through the membrane. ☐

Only the nitrate ions can diffuse through the membrane. ☐

Only the water molecules can diffuse through the membrane. ☐

[1]

(b) Explain how water molecules are absorbed into the root hair cell from wet soil.

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.... **[3]**

(c) Explain how nitrate ions are absorbed into the root hair cell from the soil.

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.... **[3]**

(d) Explain why the structure of cell **A** means it is better than cell **B** at absorbing substances from the soil.

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.... **[2]**

7 Scientists are developing new vaccines against human diseases such as influenza.

(a) New vaccines must be tested before they can be approved for widespread use in the population.

(i) New vaccines are tested in pre-clinical trials before they are tested in humans.

Describe **two** ways in which a new influenza vaccine could be tested in **pre-clinical** trials.

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.... **[2]**

(ii) The next stage of testing involves clinical trials in human volunteers.

A new **medicine** is usually tested in two groups of people. First, it is tested in:

• Group 1: Healthy people who do **not** have the disease.

Then it is tested in:

• Group 2: People who have the disease.

Suggest why a new **vaccine** is tested in group 1 but **not** in group 2.

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.... **[3]**

(b) One new type of vaccine against influenza is made of mRNA. The vaccine contains mRNA taken from the influenza virus.

- When a person is vaccinated, influenza mRNA from the vaccine enters some of the person's cells.
- These cells use the mRNA to make influenza protein.

(i) Describe how the person's cells will use the influenza mRNA to make influenza protein.

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.... **[3]**

(ii) Explain how the person's body will react to the influenza protein **and** how this could protect them from catching influenza in the future.

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.... **[4]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).