Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **October/November 2024**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **24** pages. Any blank pages are indicated.

DC (CJ/SW) 337363/5

1 (a) Animal cells, plant cells and prokaryotic cells have similarities and differences in their structure.

Table 1.1 lists five organelles found in cells.

Complete Table 1.1 by placing a tick (✓) to show whether the organelle is present in animal cells, plant cells and prokaryotic cells or a cross (✗) if the organelle is absent.

Put a tick (✓) or a cross (✗) in every box.

The first row has been completed for you.

Table 1.1

organelle	cell type		
	animal cells	plant cells	prokaryotic cells
nucleus	✓	✓	✗
large permanent vacuole			
rough endoplasmic reticulum			
Golgi body			
centrioles			

[4]

(b) Fig. 1.1 shows a section through part of an epithelial cell found in the digestive system of an animal.

The cell is specialised for absorption of digested food.

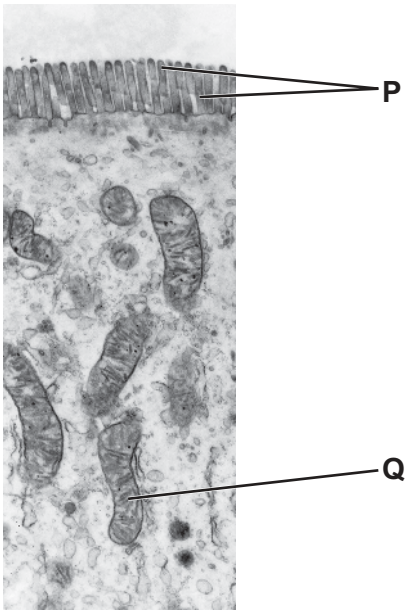

Fig. 1.1

The structures labelled **P** and **Q** in Fig. 1.1 are involved in the absorption of digested food.

(i) Name the structures labelled **P**.

..... [1]

(ii) Explain how the organelle labelled **Q** in Fig. 1.1 is involved in this process.

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..... [2]

[Total: 7]

2 **(a)** In the mammalian circulatory system, red blood cells travel through different types of blood vessel as they pass from the heart to respiring tissues and back to the heart.

Fig. 2.1 shows the types of blood vessels through which red blood cells travel in the circulatory system.

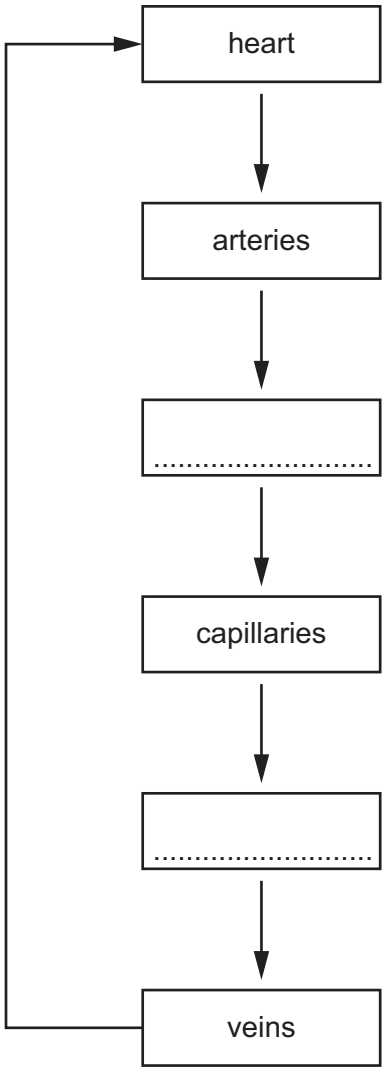

Fig. 2.1

Complete Fig. 2.1 by writing the names of the missing types of blood vessels through which red blood cells travel. [2]

(b) Water is the main component of blood. It has an important role in the transport of substances around the body.

Fig. 2.2 shows the ionic compound sodium chloride dissolving in water.

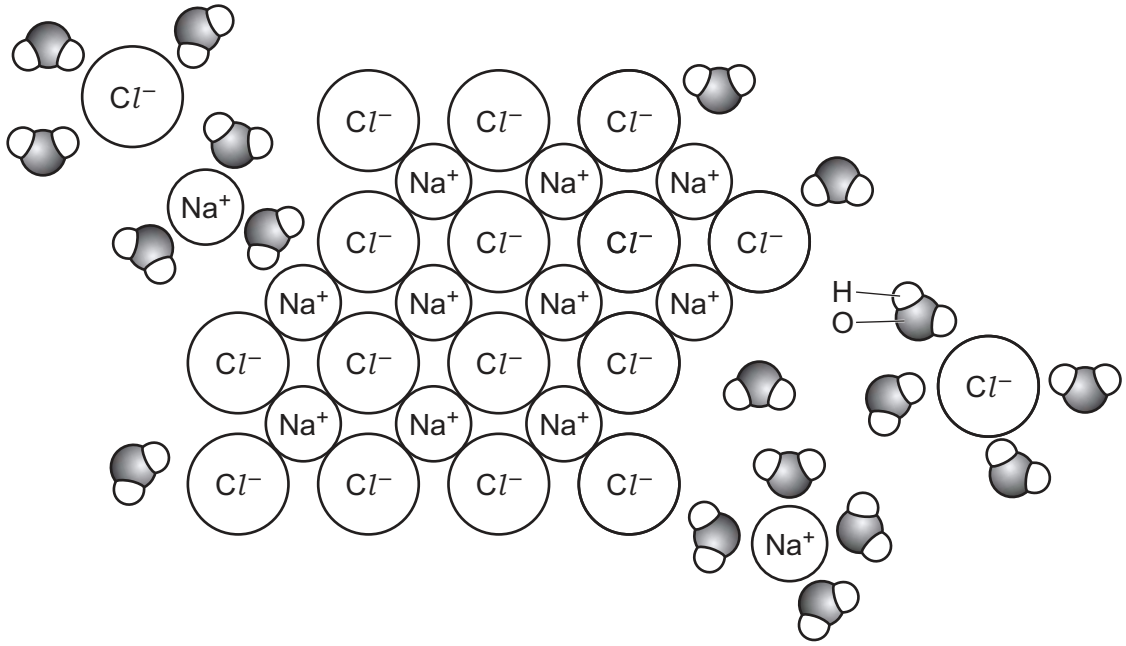

diagram not to scale

Fig. 2.2

With reference to Fig. 2.2, explain how water acts as a solvent for sodium chloride.

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..... [3]

(c) Fig. 2.3 shows a Galapagos penguin, *Spheniscus mendiculus*, swimming in the water.

Fig. 2.3

Penguins are birds that live on land but spend a lot of time swimming underwater hunting for food. Penguins can remain underwater for up to twenty minutes. During this time they do not breathe but their tissues continue to respire.

Haemoglobin in the red blood cells of penguins has a higher affinity for oxygen than haemoglobin in other birds that do not swim underwater.

Fig. 2.4 shows the oxygen dissociation curve for a bird that does **not** swim underwater.

(i) Draw a line on Fig. 2.4 to suggest the position of the oxygen dissociation curve for penguin haemoglobin. [2]

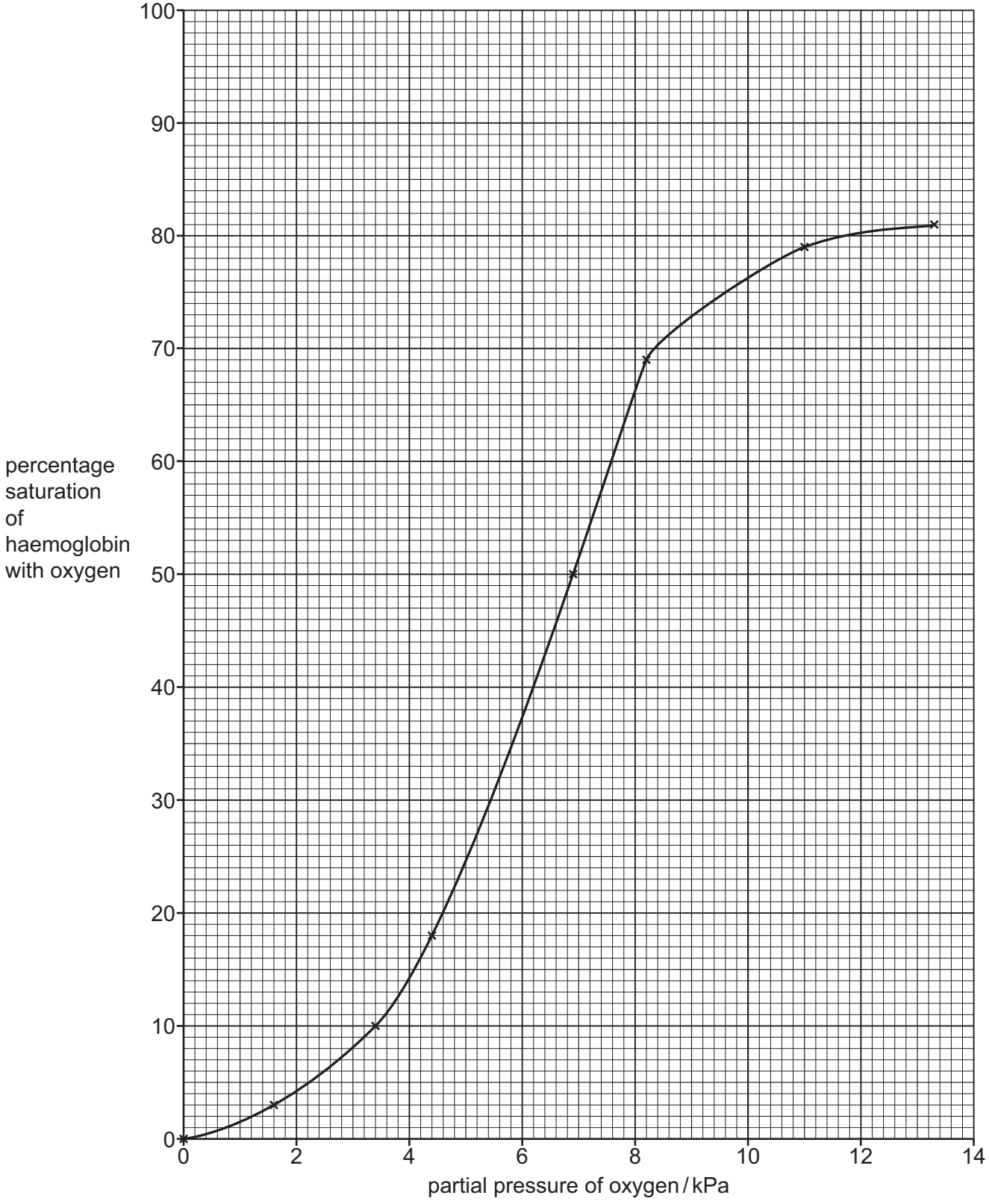

Fig. 2.4

(ii) Penguin haemoglobin is very sensitive to a decrease in pH caused by an increase in the carbon dioxide concentration in the blood.

Explain how a decrease in pH affects penguin haemoglobin, **and** suggest how this helps the penguin to swim underwater for a long time.

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..... [3]

(d) The heart rate of a penguin decreases while it is swimming underwater.

Heart rate is regulated by a group of specialised cells in the wall of the right atrium. The activity of these cells is modified by nerve impulses.

Name the group of specialised cells in the wall of the right atrium that regulates heart rate.

..... [1]

[Total: 11]

3 **(a)** Fig. 3.1 is a photomicrograph of a transverse section through a region of the wall of the bronchus in the gas exchange system.

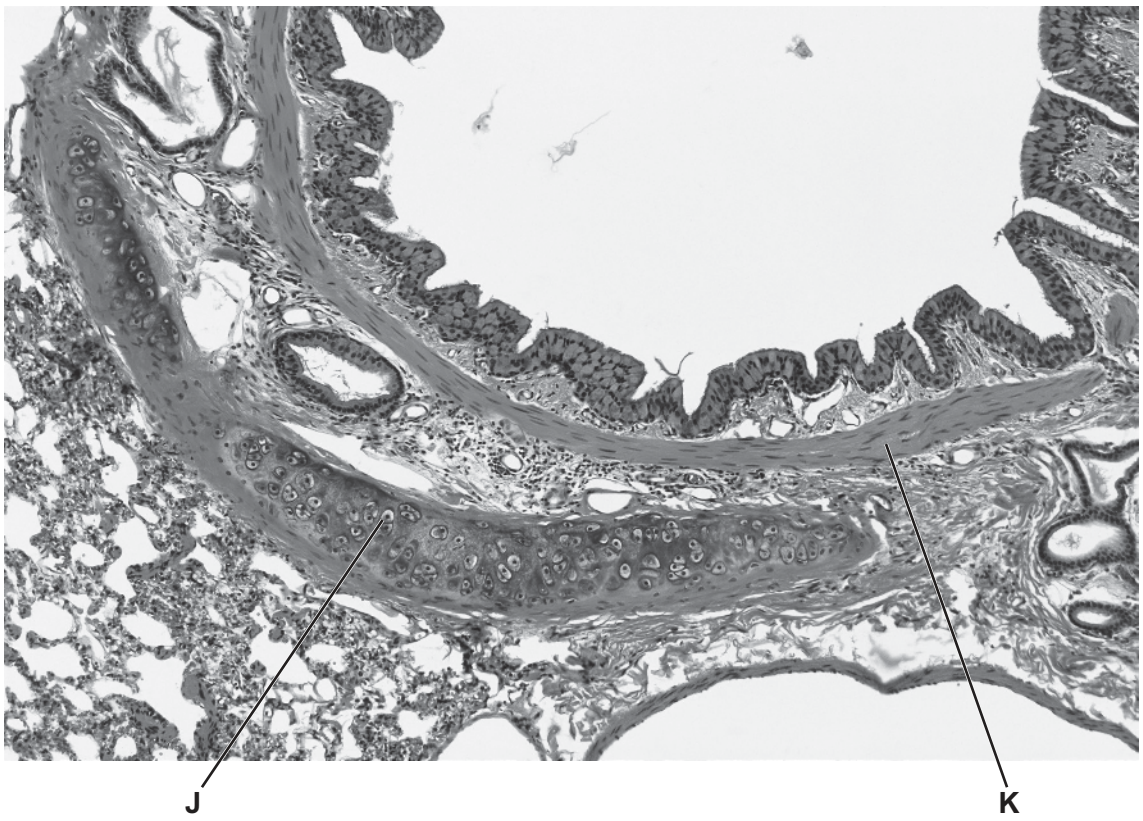

Fig. 3.1

Identify the tissues **J** and **K** shown in Fig. 3.1, **and** suggest how the wall of a bronchiole differs from the wall of the bronchus for these two tissues.

J .....

K .....

difference .....

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[3]

(b) Tuberculosis (TB) is an infectious disease that affects the human gas exchange system.

The pathogen that causes TB secretes a protein that can be detected in saliva.

Early diagnosis of TB is important in reducing the transmission of the pathogen.

Scientists have developed a test strip for TB that uses monoclonal antibodies. Monoclonal antibodies are specific in their action.

This test strip contains:

- mobile monoclonal antibodies that bind to one part of the protein secreted by the pathogen
- immobilised monoclonal antibodies.

Fig. 3.2 shows a simplified diagram of the test strip.

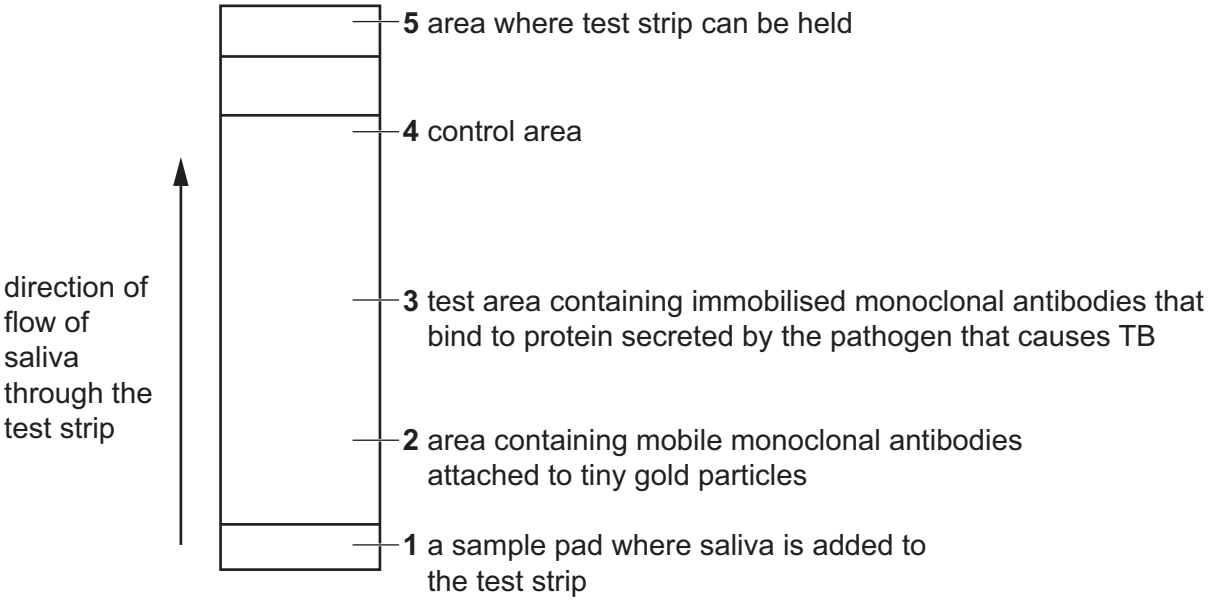

Fig. 3.2

A sample of saliva is collected and put onto the sample pad in the test strip.

The saliva moves up the test strip through area **2**.

The mobile monoclonal antibodies are attached to tiny gold particles. If these antibodies collect in test area **3**, a gold line becomes visible on the test strip.

A gold line that becomes visible in area **4** confirms that the test strip is working and that the results are valid.

(i) State the name of the pathogen that causes TB.

..... [1]

(ii) Name the part of the monoclonal antibody that binds to the protein from the pathogen.

..... [1]

(iii) Saliva is added to a test strip to test for the presence of the protein secreted by the TB pathogen.

Fig. 3.3 is a diagram showing some of the molecules in area **3** of the test strip when a positive result for TB is obtained.

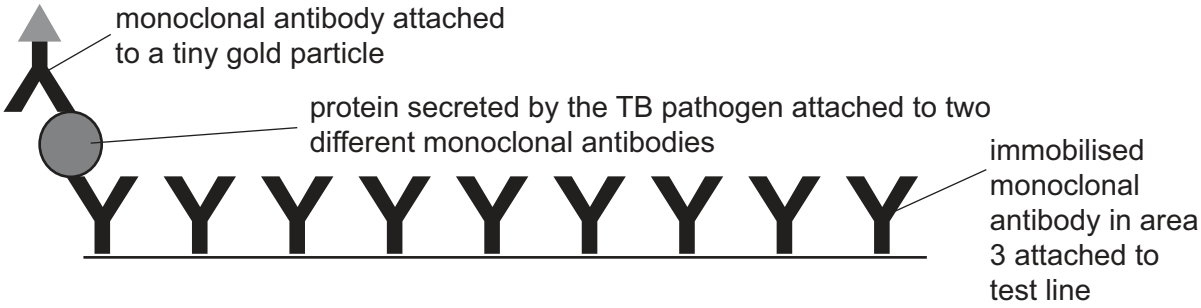

Fig. 3.3

Use the information in Fig. 3.3 to suggest **and** explain why this test is specific for TB.

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..... [2]

(iv) Area **4** contains different immobilised antibodies to those in area **3**.

The mobile monoclonal antibodies bound to tiny gold particles will bind to these immobilised monoclonal antibodies in area **4**.

If the test has functioned correctly, a gold line will be visible in area **4**.

Suggest how the structure of immobilised monoclonal antibodies in area **3** differs from the structure of the immobilised monoclonal antibodies in area **4**.

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..... [2]

(c) Vaccination is another way of reducing the transmission of infectious diseases such as TB. The BCG vaccine is used to help control the spread of TB. This vaccine contains a weakened strain of the pathogen that causes TB. The BCG vaccine stimulates the development of antigen-specific memory T-lymphocytes.

Explain how memory T-lymphocytes provide protection from TB in a person who has been given a BCG vaccination.

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..... [3]

(d) The bladder is the organ in the body used to store urine.

When cells divide uncontrollably in the bladder, a tumour develops. This can lead to bladder cancer.

The BCG vaccine has been used to treat bladder cancer.

The BCG vaccine is introduced into the bladder. The tumour cells take up the weakened pathogens in the vaccine and act as antigen-presenting cells.

(i) Name the process used by the tumour cells to take up the weakened pathogens.

..... [1]

(ii) Suggest how antigen presentation by tumour cells stimulates an immune response that leads to the destruction of the tumour cells.

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..... [3]

[Total: 16]

4 **(a)** Fig. 4.1 shows the structure of sucrose, a disaccharide produced by plant cells.

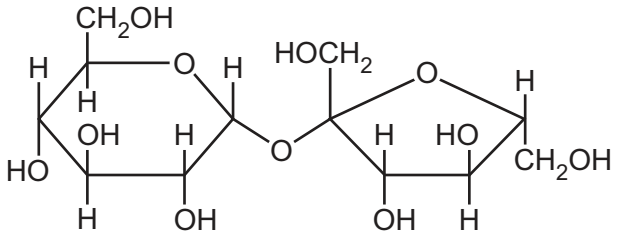


Fig. 4.1

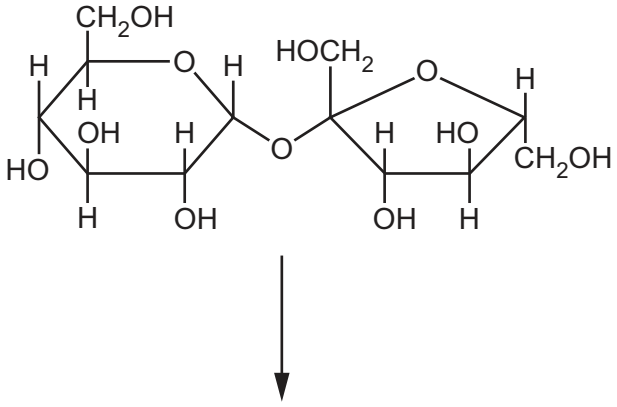
(i) Name the covalent bond that joins the two monomers in sucrose.

..... [1]

(ii) Sucrose is hydrolysed by the enzyme sucrase in the human digestive system.

The products of this hydrolysis reaction are the monosaccharides α-glucose and fructose.

Complete the diagram to show the hydrolysis of sucrose to form α-glucose and fructose.



[3]

(b) Plants transport sucrose from a source to a sink.

Fig. 4.2 is a scanning electron micrograph (SEM) of a transverse section through a plant tissue used to transport sucrose.

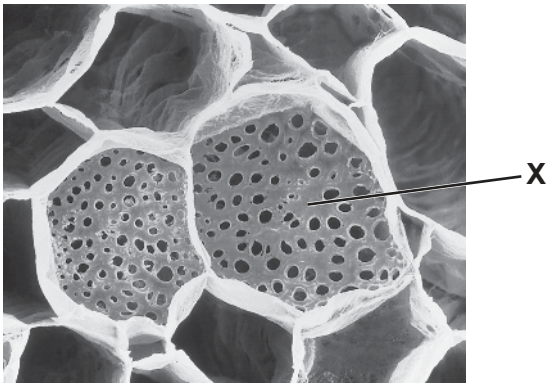


Fig. 4.2

(i) Name the structure labelled **X** in Fig. 4.2.

..... [1]

(ii) A scientist carried out an experiment to study carbohydrate transport in the stem of a woody plant.

Fig. 4.3 shows a plan diagram of a transverse section of the stem studied by the scientist. The position of the xylem tissue in the stem is shown.

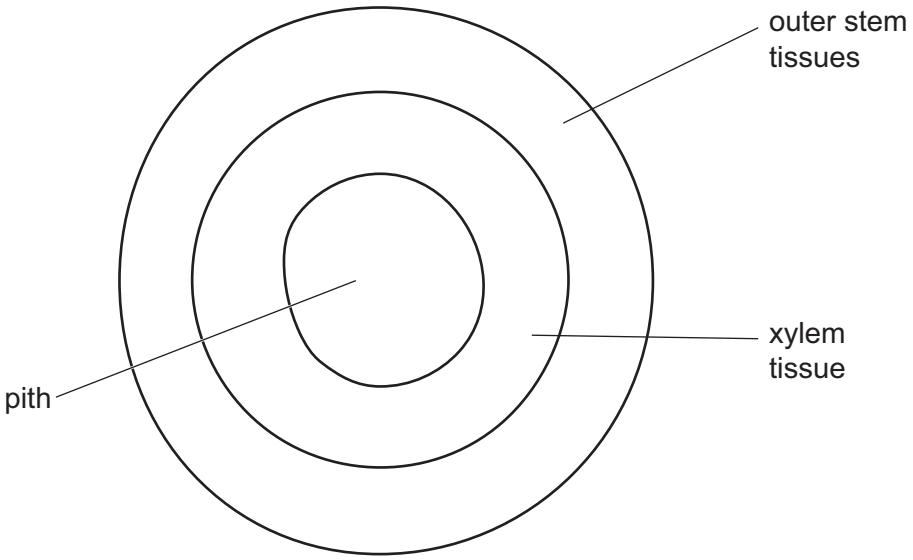


Fig. 4.3

The scientist carried out a set of experiments using plants of the same species.

In each experiment, a ring of tissue was removed from the outer stem of the plant, but the xylem tissue was left intact. This is shown in Fig. 4.4.

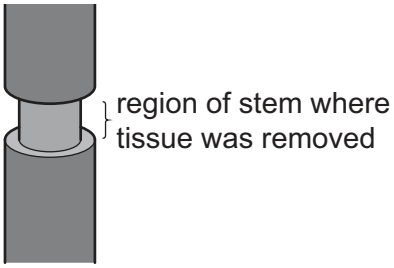


Fig. 4.4

The mass of carbohydrate transported to the lower part of the stem in 24 hours was recorded.

In each experiment a different percentage of the outer stem tissue was removed.

All other variables remained constant.

Table 4.1 shows the results of this investigation.

Table 4.1

percentage of outer stem tissue removed	mass of carbohydrate transported to lower part of the stem in 24 hours / mg
13	774
67	597
90	425
100	0

Explain the results shown in Table 4.1.

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..... [4]

(c) Sucrose is a sweet-tasting sugar found in many foods.

Some people become ill when they have sucrose in their diet. These people have a gene mutation in the gene coding for sucrase and cannot hydrolyse sucrose in the digestive system.

Scientists studying the DNA of people with this condition identified a deletion mutation in the gene coding for sucrase.

Suggest **and** explain why a person with this deletion mutation cannot digest sucrose.

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..... [4]

[Total: 13]

Question 5 starts on page 18

5 Trypsin is an enzyme which catalyses the hydrolysis of casein, a protein found in milk.

Milk that contains casein has a cloudy, white appearance. As the casein is hydrolysed by trypsin, the milk changes in appearance to a clear (transparent), colourless solution.

A student carried out an experiment to investigate the effect of enzyme concentration on the rate at which trypsin hydrolyses casein.

The student added a solution of trypsin to a sample of milk and recorded the time taken for the milk to become transparent. The student repeated the experiment with different concentrations of trypsin. All other variables were kept constant.

Fig. 5.1 shows the results from the experiment.

(a) (i) When the concentration of trypsin increases from 2.0% to 4.0%, the time taken for the milk to become transparent decreases by 48%.

Calculate the percentage decrease in the time taken for milk to become transparent when the concentration of trypsin increases from 0.25% to 0.5%.

Write your answer to the nearest whole number.

percentage decrease ..... [1]

(ii) Explain the results shown in Fig. 5.1.

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..... [5]

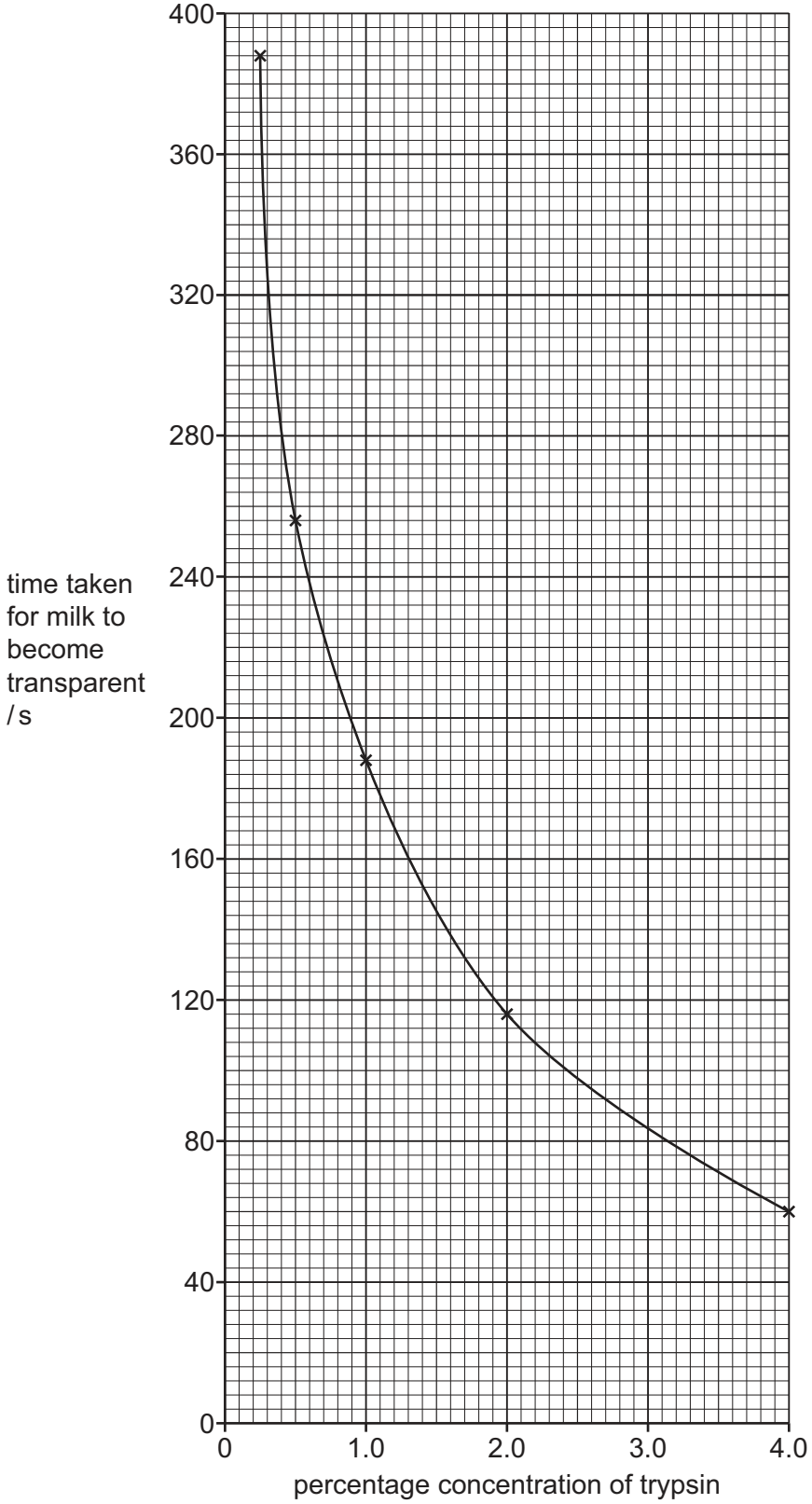

Fig. 5.1

(b) Trypsin has the potential to be used in a wide range of industrial processes.

The use of immobilised enzymes in industrial processes has many advantages.

Scientists investigated the effect of temperature on the activity of trypsin immobilised on the surface of a material and trypsin free in solution.

Table 5.1 shows the results of the investigation.

Table 5.1

temperature / °C	percentage of maximum activity of immobilised trypsin	percentage of maximum activity of trypsin free in solution
25	60	100
35	85	100
45	98	80
55	95	20
65	100	5

(i) State a reason for the difference in percentage of maximum activity of immobilised trypsin and trypsin free in solution at 25 °C.

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..... [1]

(ii) Suggest **and** explain why the percentage of maximum activity of immobilised trypsin at 55 °C is higher than the percentage of maximum activity of trypsin free in solution at 55 °C.

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..... [2]

[Total: 9]

6 Fig. 6.1 shows a plant cell in a stage of mitosis.

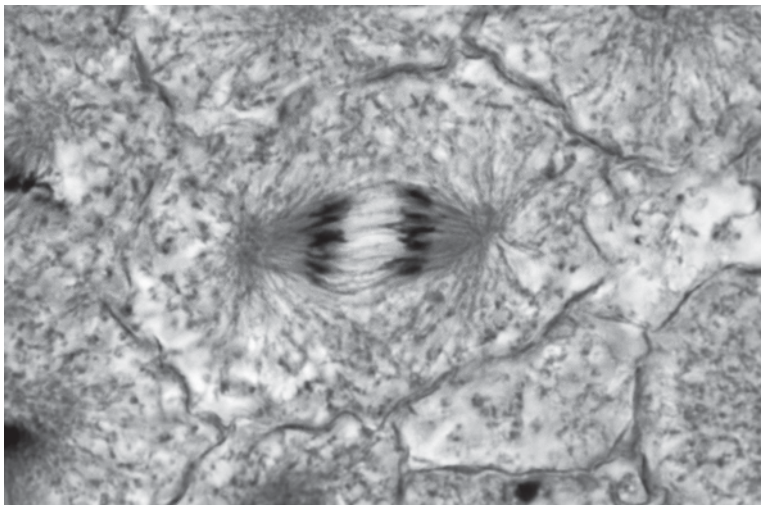

Fig. 6.1

(a) Some of the structures shown in Fig. 6.1 contain DNA.

Use a line labelled **D** on Fig. 6.1 to indicate **one** of these structures. [1]

(b) Name the stage of mitosis shown in Fig. 6.1.

..... [1]

(c) Colchicine is a chemical used by scientists to study mitosis. This chemical inhibits the organisation of the microtubules in prophase of mitosis.

The cell shown in Fig. 6.1 had **not** been treated with colchicine.

Explain the evidence in Fig. 6.1 that shows the cell had **not** been treated with colchicine.

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..... [2]

[Total: 4]

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