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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8886863394 6

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **October/November 2025**

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 **20** pages. Any blank pages are indicated.

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1 Fig. 1.1 shows a diagram of the fluid mosaic model of the structure of the cell surface membrane.

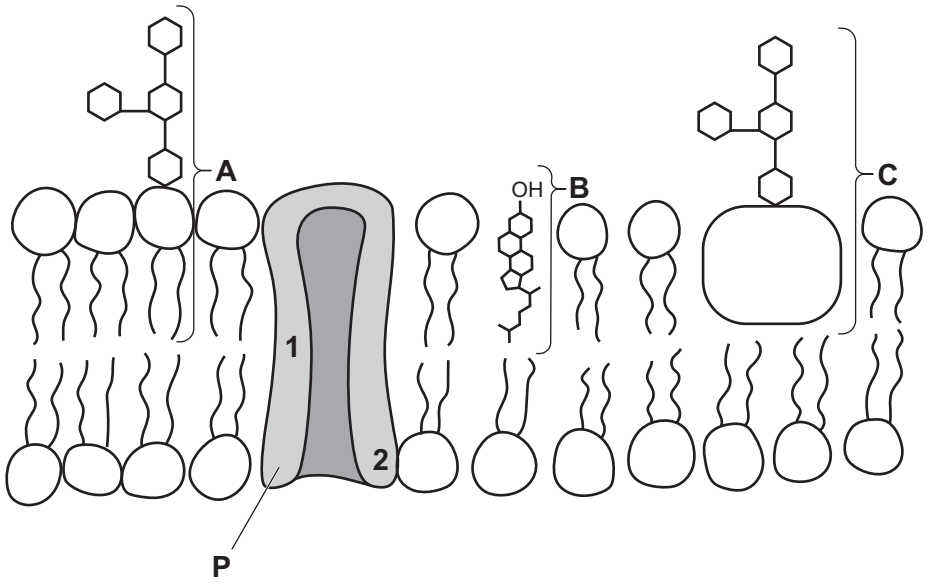


Fig. 1.1

(a) Name the structures labelled **A**, **B** and **C** in Fig. 1.1.

A .....

B .....

C .....
[3]

(b) Draw an arrow on Fig. 1.1 to show the movement of a molecule across the membrane into the cell by facilitated diffusion. [2]

(c) Explain how the fluidity of the membrane would change if the proportion of unsaturated fatty acids in the phospholipid bilayer increased.

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(d) The R-groups of amino acids give them different properties.

Suggest how the properties of the R-groups of the amino acids at position **1** of **P** may differ from the R-groups of the amino acids at position **2**.

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2 **(a)** Haemoglobin is a globular protein containing haem groups.

Explain how the presence of haem groups allows the haemoglobin molecule to transport oxygen.

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(b) In certain situations, such as during intense exercise, a person may breathe very quickly and deeply. This is known as hyperventilation.

This hyperventilation causes more carbon dioxide to be exhaled. As a result, there is a lower concentration of carbon dioxide in the blood that passes through the capillary network in respiring tissues. This increases the affinity of haemoglobin for oxygen so that there is a decrease in the release of oxygen from red blood cells.

Explain why a decrease in the concentration of carbon dioxide in the blood passing through respiring tissues leads to a decrease in the release of oxygen from red blood cells.

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(c) Fig. 2.1 is a diagram of a section through the heart.

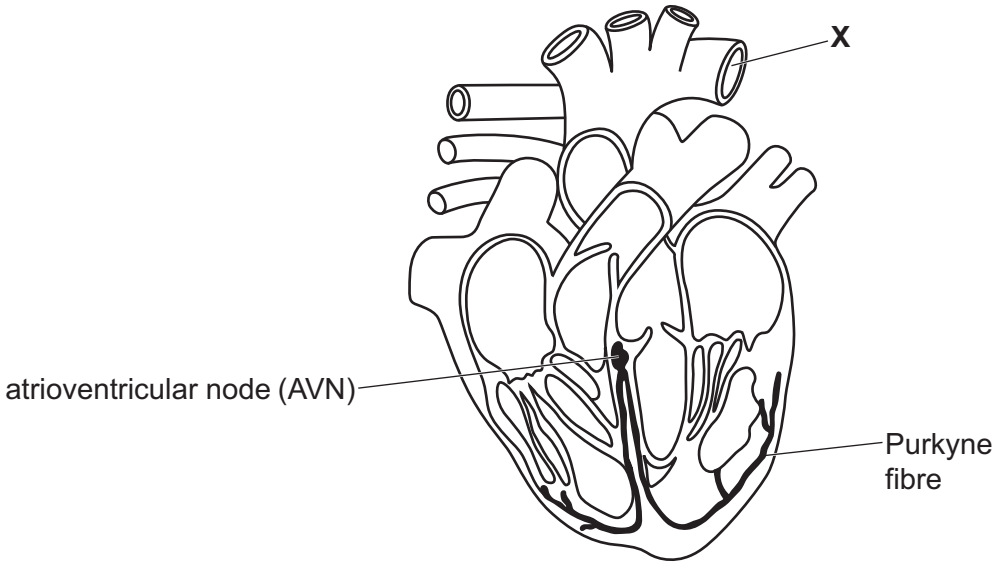


Fig. 2.1

(i) Describe and explain how the tunica media (middle layer of the wall) of blood vessel **X** adapts the blood vessel for its function.

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..... [3]

(ii) Describe the role of the atrioventricular node (AVN) and the Purkyne tissue in the cardiac cycle.

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3 **(a)** The lock-and-key hypothesis and the induced-fit hypothesis are used to describe the interaction of enzymes and their substrates.

Describe **one** similarity and **one** difference between the lock-and-key hypothesis and the induced-fit hypothesis.

similarity .....

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difference .....

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[2]

(b) Phosphorylase enzymes can catalyse the synthesis of starch **and** the breakdown of starch in some plant tissues. A reaction catalysed by starch phosphorylase is shown in Fig. 3.1.

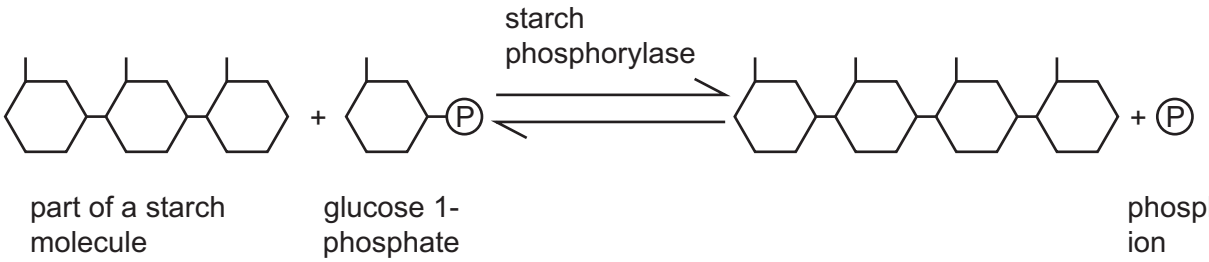


Fig. 3.1

A student carried out an experiment to study the synthesis of starch by phosphorylase found in potato tissue.

The student was provided with a solution, **E**, extracted from potato tissue. The extract was filtered to remove all the starch grains.

Extract **E** contained biological molecules from the potato tissue including phosphorylase but **no** starch.

(i) Iodine solution was used to confirm that starch was **not** present in extract **E**.

State the colour observed when iodine solution was added to a sample of extract **E**.

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The student added a small drop of a dilute starch solution and a solution of glucose 1-phosphate to a test-tube containing extract **E**.

Samples of the reaction mixture in the test-tube were removed every minute and a drop of iodine solution was added to each.

The student used a colorimeter to measure the absorbance of the solution in each sample.

The results are shown in Fig. 3.2.

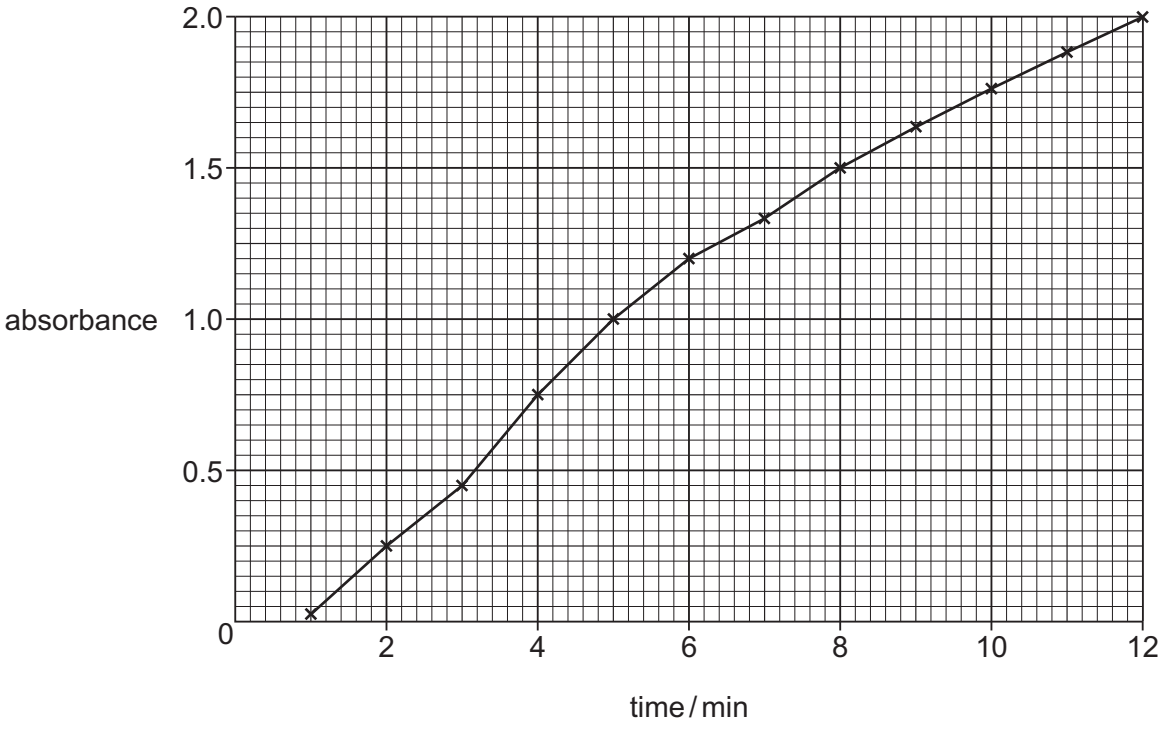


Fig. 3.2

(ii) Explain the results shown in Fig. 3.2.

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(iii) After 12 minutes, the student added a solution containing phosphate ions to the reaction mixture. The student continued taking samples every minute, adding iodine solution to each sample.

The absorbance of the solution in each of these samples was measured. The results showed that the absorbance decreased over time.

Suggest why the absorbance decreased.

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(c) Muscle cells contain glycogen phosphorylase.

Fig. 3.3 shows the effect of caffeine on the activity of glycogen phosphorylase at different concentrations of substrate.

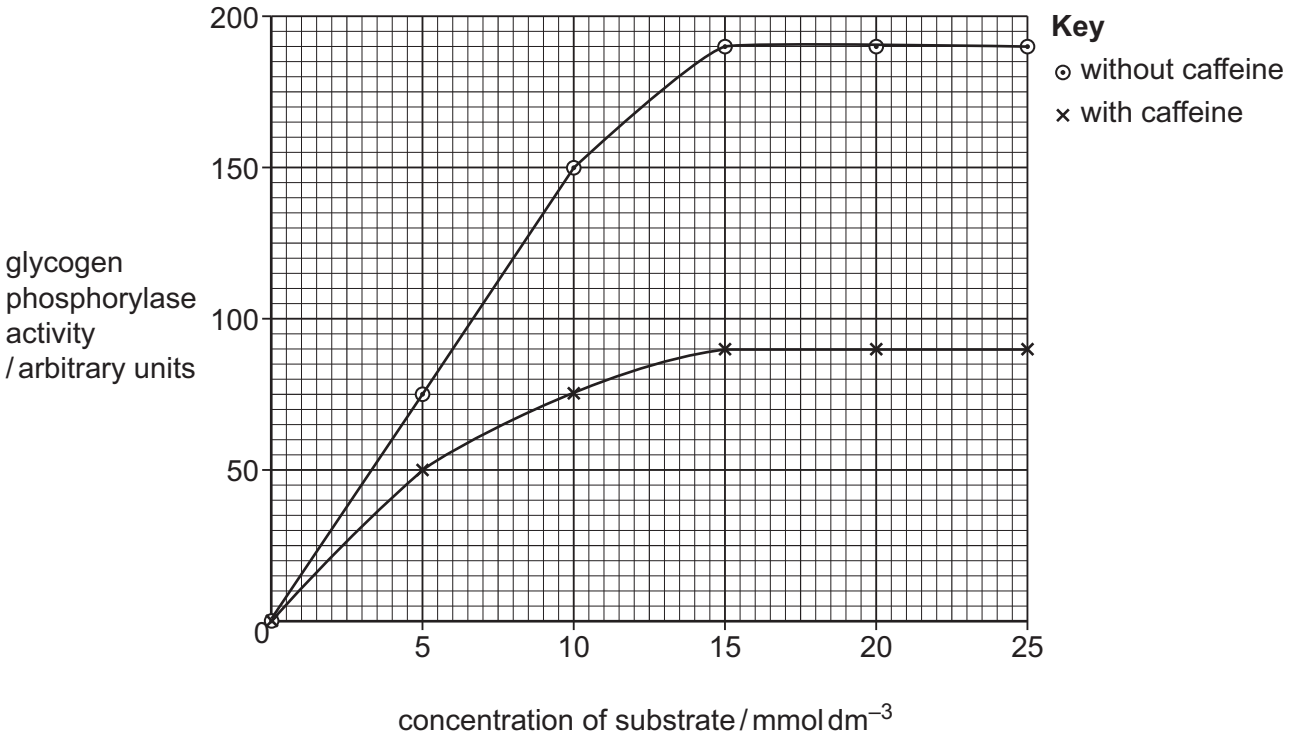


Fig. 3.3

A student concluded that caffeine acts as a non-competitive inhibitor of glycogen phosphorylase.

Explain how the results in Fig. 3.3 support this conclusion.

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4 Fig. 4.1 is a photomicrograph of a copepod. These animals are found living in sea water and in fresh water environments.

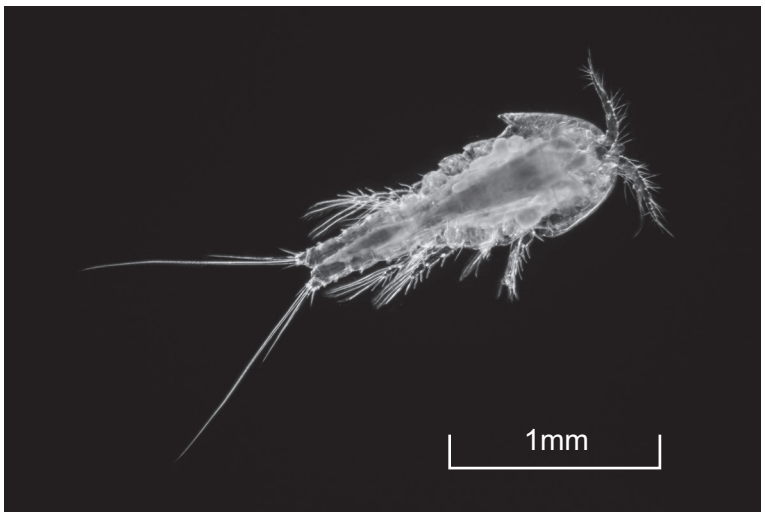


Fig. 4.1

(a) The outer surface of a copepod is covered in a layer of the polysaccharide chitin.

Fig. 4.2 shows part of a chitin molecule.

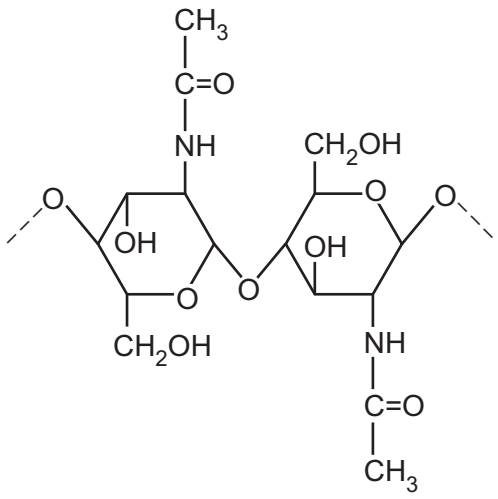


Fig. 4.2

(i) Draw a circle around a glycosidic bond in Fig. 4.2. [1]

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(ii) In aquatic environments, *Vibrio cholerae* can live on the surface of copepods. *V. cholerae* secretes enzymes to hydrolyse chitin to its N-acetylglucosamine monomers. These can be broken down to provide carbon, nitrogen and a source of energy.

Draw the monomer that is formed when chitin is hydrolysed by *V. cholerae*.

[2]

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(b) *V. cholerae* is a pathogen that causes cholera.

Scientists studied the transmission of *V. cholerae* in groups of people living in an area where there is a high number of cases of cholera.

Some families living in this area filtered their water through several layers of folded fabric from old clothing. The folded fabric traps particles and organisms larger than 20 μm.

The scientists recorded the number of cases of cholera in families that filtered their water through folded fabric and compared this to the number of cases of cholera recorded in families that did **not** filter their water through the folded fabric.

The results are shown in Fig. 4.3.

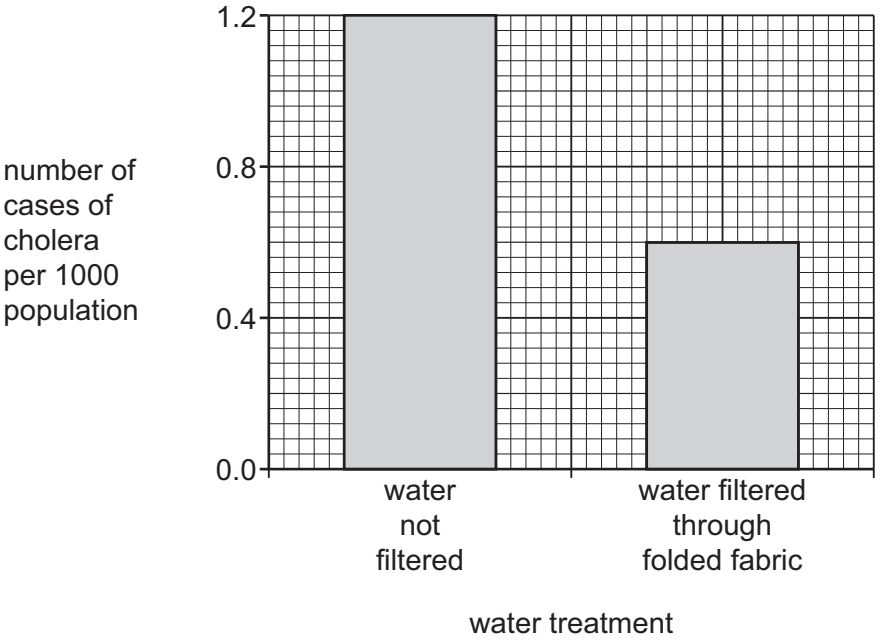


Fig. 4.3

Suggest possible explanations for the results shown in Fig. 4.3.

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(c) The World Health Organization (WHO) recommends the use of an oral cholera vaccine (OCV) to protect people living in an area where a cholera outbreak has occurred.

People who receive an OCV and make changes in their behaviour are less likely to have a serious case of cholera.

(i) Describe **one** change in behaviour that a person can make, **other** than purifying water, to help prevent a serious case of cholera.

.....

..... [1]

(ii) The antibiotic tetracycline is used to treat cholera. However, some bacteria that cause cholera have evolved resistance to this antibiotic.

Scientists have reported that resistant bacteria have an extra protein in their cell surface membrane. This protein has been found to use ATP.

Suggest how the presence of this protein in the cell surface membrane gives *V. cholerae* resistance to tetracycline.

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..... [2]

(iii) For some vaccines, there may not be an effective secondary immune response when a person is infected by the specific pathogen. The antibodies that are produced do **not** act on the pathogen. This is known as immune evasion.

Evolution of resistance of bacteria to antibiotics occurs more frequently than immune evasion.

Suggest why bacteria evolve resistance to antibiotics more frequently than vaccines that lose their effectiveness in protecting against bacterial pathogens.

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[Total: 12]

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5 **(a)** Fig. 5.1 is a photomicrograph of a longitudinal section through part of the stem of a plant.

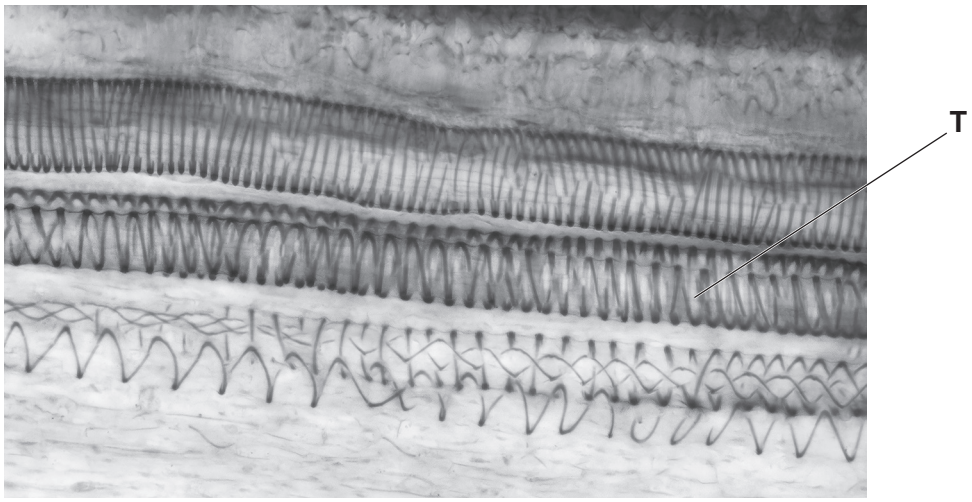


Fig. 5.1

(i) Name **one** substance transported in **T** in Fig. 5.1.

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(ii) State the name of the substance that forms the spiral thickening around the structure labelled **T** in Fig. 5.1.

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(b) A scientist studied the effect of leaf temperature on the rate of transpiration from the leaves of the wheat plant, *Triticum aestivum*.

The scientist repeated the investigation using the cotton plant, *Gossypium hirsutum*.

The results of the investigation are shown in Table 5.1.

Table 5.1

leaf temperature / °C	rate of transpiration of *T. aestivum* / mmol m^{-2} s^{-1}	rate of transpiration of *G. hirsutum* / mmol m^{-2} s^{-1}
25	7	9
30	12	10
35	15	11
40	22	12
45	31	14

(i) Suggest explanations for the relationship between leaf temperature and the rate of transpiration of *T. aestivum* as shown in Table 5.1.

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..... [3]

(ii) Suggest **one** difference between the structure of the leaves of *T. aestivum* and the leaves of *G. hirsutum* that could explain the results shown in Table 5.1.

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(c) Nematodes are microscopic animals that infect a wide range of economically important plant crops including cotton plants. Nematodes feed on the roots of plants, limiting their growth.

When root cells become infected, the nematodes disrupt the plant mitotic cell cycle. This causes the formation of a special type of feeding cell (cell **G**) in the plant, from which the nematodes absorb nutrients. Cell **G** is formed as a result of multiple cell cycles without any cytokinesis.

(i) Suggest how cell **G** differs from cells produced during a mitotic cell cycle that has **not** been disrupted by a nematode.

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..... [1]

(ii) Nematodes can also stimulate a process called endoreplication. This process causes a plant cell to go through multiple S phases during one cell cycle without entering mitosis or undergoing cytokinesis.

State how the nucleus of a cell that has been through endoreplication may differ from the nucleus of a cell in the same plant that has **not** been affected by the nematode.

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6 **(a)** Alveolar macrophages are phagocytes found in the human gas exchange system. They produce hydrolytic enzymes, such as lysozyme, to digest pathogens entering the alveolus.

(i) State the term used to describe the sequence of nucleotides in the DNA of the alveolar macrophage that codes for a protein, such as lysozyme.

..... [1]

(ii) Synthesis of lysozyme occurs in two stages. The first stage occurs in the nucleus using one strand of DNA to synthesise mRNA.

State the name of the strand of DNA that is used to synthesise mRNA.

..... [1]

(iii) Name the organelle where the translation of mRNA takes place to produce lysozyme.

..... [1]

(iv) Lysozyme destroys bacterial cells by hydrolysing bonds in peptidoglycan.

Explain how the hydrolysis of bonds in peptidoglycan leads to the destruction of bacterial cells.

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(b) (i) Alveolar macrophages are found in contact with squamous epithelial cells in the walls of alveoli.

Explain how the cells lining the alveoli are adapted for gas exchange.

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(ii) Describe the role of elastic fibres in the wall of an alveolus.

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