Cambridge International AS & A Level

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Cambridge International Advanced Subsidiary and Advanced Level

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6037156995

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **May/June 2019**

1 hour 15 minutes

Candidates answer on the Question Paper.

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Answer **all** questions.

Electronic calculators may be used.
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Answer **all** questions.

1 **(a)** Antibody molecules are proteins that show primary structure, secondary structure, tertiary structure and quaternary structure.

Fig. 1.1 shows a ribbon diagram of an antibody molecule.

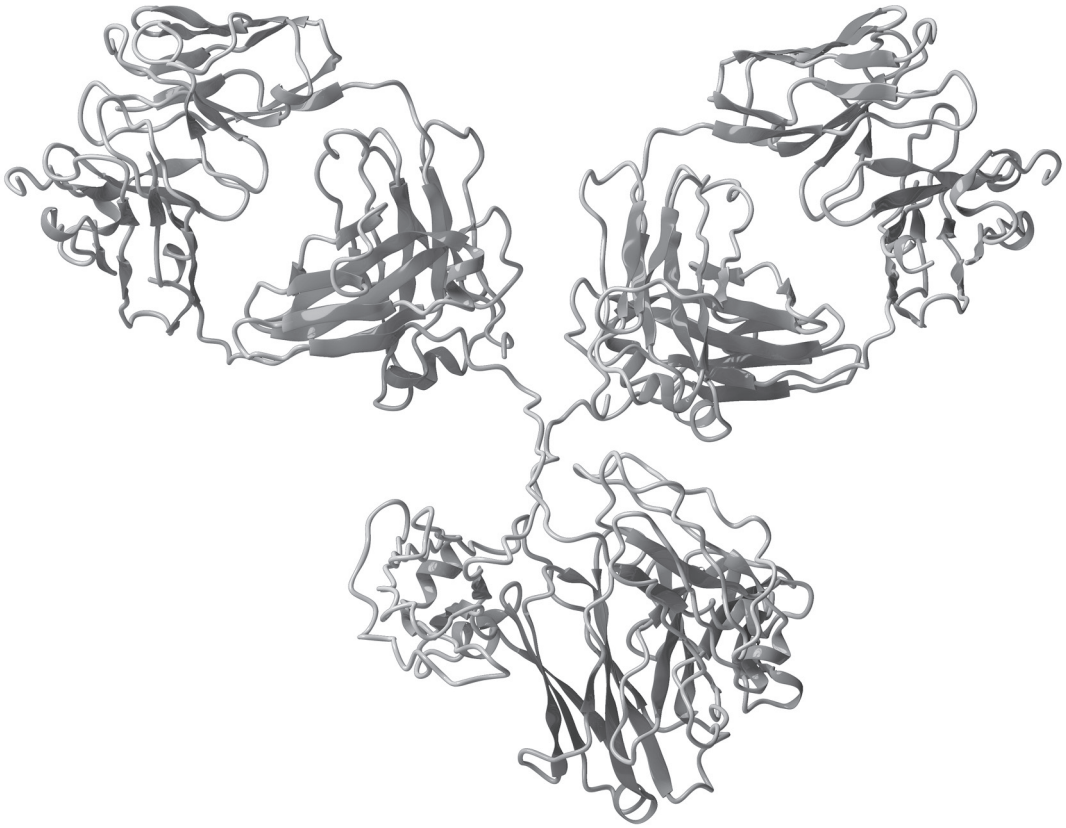


Fig. 1.1

Describe how Fig. 1.1 shows the secondary structure **and** tertiary structure of the antibody molecule.

secondary structure .....

.....

.....

tertiary structure .....

.....

.....

[3]

(b) Fig. 1.2 is a transmission electron micrograph of a hybridoma cell.

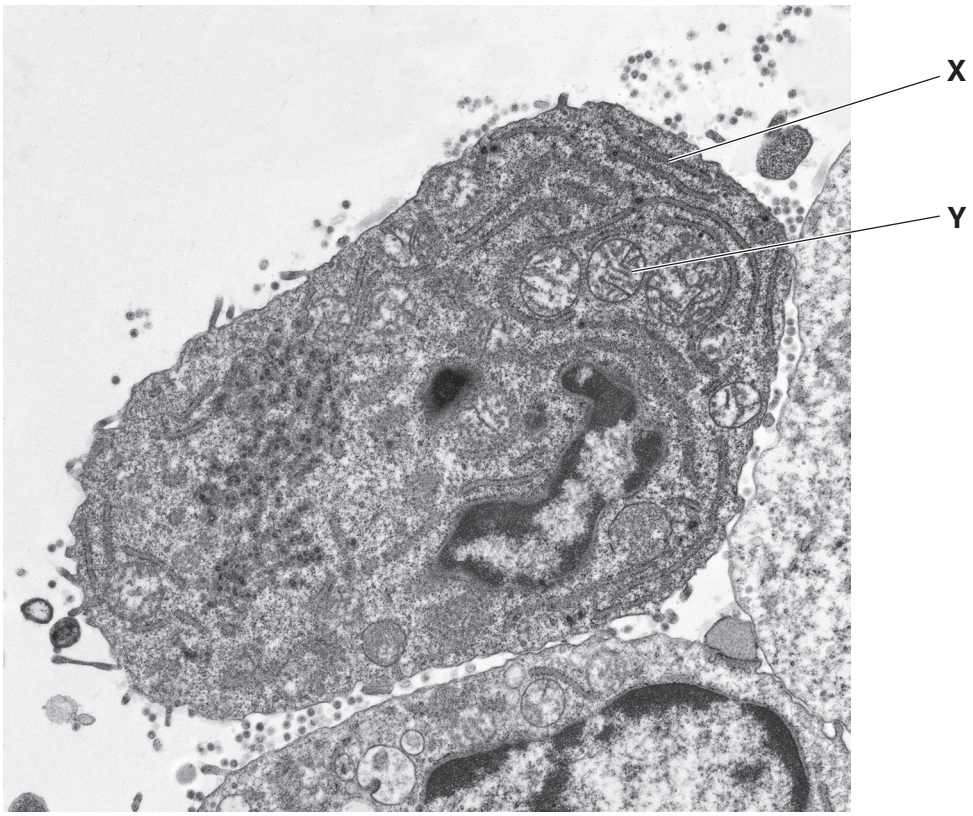


Fig. 1.2

(i) The hybridoma cell in Fig. 1.2 synthesises and secretes molecules of a monoclonal antibody.

State the roles of the structures labelled **X** and **Y** in the production of antibody molecules in the hybridoma cell.

X .....

.....

.....

Y .....

.....

.....

[2]

(ii) The hybridoma method for the production of monoclonal antibodies involves a number of stages. One of these stages is the formation of hybridoma cells.

Outline the stage in which hybridoma cells are formed.

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..... [3]

(iii) Outline the use of monoclonal antibodies in the treatment of disease.

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..... [3]

[Total: 11]

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[Turn over

2 Linoleic acid is an unsaturated fatty acid that is found in some triglycerides and some phospholipids.

Phospholipids are components of cell membranes.

Fig. 2.1 shows a molecule of linoleic acid.

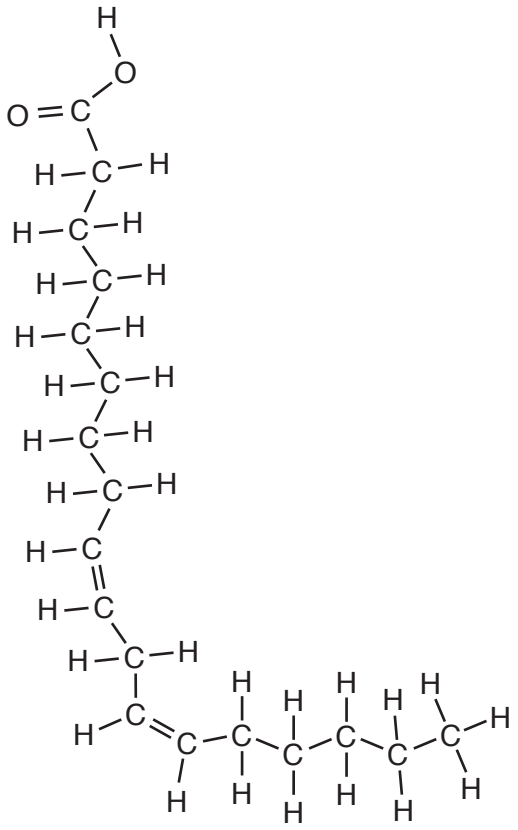


Fig. 2.1

(a) The composition of cell membranes of plants changes in response to changes in temperature.

At the start of the cold season there is an increase in the proportion of phospholipids with unsaturated fatty acids in the chickpea, *Cicer arietinum*. Chickpea plants that do not make this change do not survive.

Suggest how the increase in the proportion of phospholipids with unsaturated fatty acids helps plants, such as chickpea, survive decreases in temperature.

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..... [2]

(b) (i) State why triglycerides and phospholipids **cannot** be described as polymers.

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..... [1]

(ii) State two **differences** in the **structure** of triglycerides and phospholipids.

1 .....

.....

2 .....

.....

[2]

(c) Platelets metabolise linoleic acid to produce a molecule known as thromboxane.

Thromboxane is released by platelets when blood loss occurs. Thromboxane acts on smooth muscle cells in the walls of arteries. This causes arteries to constrict, which reduces blood flow.

Explain why the constriction of arteries following blood loss is an example of cell signalling.

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..... [4]

[Total: 9]

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[Turn over

3 Neutrase® is an enzyme that is used to hydrolyse proteins in solution. When the enzyme is mixed with a 2% protein solution the reaction mixture changes from white to colourless.

A student carried out an experiment to find the effect of copper sulfate and potassium sulfate on the activity of Neutrase®.

The student made four reaction mixtures in test-tubes **A** to **D**. Test-tubes **A** to **C** contained equal volumes of protein solution and 0.1 cm^3 of solutions of copper sulfate or potassium sulfate. Test-tube **D** contained the same volume of protein solution and 0.1 cm^3 of water.

0.5 cm^3 of a 1% Neutrase® solution was added to test-tube **A** and immediately placed into a colorimeter. The colorimeter was used to measure the intensity of light that is absorbed by the solution (absorbance) over 100 seconds. The procedure was repeated with the other reaction mixtures, **B**, **C** and **D**.

The results are shown in Fig. 3.1.

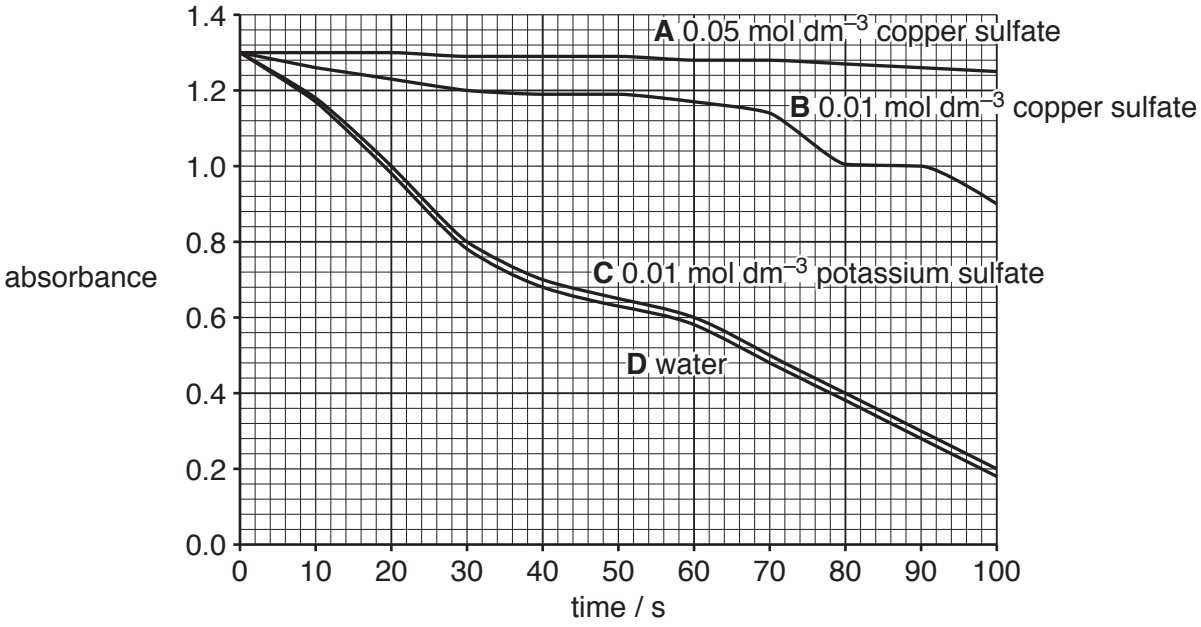


Fig. 3.1

(a) (i) Suggest **and** explain why measuring the absorbance of the reaction mixture over 100 s is a suitable method for determining the activity of Neutrase®.

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..... [2]

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(ii) With reference to Fig. 3.1:

- describe the effects of copper sulfate solution and potassium sulfate solution on the activity of Neutrase®
- suggest explanations for the effects that you have described.

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..... [5]

(b) Neutrase® can be immobilised in alginate. Immobilised Neutrase® is used in the food industry to produce foods with high nutritional content.

Explain the advantages of using immobilised enzymes, such as Neutrase®, compared with using the same enzymes free in solution.

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..... [2]

[Total: 9]

4 Meristematic tissue is found in the growing regions of plants, such as shoot tips. Meristematic cells have a similar role to stem cells in animals.

Fig. 4.1 shows some of the stages in the formation of a mature phloem sieve tube element and companion cells from a meristematic cell.

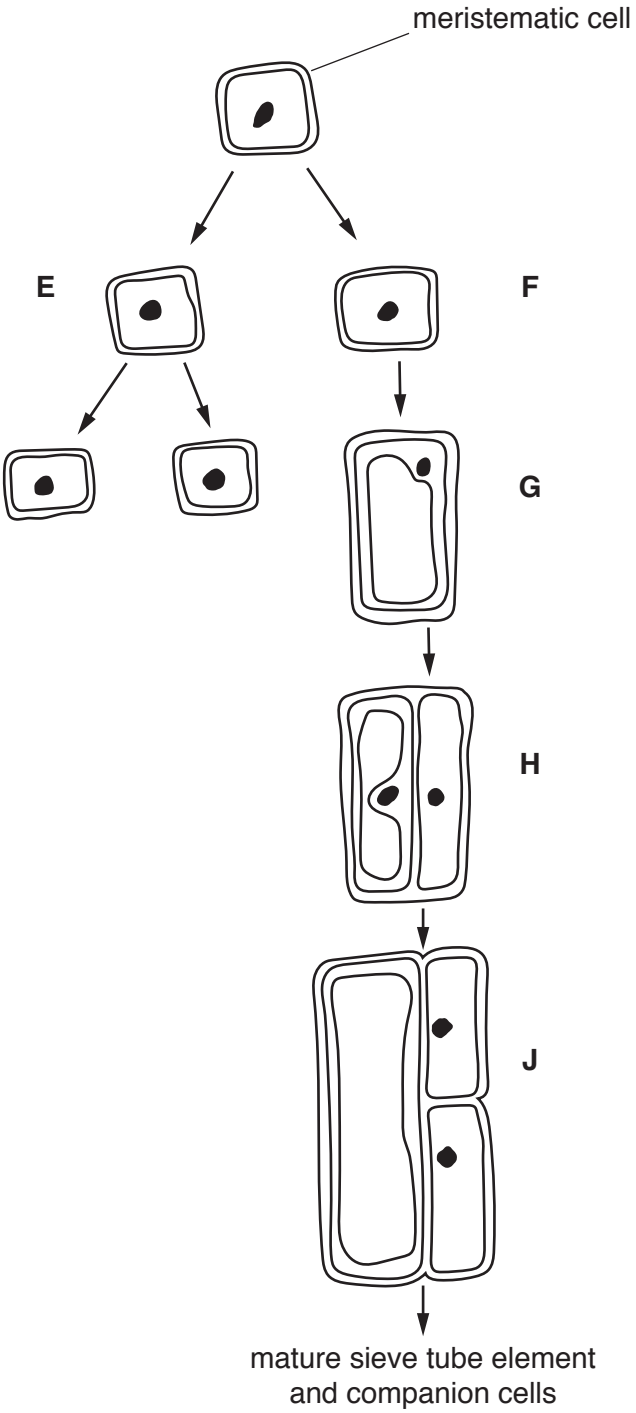


Fig. 4.1

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(a) Cells **E** and **F** in Fig. 4.1 are daughter cells produced when the meristematic cell divides in the shoot tip.

Explain why it is important that one of the daughter cells (cell **E**) is a meristematic cell.

.....

.....

..... [1]

(b) Complete Table 4.1 to describe the changes that are shown in Fig. 4.1 between stages:

- **F** and **G**
- **G** and **H**
- **H** and **J**.

Table 4.1

stages	description
F and **G**	
G and **H**	
H and **J**	

[3]

(c) Explain how the structure of a mature sieve tube element is related to its function.

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..... [4]

(d) Describe the functions of companion cells in transport in the phloem.

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..... [2]

[Total: 10]

5 **(a)** The mammalian circulatory system is described as a closed double circulation.

Explain why it is called a *closed* **and** *double* circulation.

closed .....

.....

double .....

..... [2]

(b) Fig. 5.1 shows a drawing of an external view of a mammalian heart.

Two cross-sections were made of the heart:

- section 1 was made across the line **A**–**B**.
- section 2 was made across the line **C**–**D**.

Drawings of the two sections were viewed from above as shown by the arrow on Fig. 5.1.
Fig. 5.2 is a drawing of section **A**–**B**. Fig. 5.3 is a drawing of section **C**–**D**.

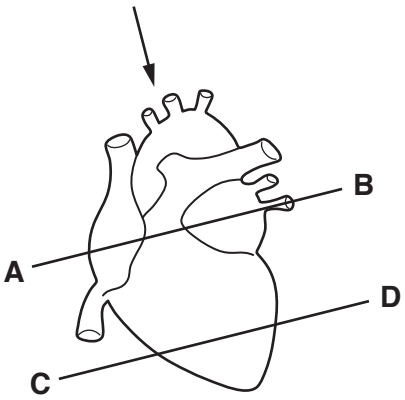


Fig. 5.1

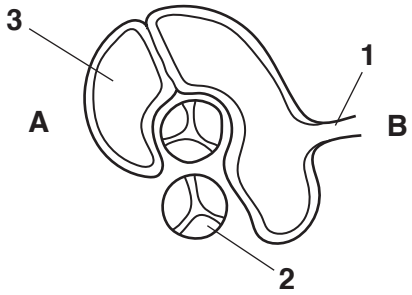


Fig. 5.2

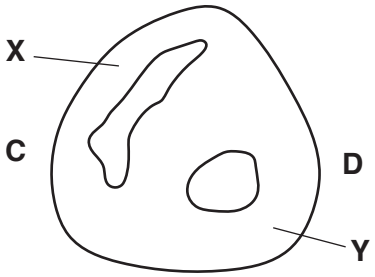


Fig. 5.3

(i) Name structures **1**, **2** and **3**, as shown in Fig. 5.2.

1 .....

2 .....

3 .....
[3]

(ii) Explain why the wall of chamber **Y** is thicker than the wall of chamber **X**, as shown in Fig. 5.3.

.....

.....

.....

.....

..... [3]

(c) Explain how the contractions of the chambers of the heart are coordinated during one cardiac cycle.

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..... [4]

[Total: 12]

6 **(a)** The DNA in the nucleus is known as nuclear DNA.

(i) In the cells of the grasshopper, *Chorthippus brunneus*, 20% of the nucleotides in nuclear DNA contain thymine.

Calculate the percentage of nucleotides in the nuclear DNA of *C. brunneus* that contain guanine **and** explain your answer in terms of the structure of DNA.

percentage .....

explanation .....

.....

.....

.....

..... [3]

(ii) State another location, **other than** the nucleus, where DNA occurs in cells of *C. brunneus*.

..... [1]

(b) Fig. 6.1 is a diagram of a molecule of tRNA.

The region labelled **R** shows detail of part of the tRNA molecule.

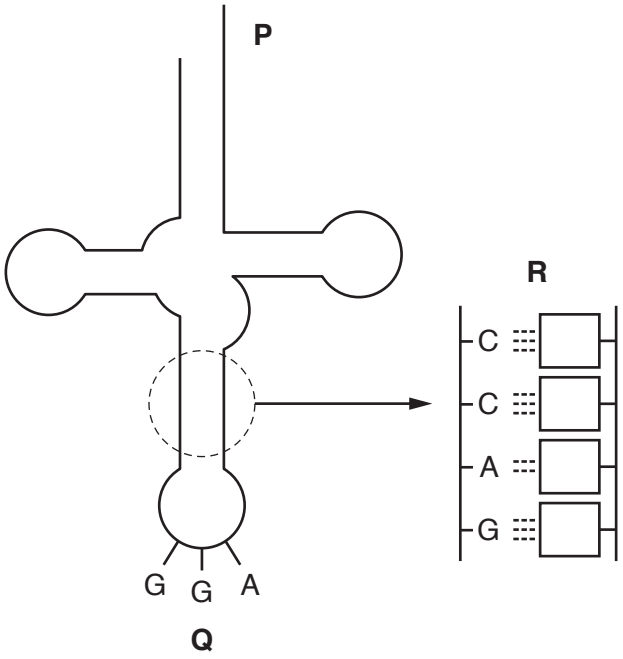


Fig. 6.1

(i) Complete Fig. 6.1 by writing the sequence of bases in the region labelled **R**. [1]

(ii) State the name of region **Q and** explain the role of region **Q** in translation.

name .....

explanation .....

.....

.....

..... [3]

(iii) State the function of region **P**.

.....

.....

..... [1]

[Total: 9]

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BIOLOGY **9700/22**

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[Turn over

Answer **all** questions.

1 Fig. 1.1 is a photomicrograph of a low power image of part of the common sunflower, *Helianthus annuus*. Fig. 1.1 is a transverse section.

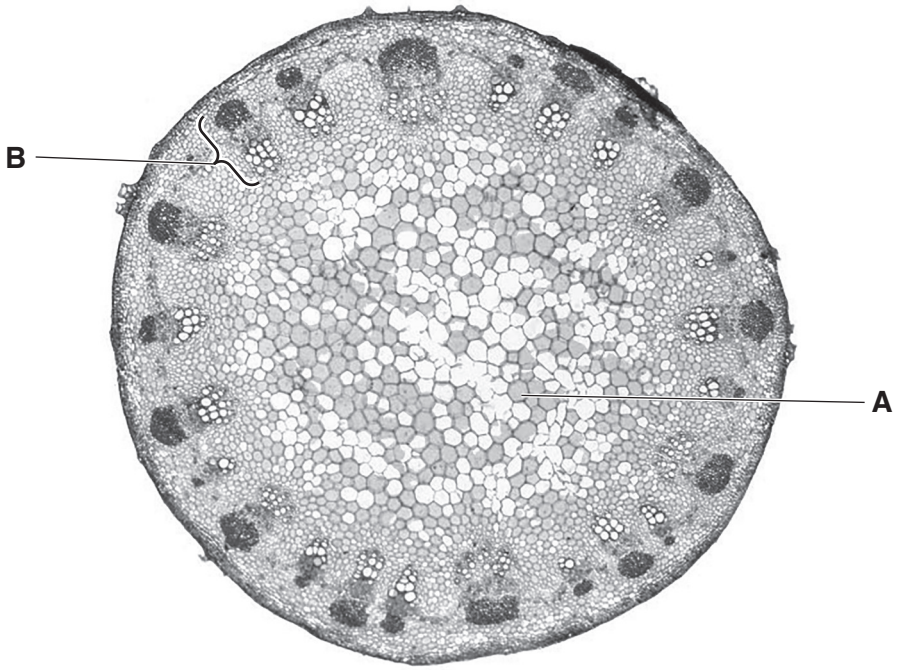


Fig. 1.1

(a) State, **with a reason**, whether Fig. 1.1 shows a section through the root or the stem of *H. annuus*.

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.....

..... [1]

(b) Cell type **A** in Fig. 1.1 has a large central vacuole.

Suggest, with reasons, the role of the tissue formed by this type of cell.

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..... [2]

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(c) Structure **B** in Fig. 1.1 contains phloem tissue and xylem tissue and other tissues that provide support.

(i) Name structure **B**.

..... [1]

(ii) The actual length of structure **B** is 650 μm.

State the actual length of structure **B** in mm.

..... [1]

(d) When structure **B** is observed at a higher magnification, more detail of xylem vessel elements and phloem sieve tube elements can be seen.

Outline the differences in the structure of a xylem vessel element and a phloem sieve tube element.

.....

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.....

.....

..... [3]

[Total: 8]

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[Turn over

2 Some tissues of the gas exchange system include cells that are able to produce and secrete mucins. Mucins are stored in vesicles in these cells, ready for secretion. Once outside the cell, mucins adsorb water to form mucus.

(a) Name the structures in the gas exchange system that produce and secrete mucins.

.....

..... [2]

(b) Mucins are described as glycosylated proteins. The process of glycosylation involves the addition of sugar components after polypeptides are synthesised.

Suggest **one** location in the cell where glycosylation of mucin could occur.

..... [1]

(c) The processes that occur in the production and secretion of mucins are listed.

translation **exocytosis** **glycosylation** **transcription**

Complete Table 2.1 by writing the processes in the correct order in which they would take place.

Table 2.1

first process	
second process	
third process	
fourth process	

[2]

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(d) Chloride ions move out of the mucin-producing cells at the same time as mucin is secreted.

Suggest **and** explain how the exit of chloride ions helps the formation of mucus from mucin.

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..... [3]

(e) The gas exchange system includes some cells that are able to divide by mitosis.

Explain why it is important to have these cells in the gas exchange system.

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..... [3]

[Total: 11]

3 Fig. 3.1 is a photomicrograph of human blood cells from a healthy individual who lives at sea level. The cells labelled **C**, **D** and **E** are white blood cells.

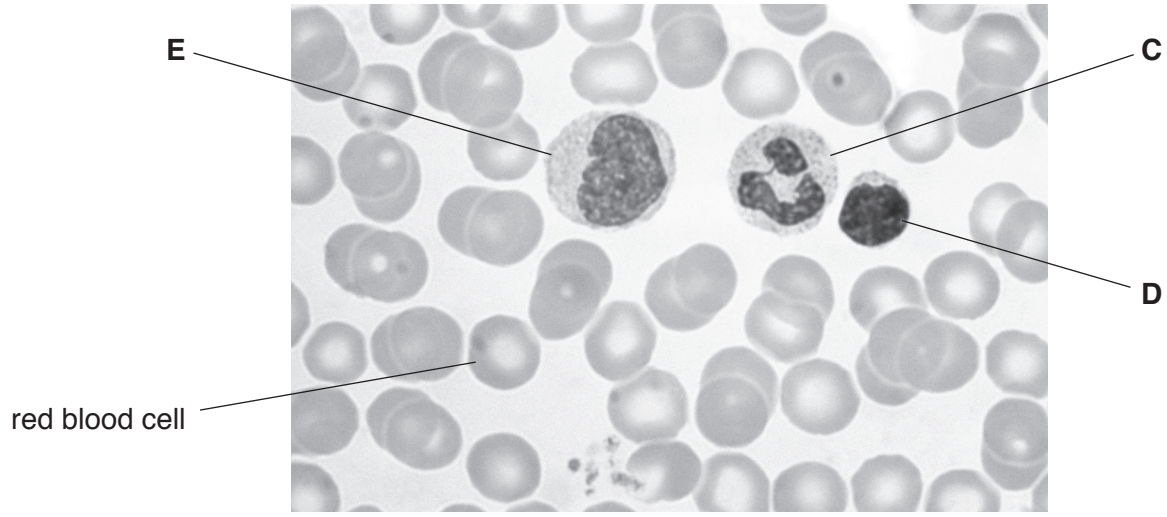


Fig. 3.1

(a) Name cells **C**, **D** and **E**.

C .....

D .....

E ..... [3]

(b) In humans, an increase in the white blood cell count can be associated with leukaemias and with infectious diseases, such as measles.

Chronic lymphocytic leukaemia (CLL) is a type of cancer that starts in the bone marrow. In the early stages, many people with CLL feel well. The disease is sometimes diagnosed by chance during a routine blood analysis, when a high white blood cell count is noticed. Many of these white blood cells are only partially mature.

(i) Suggest why CLL starts in the bone marrow and **not** in any other location in the body.

.....

.....

.....

.....

..... [2]

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(ii) Explain why a high white blood cell count is a feature of measles and of CLL.

measles .....

.....

.....

CLL .....

.....

..... [3]

(c) Most of the oxygen that enters the mammalian circulatory system is transported by red blood cells.

(i) Describe **and** explain the passage of oxygen across the cell surface membrane of the red blood cell.

.....

.....

.....

.....

..... [2]

(ii) At a high altitude, the partial pressure of oxygen in the atmosphere is lower than at sea level. If a person travels from low altitude to high altitude and remains there for a few weeks, the red blood cell count increases.

Explain why the body needs to respond to high altitude by increasing the number of red blood cells.

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..... [3]

(d) Polypeptide synthesis occurs before a red blood cell is released into the circulation.

The *HBB* gene codes for the β-globin polypeptide of haemoglobin.

There are two alleles of *HBB*, known as Hb^A and Hb^S.

Describe the difference between the Hb^A allele and the Hb^S allele **and** state how this difference affects:

- the β-globin polypeptide
- the haemoglobin molecule.

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..... [4]

[Total: 17]

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4 The bacterium *Vibrio cholerae* is the causative organism of the infectious disease cholera.

V. cholerae has structural features typical of all bacterial cells. It also has a flagellum for movement.

(a) Fig. 4.1 is an outline drawing of *V. cholerae*.

Complete Fig. 4.1 by drawing **and** labelling the structures found in *V. cholerae*.

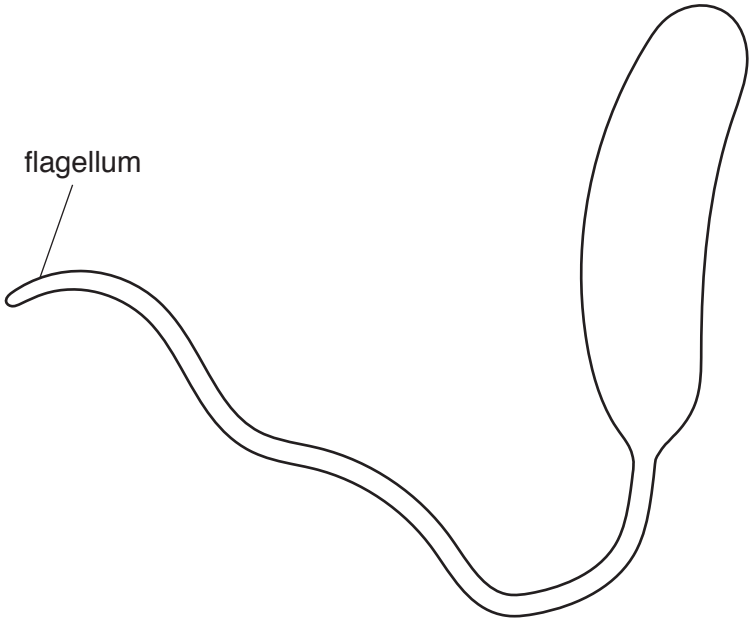


Fig. 4.1

[4]

(b) The World Health Organization (WHO) collects data about cholera from the 194 countries that are members of the World Health Assembly (WHA).

In 2015:

- there were cases of cholera in 42 of the member countries of the WHA
- the total number of cases of cholera reported was 172 454
- there were deaths as a result of cholera in 23 of these countries
- the total number of deaths from cholera reported was 1304.

The case fatality rate for cholera is the proportion of cases of cholera that results in death within a particular time period.

A country with cases of cholera that are properly treated should have a case fatality rate of less than 1%.

(i) Calculate the case fatality rate for the 42 member countries of the WHA for 2015.

Give your answer to the nearest 0.1%.

case fatality rate = ... % [1]

(ii) Many of the 23 countries reporting deaths from cholera in 2015 had a case fatality rate of less than 1%.

However, two of the 23 countries had case fatality rates greater than 5%.

Suggest **two** explanations for the higher case fatality rate in these two countries.

.....

.....

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.....

..... [2]

(c) In 2010, the country of Haiti experienced a major earthquake. This led to an outbreak of cholera.

(i) Explain why an earthquake may lead to a cholera outbreak.

.....

.....

.....

..... [1]

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(ii) Fig. 4.2 shows data about cholera collected by WHO over a period of 8 years, from 2008 to 2015. These data include:

- the total number of cases of cholera for each year
- the number of countries in each year that had cases of cholera.

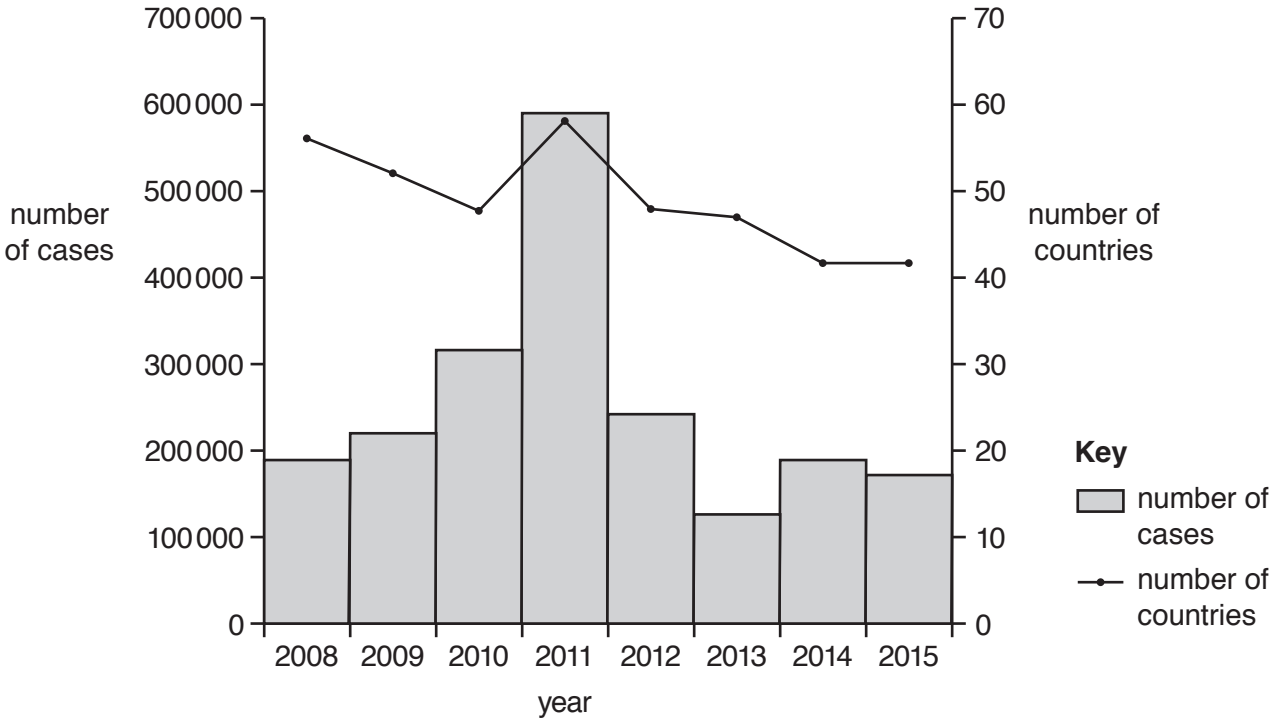


Fig. 4.2

Comment on the trends shown in Fig. 4.2.

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..... [3]

[Total: 11]

5 Cells contain carbohydrates, proteins, lipids and nucleic acids.

(a) Fig. 5.1 is a list of biological molecules, some of which are components of larger molecules.

cellulose
thymine nucleotide
α-glucose
β-glucose
messenger RNA
glycogen
glycine
α-globin

Fig. 5.1

Complete Table 5.1 by using **only** the molecules listed in Fig. 5.1.

- Each example can be written under **one or more** correct headings.
- **All** the examples in Fig. 5.1 should appear at least **once** in Table 5.1.

Table 5.1

examples			
monomers	polymers	monosaccharides	polysaccharides

[5]

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(b) Explain how the structure of phospholipids allows the formation of the phospholipid bilayer of cell membranes.

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.....

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.....

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.....

.....

..... [3]

[Total: 8]

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[Turn over

6 Catalase is an enzyme that catalyses the breakdown of hydrogen peroxide, which is a waste product of cell metabolism.

The reaction catalysed by catalase is shown in Fig. 6.1.

$$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$$

Fig. 6.1

(a) A student carried out two experiments to investigate the progress of the reaction shown in Fig. 6.1. Potato tissue was used as the source of the enzyme.

Six pieces of potato were cut, each measuring 20 mm × 10 mm × 10 mm.

In the first experiment, hydrogen peroxide solution was added to three of the pieces of potato tissue and the progress of the reaction was measured.

Fig. 6.2 shows how the first experiment was set up.

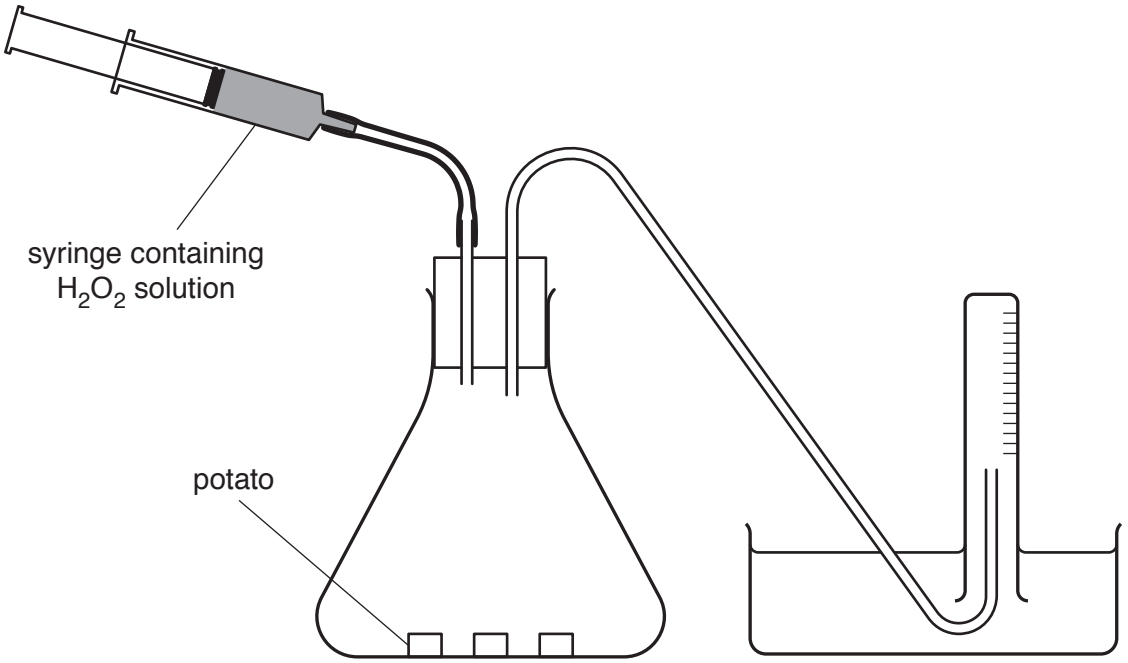


Fig. 6.2

(i) Suggest how the progress of the reaction could be measured.

.....

.....

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..... [2]

(ii) In the second experiment, the student cut each of the three remaining pieces of potato to obtain six pieces, each measuring 10 mm × 10 mm × 10 mm.

Using exactly the same conditions, the student measured the progress of the reaction and obtained different results to the first experiment.

Explain why the results of the second experiment were different from the results of the first experiment.

.....

.....

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.....

.....

..... [2]

(b) The student then investigated the effect of temperature on the activity of catalase.

On Fig. 6.3, sketch a curve to show how temperature affects the activity of an enzyme such as catalase.

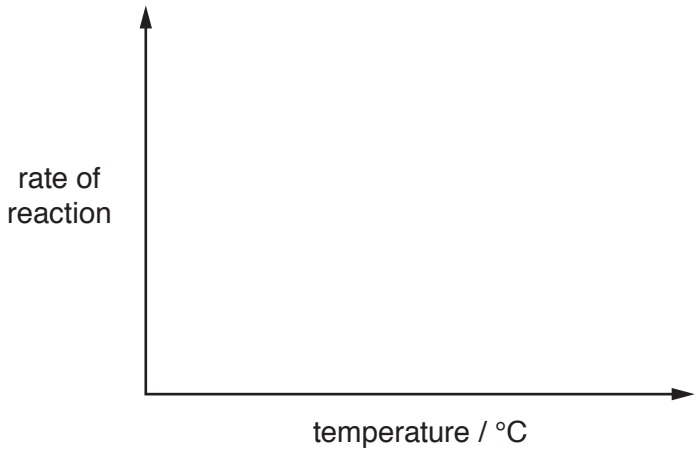


Fig. 6.3

[1]

[Total: 5]

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BIOLOGY **9700/23**

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Cambridge Assessment International Education

Answer **all** questions.

1 Fig. 1.1 is a diagram showing the structure of a section of a DNA molecule.

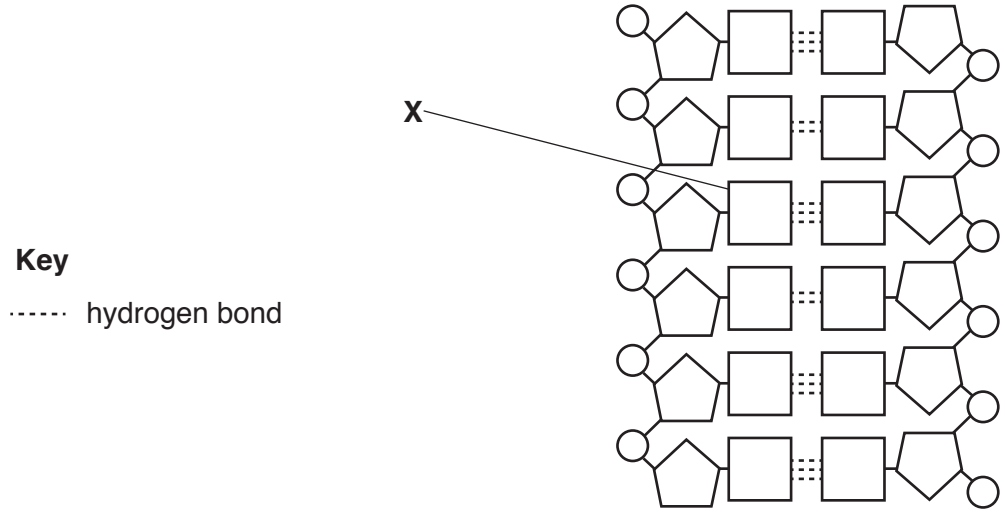


Fig. 1.1

(a) Draw a circle around **one** monomer of DNA in Fig. 1.1. [1]

(b) Name the two bases forming the base pair at **X** in Fig. 1.1 **and** give a reason for your answer.

bases .....

reason .....

.....

.....

..... [2]

(c) The statements 1–5 describe events that occur during DNA replication.

1 DNA polymerase forms a phosphodiester bond
2 DNA double helix forms
3 hydrogen bonds break
4 hydrogen bonds form
5 two strands of the double helix separate

Write the numbers 1 to 5 in the spaces below to show the order in which these events occur. The first one has been done for you.

..... **3** .... [1]

(d) The telomere is a region found at the end of a chromosome.

Outline the function of telomeres.

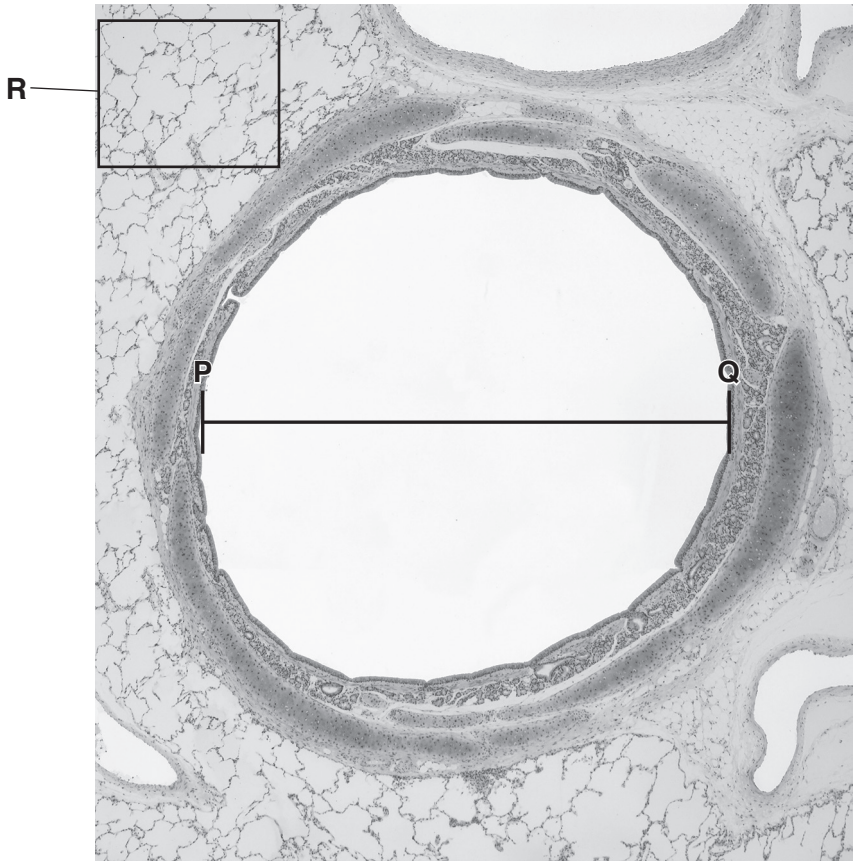
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..... [2]

[Total: 6]

2 Fig. 2.1 is a photomicrograph showing a transverse section through a bronchus and the surrounding lung tissue.



magnification x40

Fig. 2.1

(a) Calculate the actual diameter of the lumen of the bronchus using the line **P**–**Q**.

Write down the formula used to make your calculation.

Show your working and give your answer to the nearest micrometre (μm).

formula

actual diameter = ... μm [2]

(b) (i) In Fig. 2.1, the area labelled **R** shows a section through some alveoli.

Name the tissue that lines the air spaces of the alveoli.

..... [1]

(ii) Suggest how the alveoli are adapted for gas exchange.

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..... [2]

(c) In the leaves of plants, both gas exchange and transpiration occur through open stomata.

Suggest how the arrangement of cells in the leaf of a dicotyledonous plant contributes to the loss of water by transpiration.

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..... [3]

(d) Fig. 2.2 shows the mean transpiration rate of a xerophyte between 08:00 and 19:00.

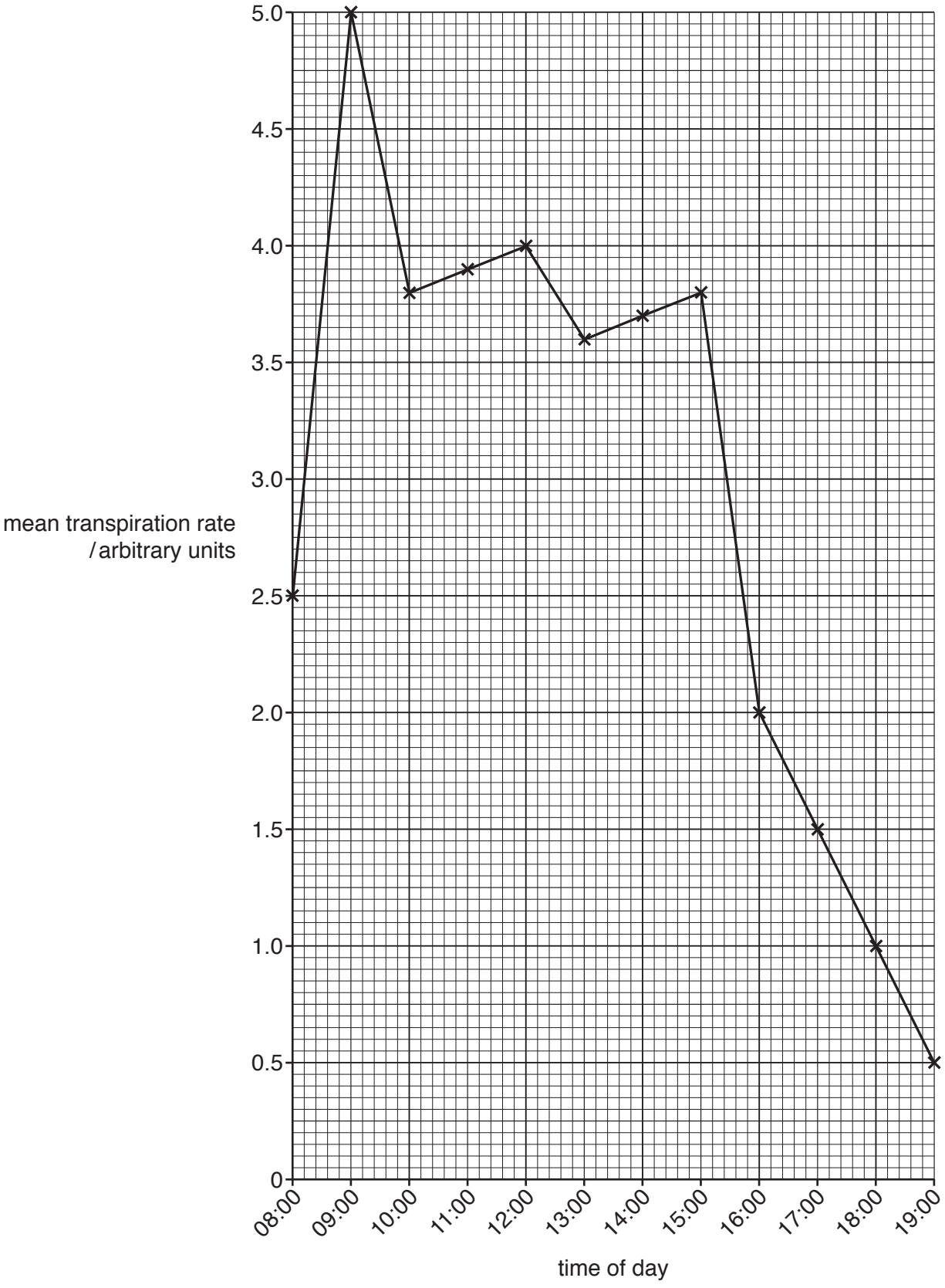


Fig. 2.2

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(i) Describe the data shown in Fig. 2.2.

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..... [3]

(ii) Suggest why the transpiration rate changed between 09:00 and 10:00.

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.....

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..... [2]

[Total: 13]

3 Cholera is an infectious disease caused by the bacterium *Vibrio cholerae*. The pathogen causes disease by disrupting the activity of the epithelial cells in the human intestine.

(a) Complete Table 3.1 to compare the structure of *V. cholerae* and an epithelial cell from the human intestine.

Use a tick (✓) to indicate the presence of the structure.

Use a cross (✗) to indicate the absence of the structure.

The first row has been completed for you.

Table 3.1

cell structure	*V. cholerae*	epithelial cell from the human intestine
cell wall	✓	✗
cell surface membrane		
ribosomes		
large permanent vacuole		
organelles surrounded by a double membrane		

[4]

(b) Describe the methods that can be used to prevent the spread of cholera.

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..... [5]

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(c) The World Health Organization has suggested that people with HIV/AIDS take a longer time to recover from cholera and are at an increased risk of death from cholera.

The human immunodeficiency virus (HIV) only infects certain types of cell. These cells have CD4 receptor proteins in their cell surface membrane. Helper T-lymphocytes have CD4 receptor proteins.

(i) Fig. 3.1 is a diagram of HIV showing the glycoprotein gp120.

This glycoprotein is embedded in a membrane envelope which surrounds the viral protein coat.

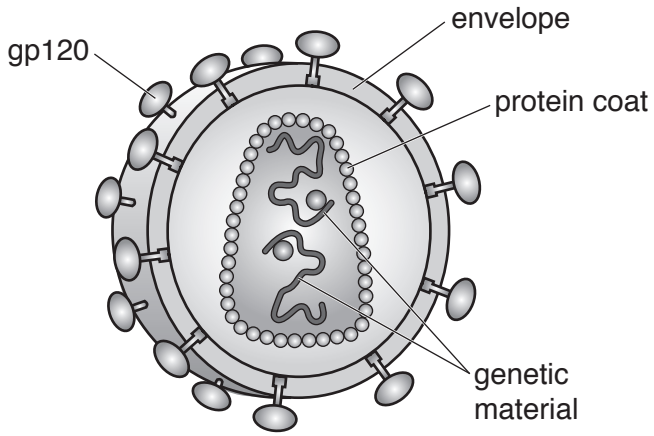


Fig. 3.1

The glycoprotein gp120 is important in allowing HIV to only infect certain types of cell.

Suggest the role of gp120.

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..... [2]

(ii) People with HIV/AIDS have a low helper T-lymphocyte count.

Explain how a low helper T-lymphocyte count could reduce the body's ability to produce antibodies against *V. cholerae*.

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.....

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..... [2]

[Total: 13]

4 Phloem sieve tube elements and xylem vessel elements are cells that are involved with the transport of substances in plants.

(a) Describe **two** differences between the structure of a phloem sieve tube element and a xylem vessel element.

.....

.....

.....

.....

..... [2]

(b) Sucrose is transported in phloem sieve tubes.

A student carried out a test to identify the presence of sucrose in a sample of sap taken from inside a phloem sieve tube. One of the steps in the procedure instructed the student to heat the phloem sap with hydrochloric acid.

Explain why it is necessary to carry out this step in the procedure.

.....

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.....

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..... [2]

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(c) The process of loading sucrose into a phloem sieve tube element involves a companion cell.

(i) Fig. 4.1 shows a stage in the process of loading sucrose into the phloem.

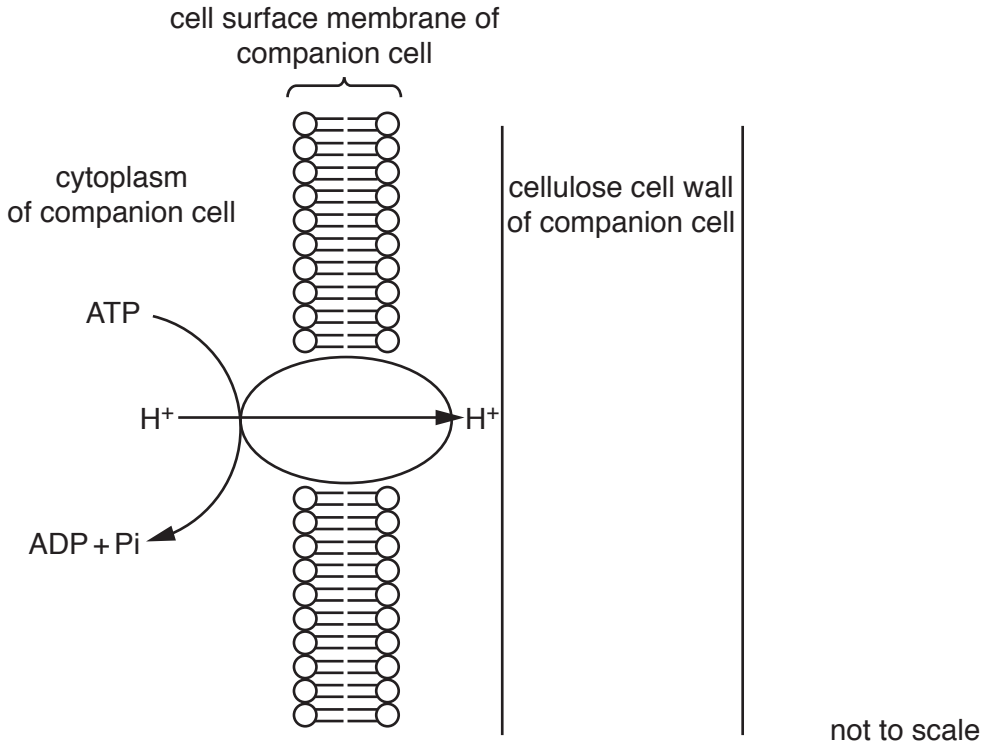


Fig. 4.1

Companion cells contain large numbers of mitochondria and ribosomes.

Explain the roles of mitochondria and ribosomes for the stage shown in Fig. 4.1.

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..... [2]

(ii) Describe **and** explain how sucrose is transported from the cell wall of the companion cell into the cytoplasm.

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..... [3]

[Total: 9]

5 **(a)** Fig. 5.1 is a photomicrograph of human blood cells that have been placed in a solution of sodium chloride.

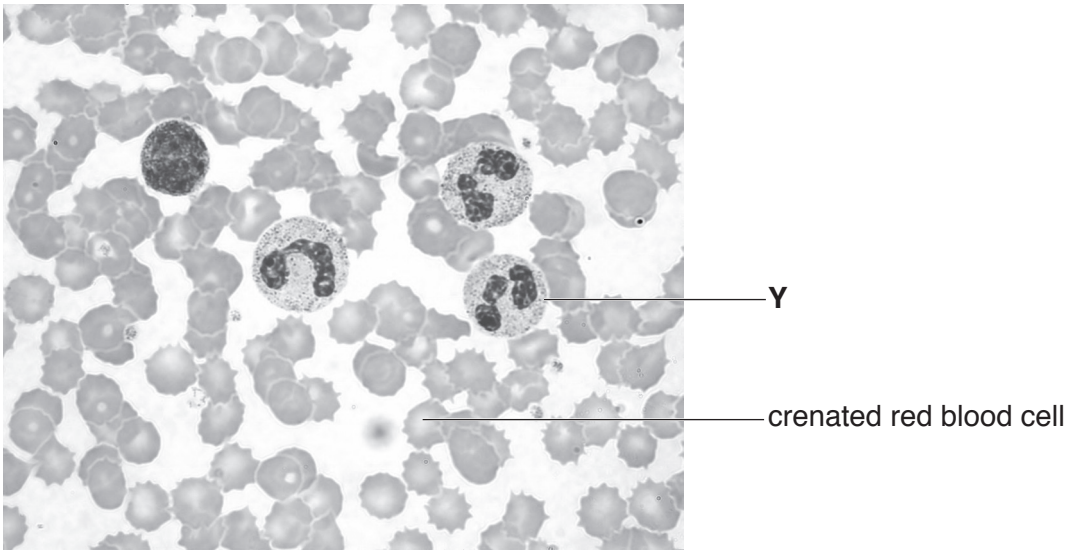


Fig. 5.1

(i) State the function of the cell labelled **Y**.

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..... [1]

(ii) The red blood cell labelled in Fig. 5.1 is described as crenated because it has an abnormal, shrivelled appearance.

Explain how this red blood cell has become crenated.

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..... [2]

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(b) Researchers studied the effect of altitude on the red blood cell count of humans. They recorded the red blood cell count of healthy adults from populations living at four different altitudes in a mountainous region.

The results are shown in Table 5.1.

Table 5.1

population	altitude of population / m above sea level	mean red blood cell count / number of cells $\times 10^6$ mm^{-3}
A	695	4.50
B	1676	5.14
C	2003	5.04
D	2118	5.11

(i) Calculate the percentage increase in mean red blood cell count between population **A** and population **D**.

.....% [1]

(ii) Describe and suggest explanations for the data shown in Table 5.1.

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..... [4]

(c) Carbonic anhydrase is an enzyme found in red blood cells which has an important role in the transport of respiratory gases.

Explain why a non-competitive inhibitor of carbonic anhydrase will reduce the supply of oxygen to actively respiring tissues.

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..... [2]

[Total: 10]

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6 Fig. 6.1 is a diagram of a vertical section of the human heart and the associated blood vessels.

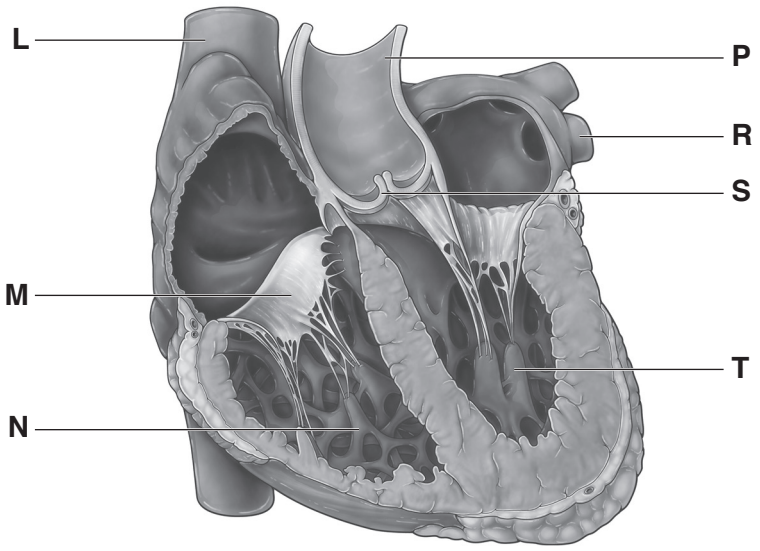


Fig. 6.1

(a) Complete Table 6.2 by writing the letter from Fig. 6.1 that identifies each of the structures described.

Table 6.2

structure in the heart	letter
valve preventing back flow of blood into a ventricle	
blood vessel carrying blood under highest pressure	
chamber that pumps blood to the lungs	

[3]

(b) Describe the short-term effects of nicotine on the cardiovascular system.

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.....

..... [3]

Question 6 continues on page 16

(c) Cardiac myocytes are heart muscle cells.

Fetal cardiac myocytes are present before birth and divide rapidly during fetal development.

Soon after birth the cell cycle in most of these fetal cardiac myocytes stops, forming adult cardiac myocytes. Most of the adult cells have completed the cell cycle but in some the cell cycle stops at the end of mitosis.

(i) State the difference between adult cardiac myocytes that have completed the cell cycle and those that have stopped at the end of mitosis.

..... [1]

(ii) Suggest why it could be a disadvantage that the cell cycle has stopped in most adult cardiac myocytes.

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..... [2]

[Total: 9]

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