UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CANDIDATE NAME

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CANDIDATE NUMBER

6723760386

BIOLOGY **9700/21**

Paper 2 Structured Questions AS **May/June 2011**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Answer **all** questions.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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1	
2	
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4	
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6	
Total	

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Answer **all** the questions.

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1 Fig. 1.1 is an electron micrograph of cells from the ciliated epithelium of the trachea.

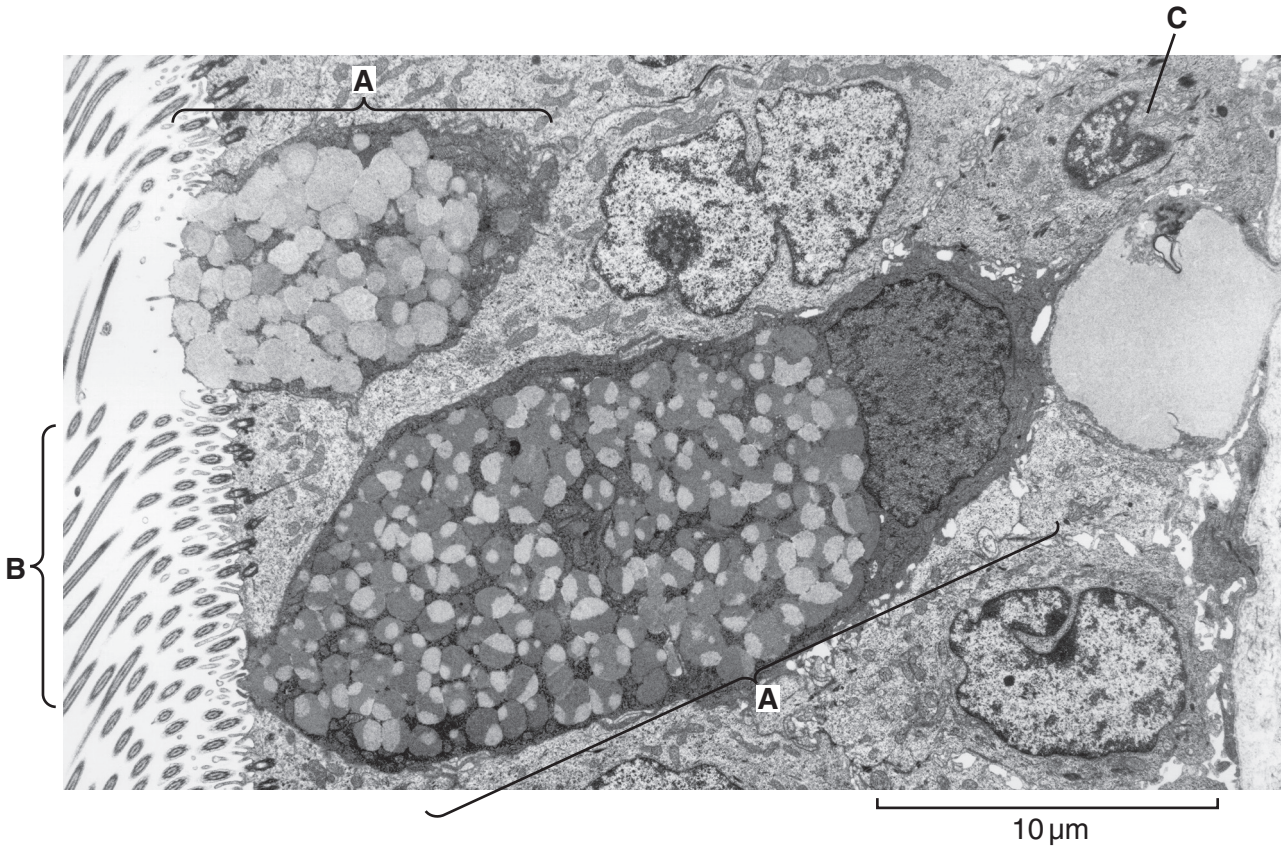


Fig. 1.1

(a) Calculate the magnification of the electron micrograph in Fig. 1.1.

Show your working and express your answer to the nearest whole number.

magnification × .....[2]

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(b) Explain how the cells labelled **A** and the structures labelled **B** in Fig. 1.1 protect the lining of the trachea.

For Examiner's Use

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.....[4]

(c) Cells, such as **C**, at the base of the epithelium of the trachea divide by mitosis.

Describe the changes that occur within the cell between the beginning of prophase and the end of metaphase.

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.....[5]

[Total: 11]

For Examiner's Use

2 **(a)** Carbon dioxide is transported in the blood in various forms.

Describe how carbon dioxide molecules reach red blood cells from respiring cells.

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.....[2]

Fig. 2.1 shows part of a capillary network and some cells of the surrounding tissue.

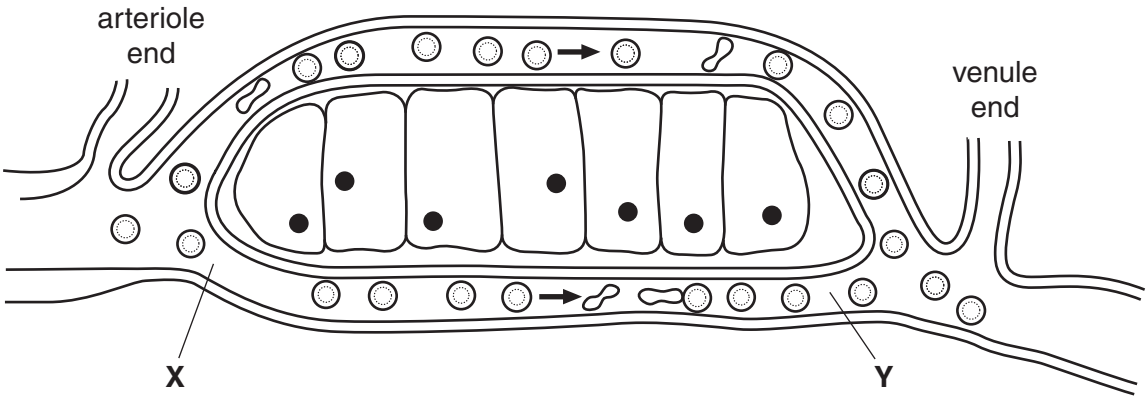


Fig. 2.1

(b) State three ways in which the blood at **Y** differs from the blood at **X other than** in the concentration of carbon dioxide.

1. .....

2. .....

3. .....[3]

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An enzyme in red blood cells catalyses the reaction between carbon dioxide and water as blood flows through respiring tissues.

For Examiner's Use

$$CO_2 + H_2O \xrightarrow{\text{enzyme}} H_2CO_3 \longrightarrow H^+ + HCO_3^-$$

(c) (i) Name the enzyme that catalyses this reaction.

.....[1]

(ii) Explain the significance of this reaction in the transport of carbon dioxide.

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.....[3]

(d) Fig. 2.2 shows the effect of increasing the carbon dioxide concentration on the oxygen haemoglobin dissociation curve.

For Examiner's Use

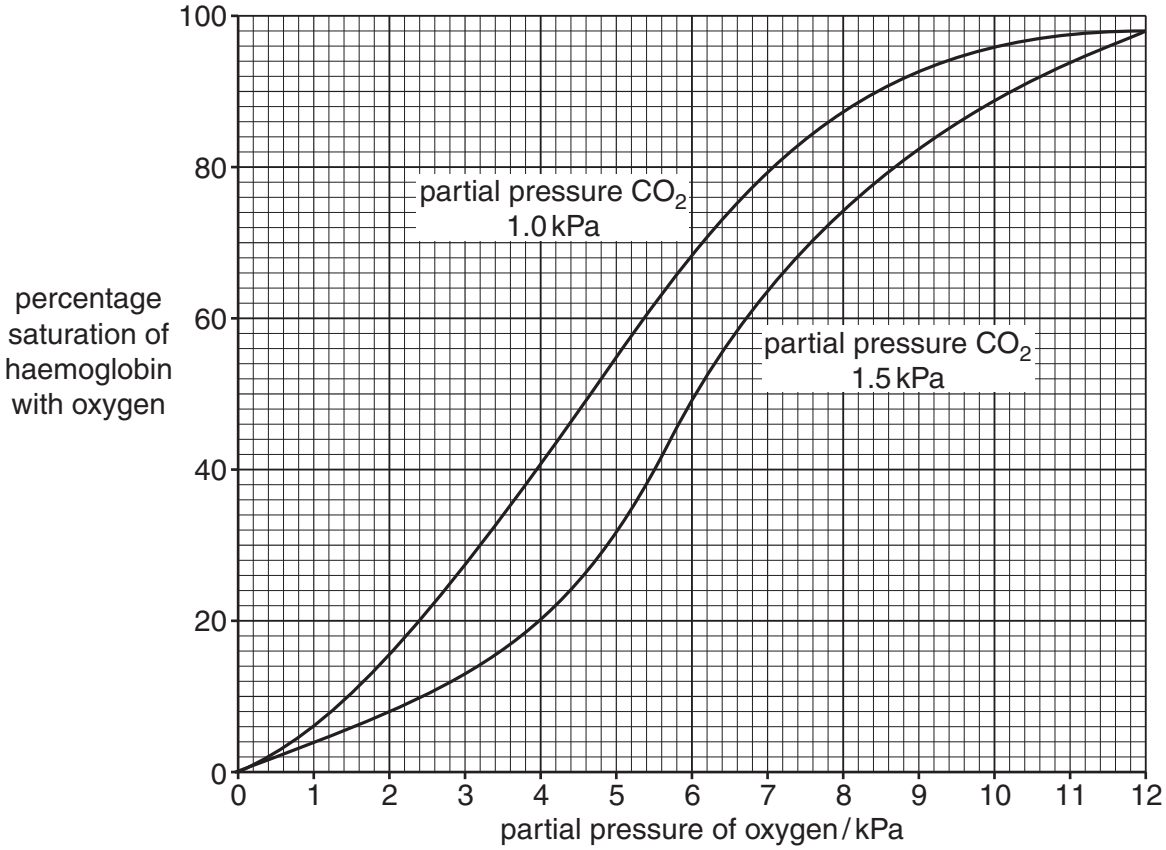


Fig. 2.2

(i) State the percentage saturation of haemoglobin with oxygen at a partial pressure of 5 kPa of oxygen when the partial pressure of carbon dioxide is:

1.0 kPa .....

1.5 kPa .....[1]

(ii) The percentage saturation of haemoglobin with oxygen **decreases** as the partial pressure of carbon dioxide increases.

Explain how this happens.

.....

.....

.....

.....[2]

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(iii) Name the effect of increasing carbon dioxide concentration on the oxygen dissociation curve.

For Examiner's Use

.....[1]

(iv) Explain the importance of the effect of carbon dioxide on haemoglobin as shown in Fig. 2.2.

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.....[3]

[Total: 16]

3 A molecule of messenger RNA (mRNA) was produced during the transcription of a gene. Part of the template sequence of DNA was ATGC.

For Examiner's Use

Fig. 3.1 shows the part of the molecule of messenger RNA corresponding to that sequence of four bases.

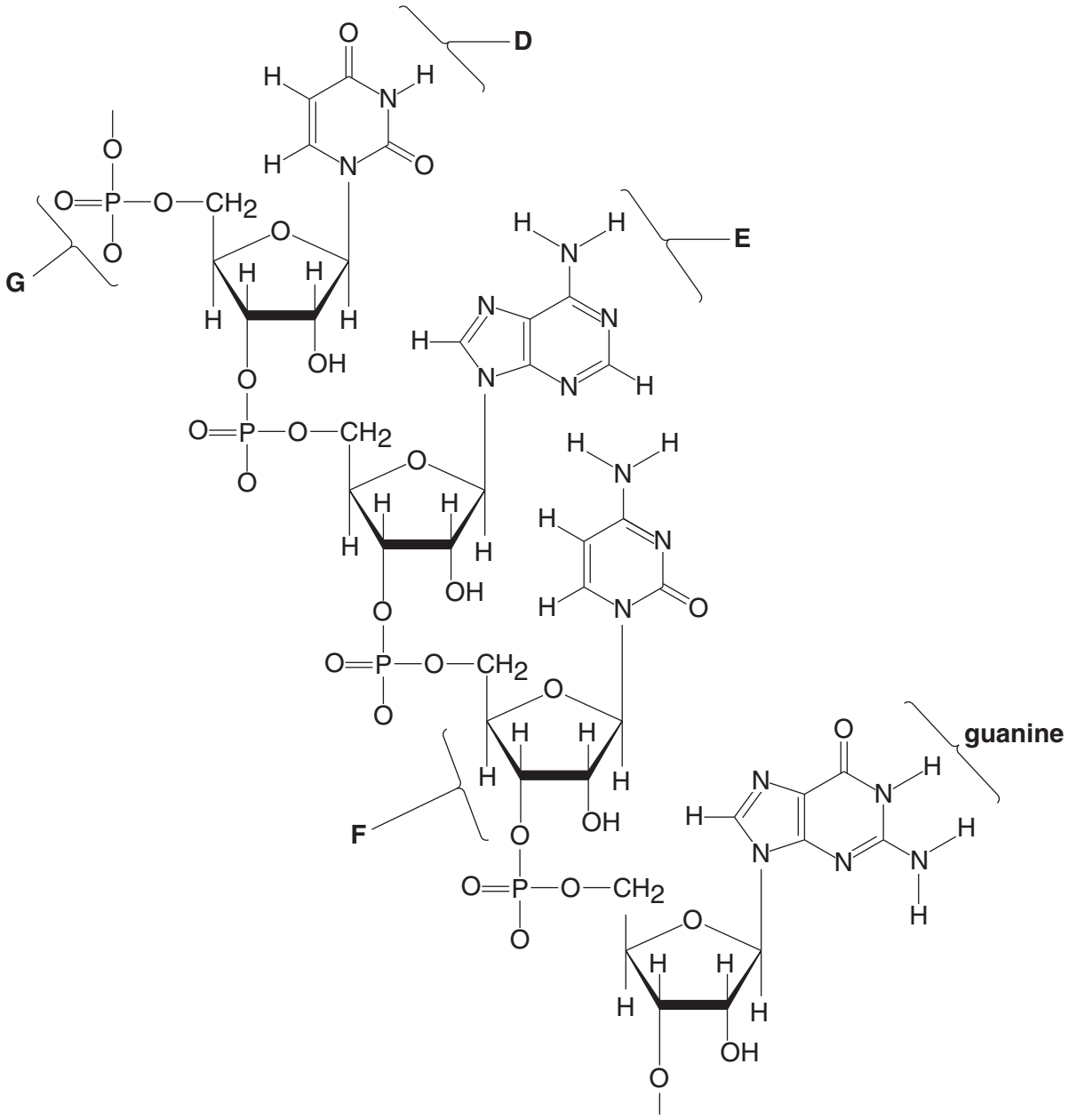


Fig. 3.1

(a) Name the parts of the mRNA molecule shown in Fig. 3.1 labelled **D**, **E**, **F** and **G**.

D .....

E .....

F .....

G .....[4]

(b) Complete the table to show **three** ways in which mRNA differs from DNA.

For Examiner's Use

	mRNA	DNA
1		
2		
3		

[3]

(c) Describe the role of mRNA after it leaves the nucleus and enters the cytoplasm of a eukaryotic cell.

.....

.....

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.....[4]

[Total: 11]

4 The enzyme sucrase catalyses the breakdown of the glycosidic bond in sucrose.

For Examiner's Use

A student investigated the effect of increasing the concentration of sucrose on the rate of activity of sucrase.

Ten test-tubes were set up with each containing $5\,cm^3$ of different concentrations of a sucrose solution. The test-tubes were placed in a water bath at 40 °C for ten minutes. A flask containing a sucrase solution was also put into the water bath.

After ten minutes, $1\,cm^3$ of the sucrase solution was added to each test-tube. The reaction mixtures were kept at 40 °C for a further ten minutes.

After ten minutes, the temperature of the water bath was raised to boiling point. Benedict's solution was added to each test-tube. The time taken for a colour change was recorded and used to calculate rates of enzyme activity.

The results are shown in Fig. 4.1.

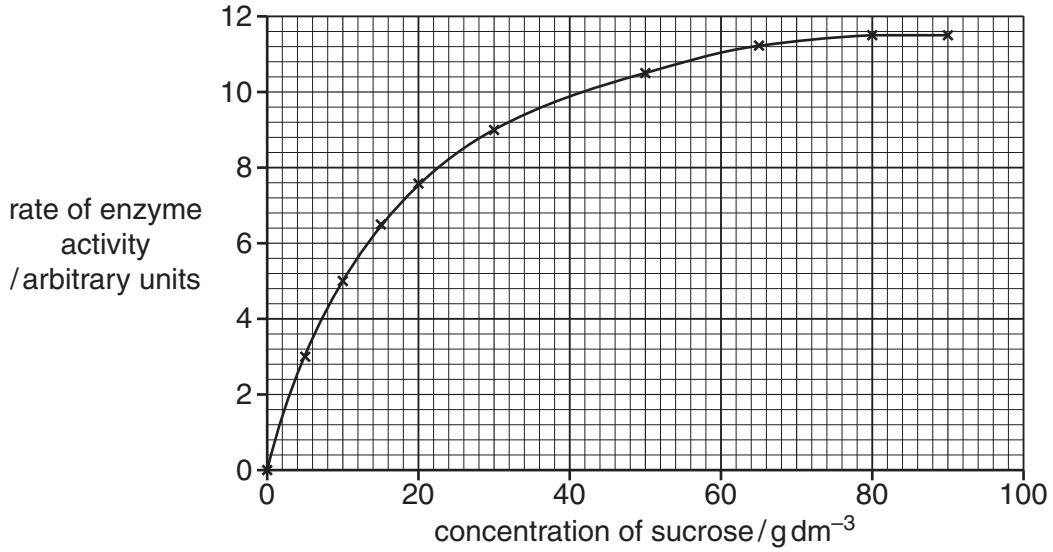


Fig. 4.1

(a) (i) Name the type of reaction catalysed by sucrase.

.....[1]

(ii) Explain why the temperature of the water was raised to boiling point.

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.....[2]

(b) Describe **and** explain the results shown in Fig. 4.1.

For Examiner's Use

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.....[5]

[Total: 8]

5 Fig. 5.1 shows five different biological molecules.

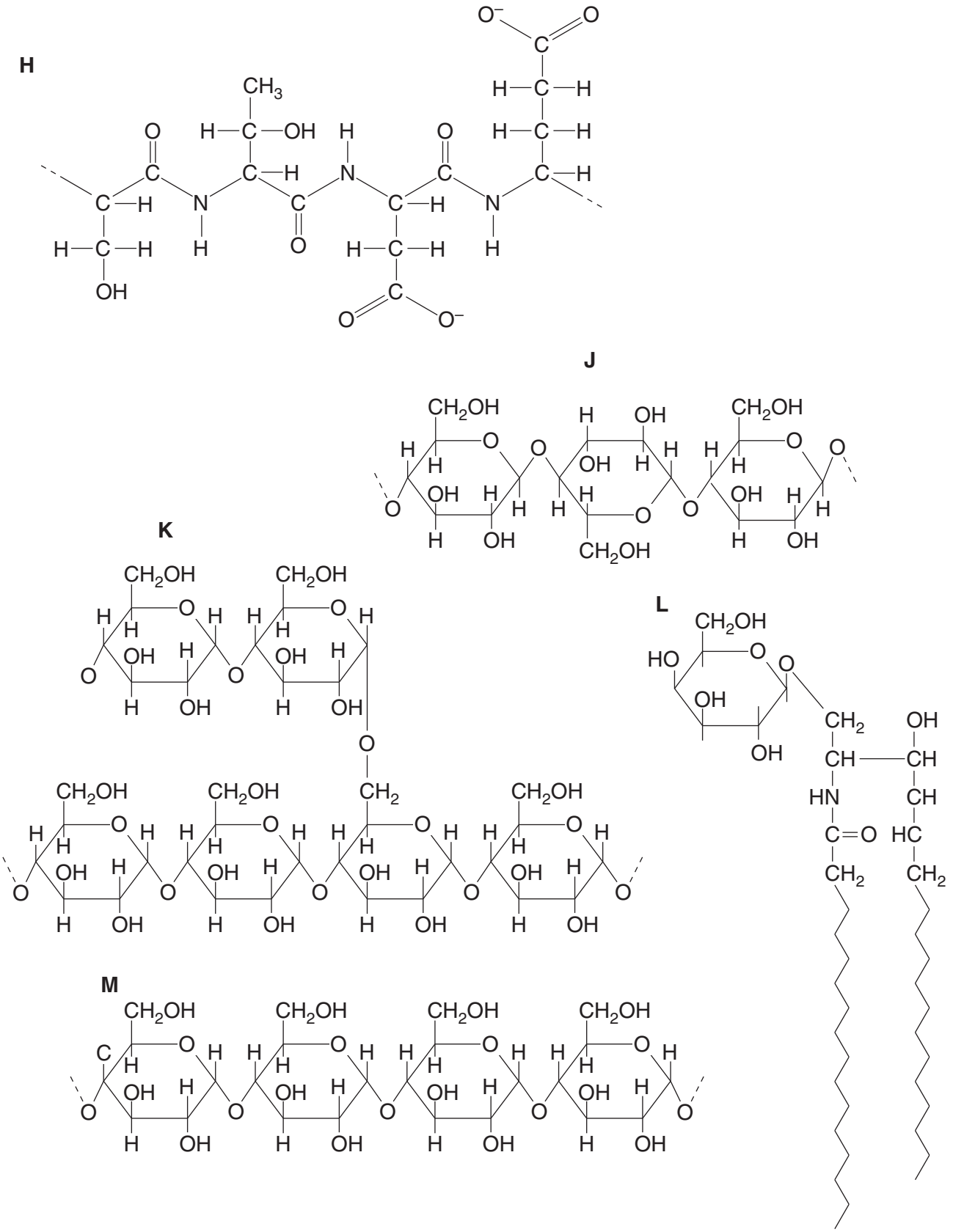


Fig. 5.1

Complete Table 5.1 by indicating which molecule matches each statement.

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You may use each letter (**H** to **M**) once, more than once or not at all.

You should write only one letter in each box.

Table 5.1

statement	letter
contains peptide bonds	
part of the molecule forms the hydrophobic part of cell membranes	
contains 1-4 and 1-6 glycosidic bonds	
forms the primary structure of a protein	
used for energy storage in plants	
forms a helical structure	
the sub-unit molecule is β-glucose	

[Total: 7]

For Examiner's Use

6 Measles is a common viral infection. A vaccine has been available for measles since the 1960s. There are vaccination programmes for many diseases including measles. Babies are born with a passive immunity to measles so the vaccine is not given in the first few months after birth.

(a) Explain how active immunity differs from passive immunity.

.....

.....

.....

.....

.....

.....[3]

(b) Explain why the vaccine for measles is not given in the first few months of a child's life.

.....

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.....

.....

.....[2]

The World Health Organization (WHO) publishes data on the vaccination programmes for infectious diseases. The WHO recommends vaccination rates of over 90% of children.

Each health authority in a country reports its success in vaccinating children in their district. The WHO uses these figures to estimate the percentage of districts in each country that vaccinate 90% of children against measles.

The WHO also collects statistics on death rates of children under the age of 5 from all causes, including infectious diseases.

Fig. 6.1 shows these statistics for 24 countries for the year 2007.

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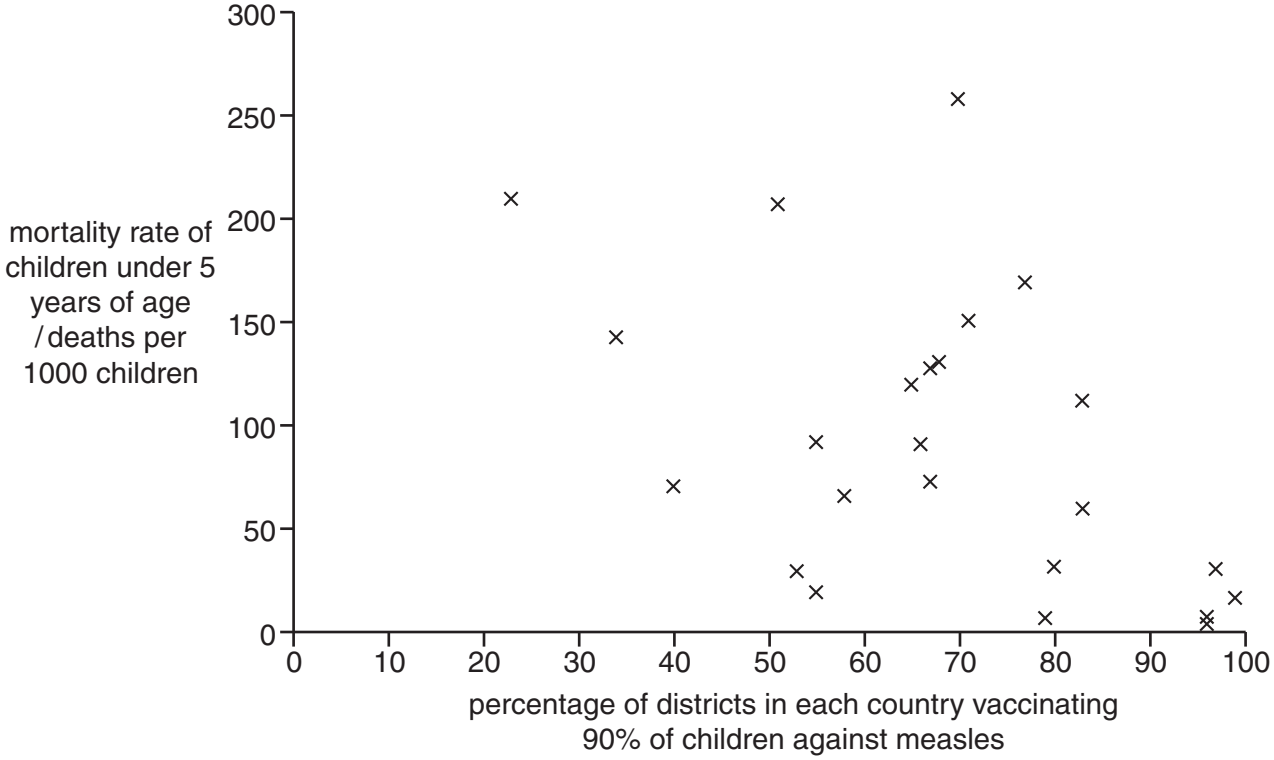


Fig. 6.1

(c) Use the information in Fig. 6.1 to explain why the WHO recommends immunisation of 90% of children.

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.....[2]

[Total: 7]

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Fig. 1.1 © Image taken by Prof. H. Wartenberg from Dr. Jastrow's electron microscope atlas on http://www.drjastrow.de.

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BIOLOGY **9700/22**

Paper 2 Structured Questions AS **May/June 2011**

1 hour 15 minutes

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1 Fig. 1.1 is a photomicrograph of a root tip of onion, *Allium cepa*, showing cells in interphase and in stages of mitosis.

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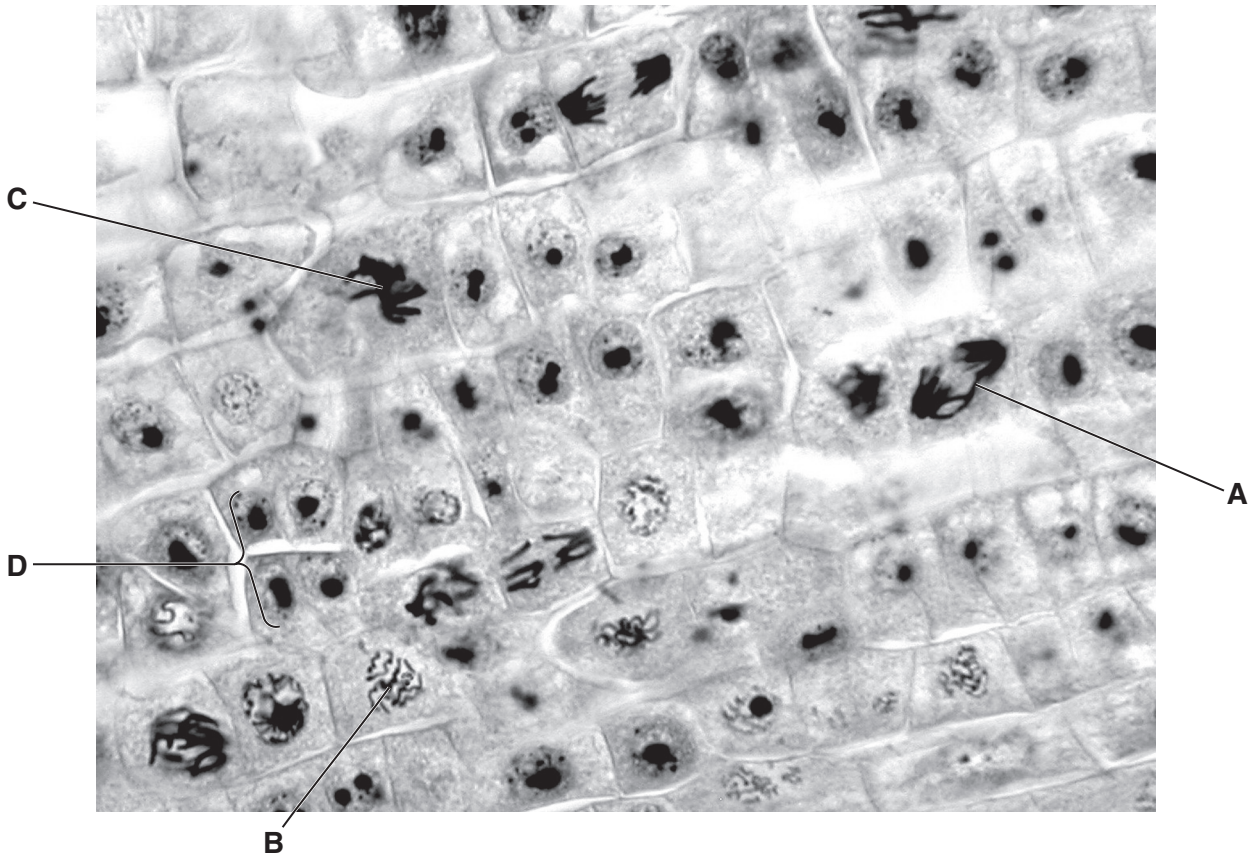


Fig. 1.1

(a) Name the stages of mitosis shown in cells **A**, **B** and **C**.

A .....

B .....

C .....[3]

(b) Suggest why the cells labelled **D** are smaller than most of the other cells in Fig. 1.1.

.....

.....

.....[1]

(c) Interphase is often described as a 'resting stage'.

Explain why the term 'resting stage' is not an appropriate description for cells in interphase.

.....

.....

.....[2]

[Total: 6]

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2 Read the passage below. Parts of the passage are in **bold type**. These are examples of ecological terms and are labelled **A** to **F**.

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A class of students carried out an ecological study of **a defined area of seashore (A)** in Brittany, France. One group decided to study a **rockpool (B)** and recorded information such as the **oxygen concentration and temperature of the seawater (C)**. After investigating **all the different living organisms (D)** present in the rockpool, the students decided to study in more detail the **group of limpets, *Patella vulgata* (E)**. They collected information about the **role of the limpets within the rockpool, including interactions with other organisms (F)**. For example, limpets grazed on green seaweeds, while the shore crab, *Carcinus maenas*, fed on small limpets.

(a) State the correct letter, **A** to **F**, from the passage above that corresponds to each of the ecological terms below.

habitat	
ecosystem	
abiotic component	
ecological niche	
population	
community	

[4]

(b) State the trophic levels to which each of the organisms named in the passage belong **and** outline the energy losses that occur in the food chain.

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.....[4]

[Total: 8]

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3 **(a)** Explain how the structure of red blood cells is suited to their function of transporting oxygen to body tissues.

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.....[3]

(b) The circulating red blood cell is metabolically active but only lives for about 120 days. During this time, some important enzymes are gradually broken down and this may contribute to the death of the cell.

Explain why the red blood cell is **not** able to replace important enzymes that have been broken down.

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.....[2]

(c) Red blood cells are broken down by phagocytic cells in the liver and spleen. The haemoglobin is broken down into haem and globin before further processing. Some of the components of haemoglobin are re-used in the body.

(i) Name the mineral ion released from the breakdown of haem.

.....[1]

(ii) State the products of globin hydrolysis.

.....[1]

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Haemoglobin plays an important role in carrying oxygen and carbon dioxide.

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Fig. 3.1 summarises some of the events that occur as blood enters a capillary located in an area of actively respiring cells.

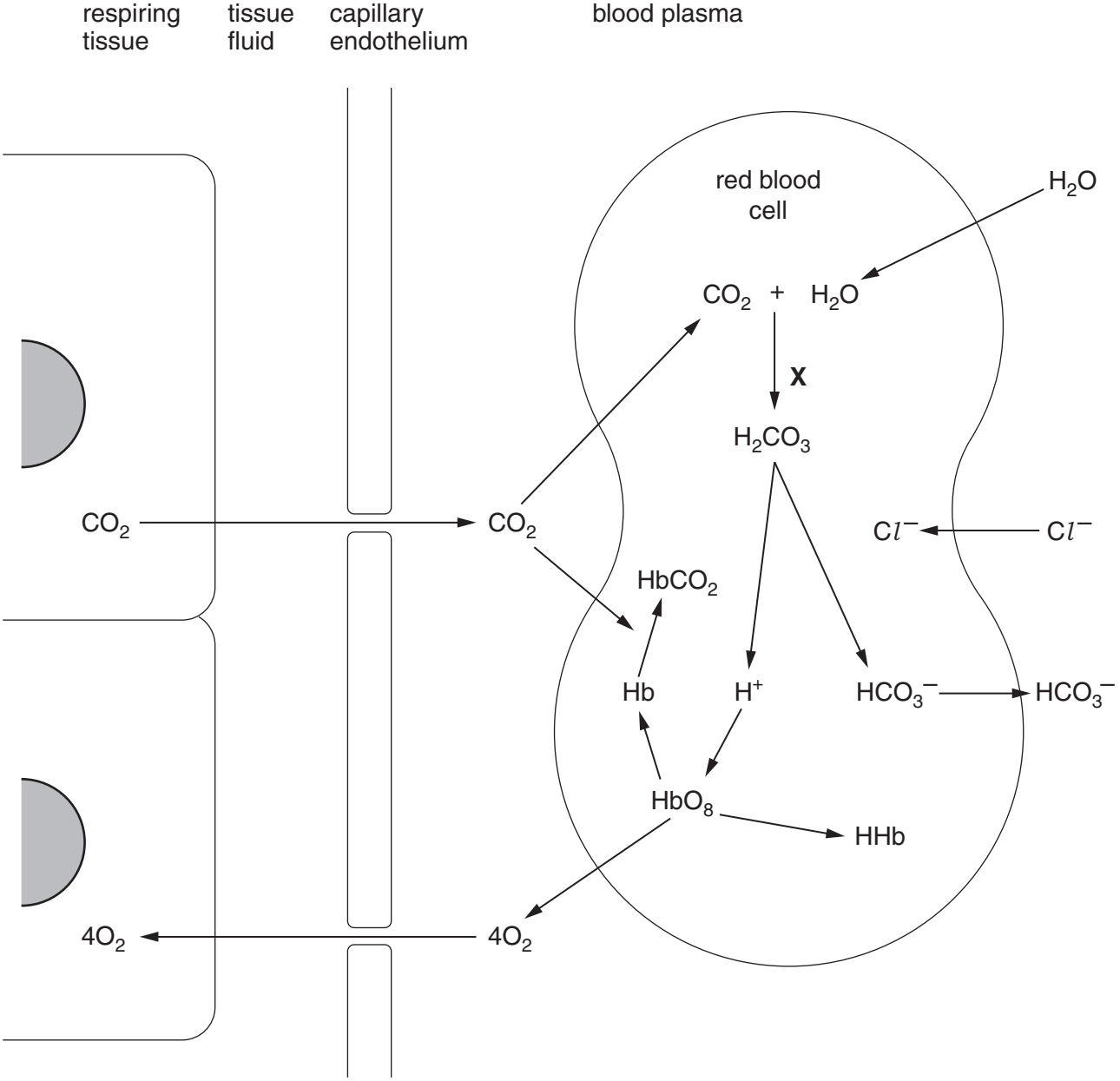


Fig. 3.1

(d) State the name of the enzyme that catalyses the reaction occurring at **X**.

.....[1]

(e) With reference to Fig. 3.1, describe **and** explain how carbon dioxide (CO_2) and hydrogen ions (H^+) play a role in the unloading of oxygen from haemoglobin.

For Examiner's Use

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.....[5]

[Total: 13]

For Examiner's Use

4 Tuberculosis (TB) is an infectious disease that kills about three million people worldwide each year.

(a) Name the pathogenic organism that causes tuberculosis.

.....[1]

Fig. 4.1 is a transmission electron micrograph of the organism that causes tuberculosis.

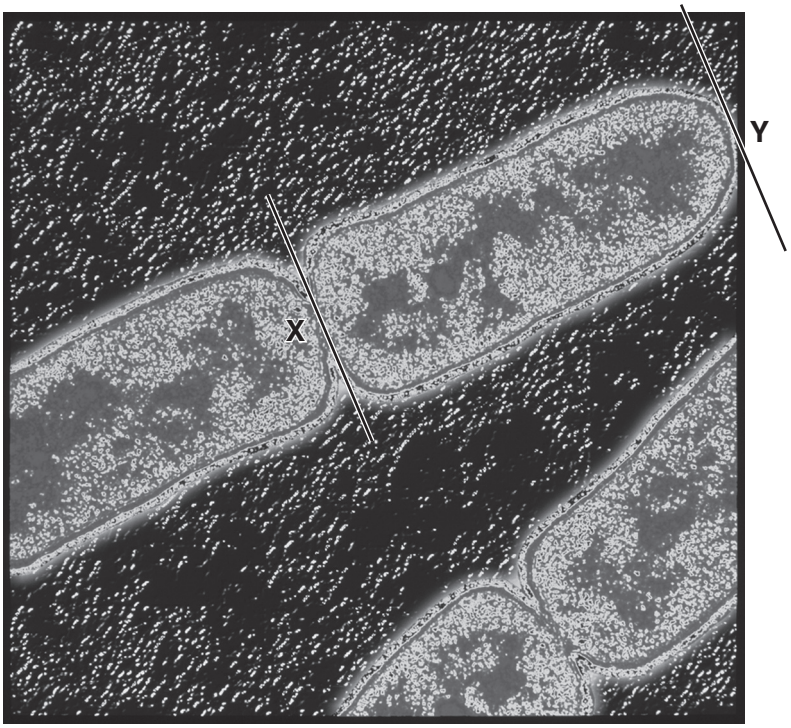


Fig. 4.1

(b) (i) The actual length of the cell between **X** and **Y** in Fig. 3.1 is 2 µm.

Calculate the magnification of the electron micrograph.

Show your working and give your answer to the nearest whole number.

magnification × .....[2]

(ii) The organism that causes tuberculosis is a prokaryote. State three features of prokaryotes.

1. .....

2. .....

3. .....[3]

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In the 1940s, the use of antibiotics led to a steady decrease in the number of new cases of tuberculosis. However, in many developed countries, the number of new cases stopped decreasing in the mid-1980s and is now increasing.

For Examiner's Use

(c) (i) State **one** factor, other than drug therapy, that contributed to the **steady decrease** in the number of new cases of tuberculosis.

.....[1]

(ii) Outline three reasons why, in many developed countries, the number of new cases of tuberculosis is now increasing.

1. .....

.....

2. .....

.....

3. .....

.....[3]

(d) Streptomycin was the first antibiotic to be discovered that was effective against the pathogen that causes tuberculosis. Streptomycin causes the death of the pathogen by binding to ribosomes and inhibiting protein synthesis.

(i) Suggest two ways in which streptomycin acts at ribosomes to inhibit protein synthesis.

1. .....

.....

.....

2. .....

.....

.....[2]

(ii) Streptomycin does not harm mammalian cells.

Suggest an explanation for this.

.....

.....[1]

[Total: 13]

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5 **(a)** Fig. 5.1 represents a molecule of a triglyceride.

For Examiner's Use

Name the components **A** and **C** and name the bond **B**.

Write your answers on the dotted lines provided in Fig. 5.1.

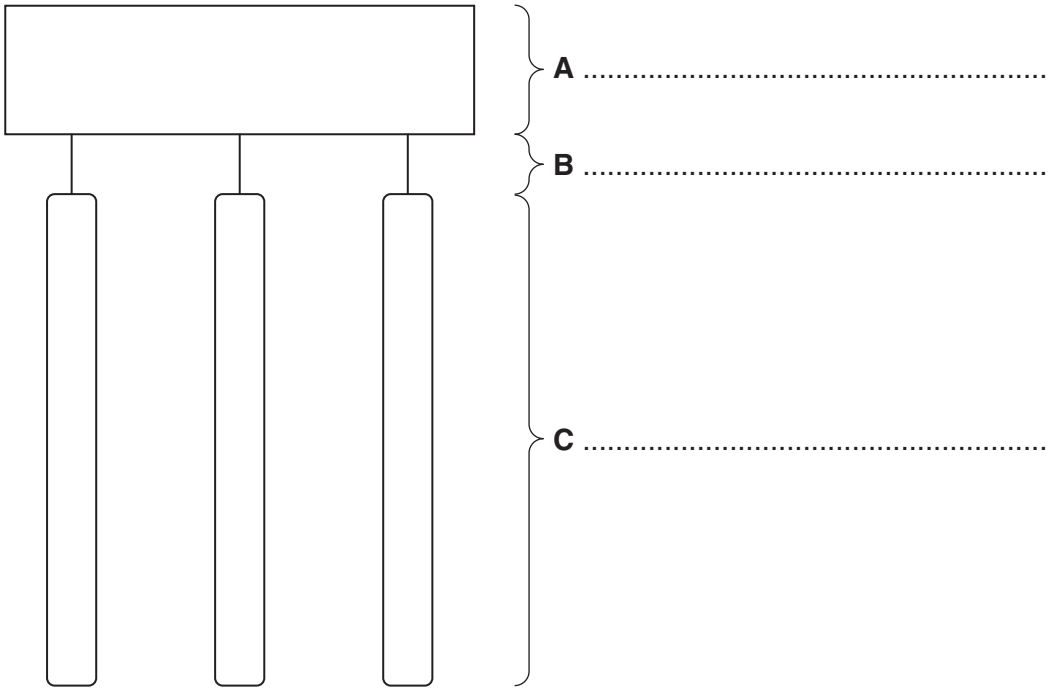


Fig. 5.1 [3]

(b) A phospholipid is sometimes described as a modified triglyceride.

(i) State how the structure of a phospholipid differs from a triglyceride.

.....

.....

.....[2]

(ii) Explain how a phospholipid is suited to its role in cell membranes.

.....

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.....[3]

A student carried out an investigation into the digestion of triglycerides using lipase.

For Examiner's Use

Ten cm^3 of olive oil, adjusted to pH 8.0, was added to a test-tube, which was then put in a water bath at 37 °C for ten minutes.

One cm^3 of lipase solution was incubated at the same temperature in a separate test-tube before being added to the olive oil.

The initial pH of the reaction mixture was measured using a pH meter. The pH was recorded at five minute intervals for 60 minutes.

(c) Suggest why the olive oil was adjusted to pH 8.0 before the lipase was added.

.....[1]

(d) Fig. 5.2 shows the results of the investigation.

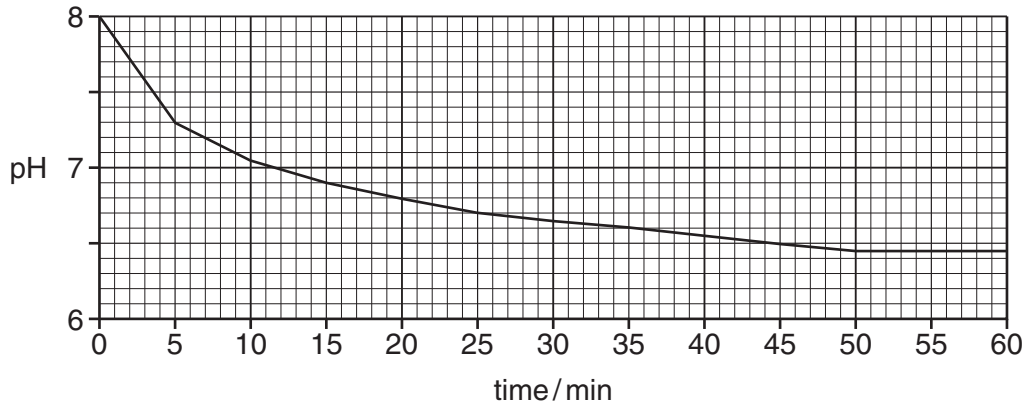


Fig. 5.2

With reference to Fig. 5.2,

For Examiner's Use

(i) describe the results of the investigation

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.....

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.....

.....[2]

(ii) explain the results of the investigation.

.....

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.....

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.....

.....

.....[4]

[Total: 15]

For Examiner's Use

6 Leaves of tobacco plants, *Nicotiana spp*, have a high concentration of nicotine, the addictive component of tobacco smoke. Scientists are continually seeking ways to produce tobacco plants that have reduced nicotine content.

(a) Describe **and** explain the effects of nicotine on the cardiovascular system that can contribute to a person developing **coronary heart disease**.

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.....[4]

(b) The production of low-nicotine cigarettes and cigars is considered a strategy that may reduce the harmful effects of smoking.

Explain whether or not you agree with this statement.

.....

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.....[1]

[Total: 5]

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BIOLOGY **9700/23**

Paper 2 Structured Question AS **May/June 2011**

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1 Fig. 1.1 shows a stage in the mitotic cell cycle in an animal cell.

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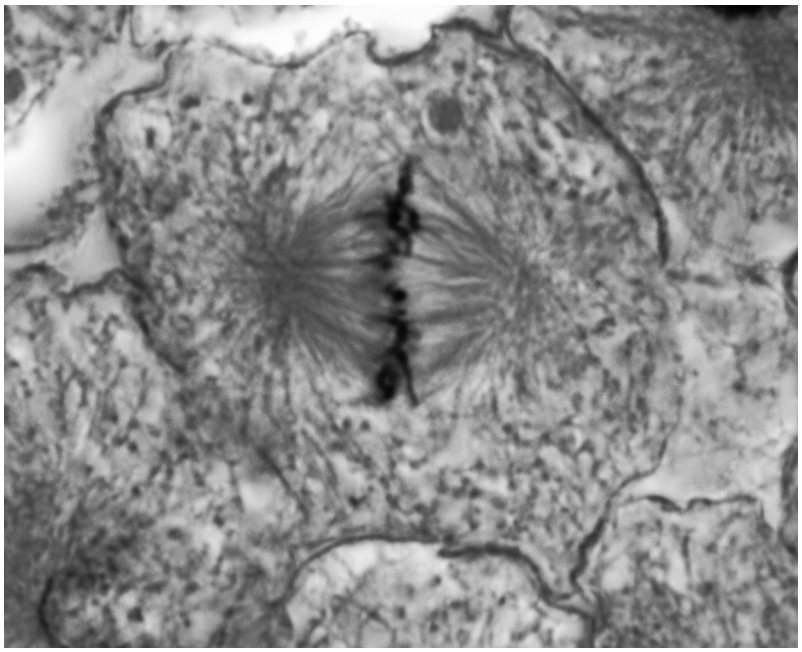


Fig. 1.1

(a) (i) Name the stage of mitosis shown in Fig. 1.1.

..... [1]

(ii) State three features which are characteristic of the stage of mitosis shown in Fig. 1.1.

1. .....

.....

2. .....

.....

3. .....

..... [3]

(b) Explain the importance of mitosis in organisms.

For Examiner's Use

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.....

.....

.....

..... [3]

(c) In many multicellular organisms, such as mammals, the time taken for the mitotic cell cycle varies considerably between different tissues, but is very carefully controlled in each cell.

Suggest the importance of this control in mammals.

.....

.....

.....

.....

.....

..... [2]

[Total: 9]

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2 **(a)** Complete the table to show **three** ways in which the **structure** of DNA differs from RNA.

	DNA	RNA
1		
2		
3		

[3]

(b) Table 2.1 shows two messenger RNA (mRNA) codons. Fill in the complementary transfer RNA (tRNA) anticodons in the spaces provided.

Table 2.1

mRNA codons	GCG	ACA
complementary tRNA anticodons		

[2]

(c) Calculate the minimum number of DNA nucleotides necessary to code for a polypeptide with 238 amino acids.

Show your working.

answer ..... nucleotides [2]

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(d) Describe the role played by tRNA in polypeptide synthesis.

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..... [4]

[Total: 11]

For Examiner's Use

3 **(a)** Plants take in mineral ions through their root hair cells. This may happen by a process which moves the ions from a low concentration in the soil to a higher concentration in the root hair cell.

(i) Name and describe this process by which mineral ions are taken in.

name .....

description .....

.....

.....

..... [3]

(ii) Phosphate is an example of an ion transported in this way. State **one** use for this ion in plant cells.

.....

..... [1]

Fig. 3.1 is a plan diagram of a transverse section of a plant root.

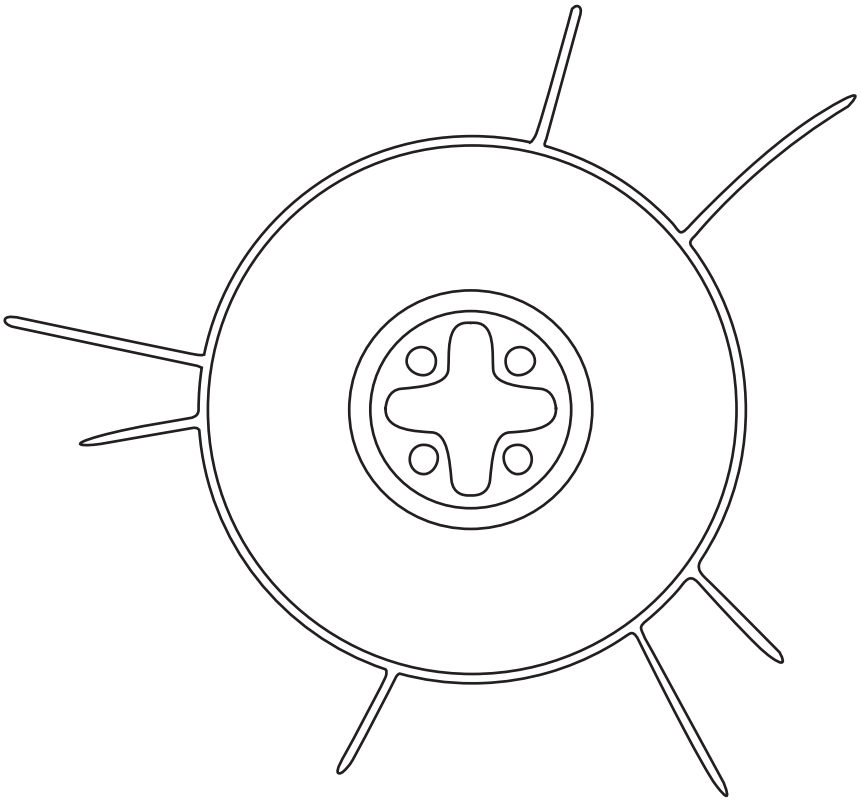


Fig. 3.1

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(b) (i) Write the letter **W** on Fig. 3.1 in the area where cells are specialised for the transport of water and mineral ions. [1]

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(ii) Water is also absorbed from the soil by the root hair cells.

Outline the mechanism by which this occurs.

.....

.....

.....

..... [2]

(iii) Describe the pathway taken by water as it passes from the root hair cells into the cells which are specialised for transport of water and mineral ions.

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..... [4]

[Total: 11]

4 In mammals, haemoglobin is used to transport oxygen and myoglobin is used to store oxygen in muscles.

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Fig. 4.1 shows the oxygen dissociation curves for myoglobin, fetal haemoglobin and adult haemoglobin.

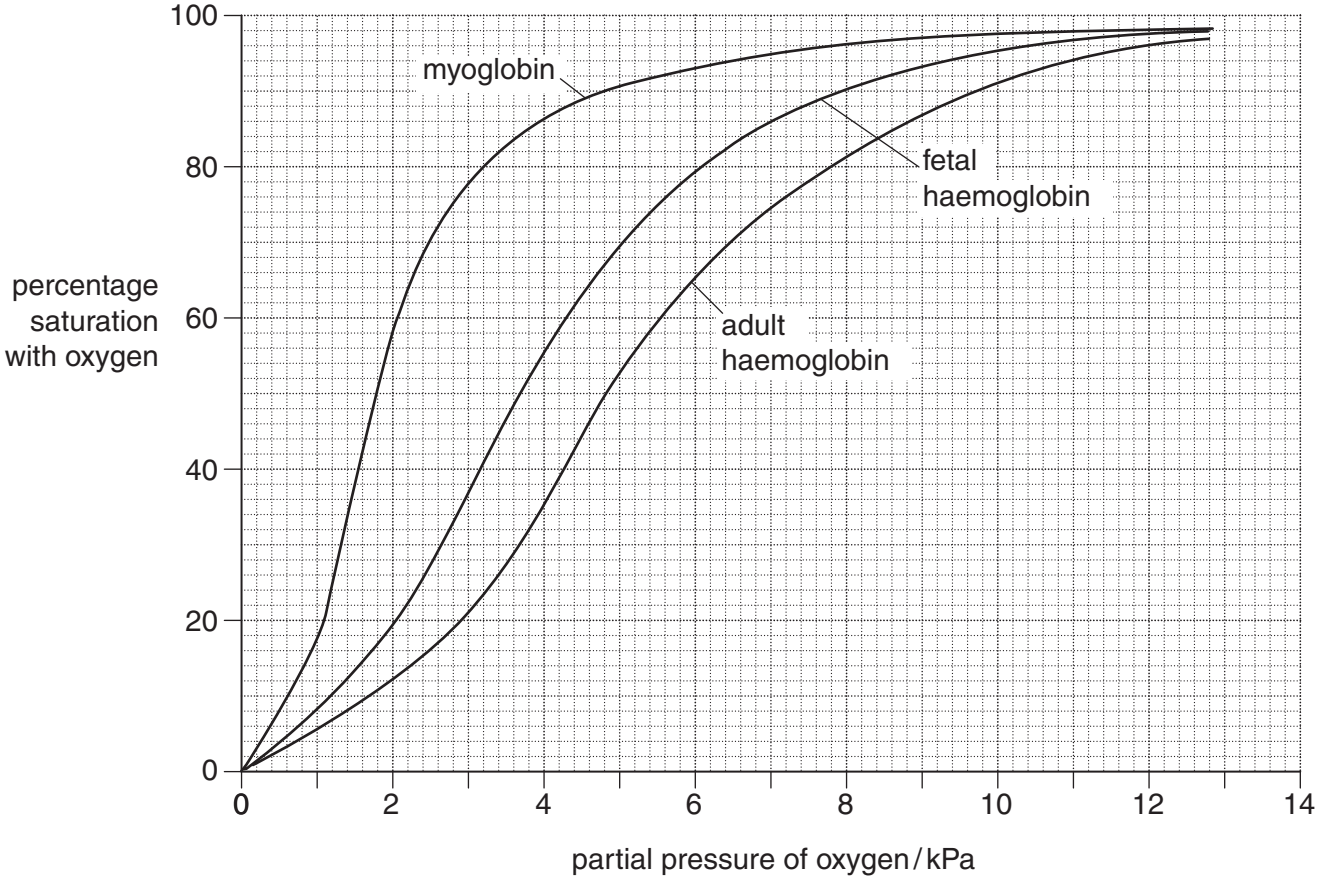


Fig. 4.1

(a) (i) Name the cells in which haemoglobin is found.

..... [1]

(ii) Use Fig. 4.1 to determine the percentage saturation of **myoglobin** and **adult haemoglobin** when the partial pressure of oxygen is 3 kPa.

myoglobin .....

adult haemoglobin ..... [1]

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(iii) There is a large difference between the percentage saturation of myoglobin and that of adult haemoglobin at **low** partial pressures of oxygen. Suggest reasons for this.

.....

.....

.....

..... [2]

(b) Fetal haemoglobin has a different oxygen binding affinity to that of adult haemoglobin, as shown in Fig. 4.1. Normally, after birth, the production of the fetal form stops and the adult form is produced.

In a rare condition known as Hereditary Persistence of Fetal Haemoglobin (HPFH), fetal haemoglobin continues to be produced well into adulthood in addition to adult haemoglobin. This condition, however, usually lacks any symptoms.

(i) Explain, with reference to Fig. 4.1, the significance of the difference in oxygen binding affinity between fetal and adult haemoglobin.

.....

.....

.....

..... [2]

(ii) Suggest why HPFH usually lacks symptoms.

.....

.....

..... [1]

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(c) Sketch on Fig. 4.2 the dissociation curve you would expect for adult haemoglobin if the concentration of carbon dioxide is increased. [2]

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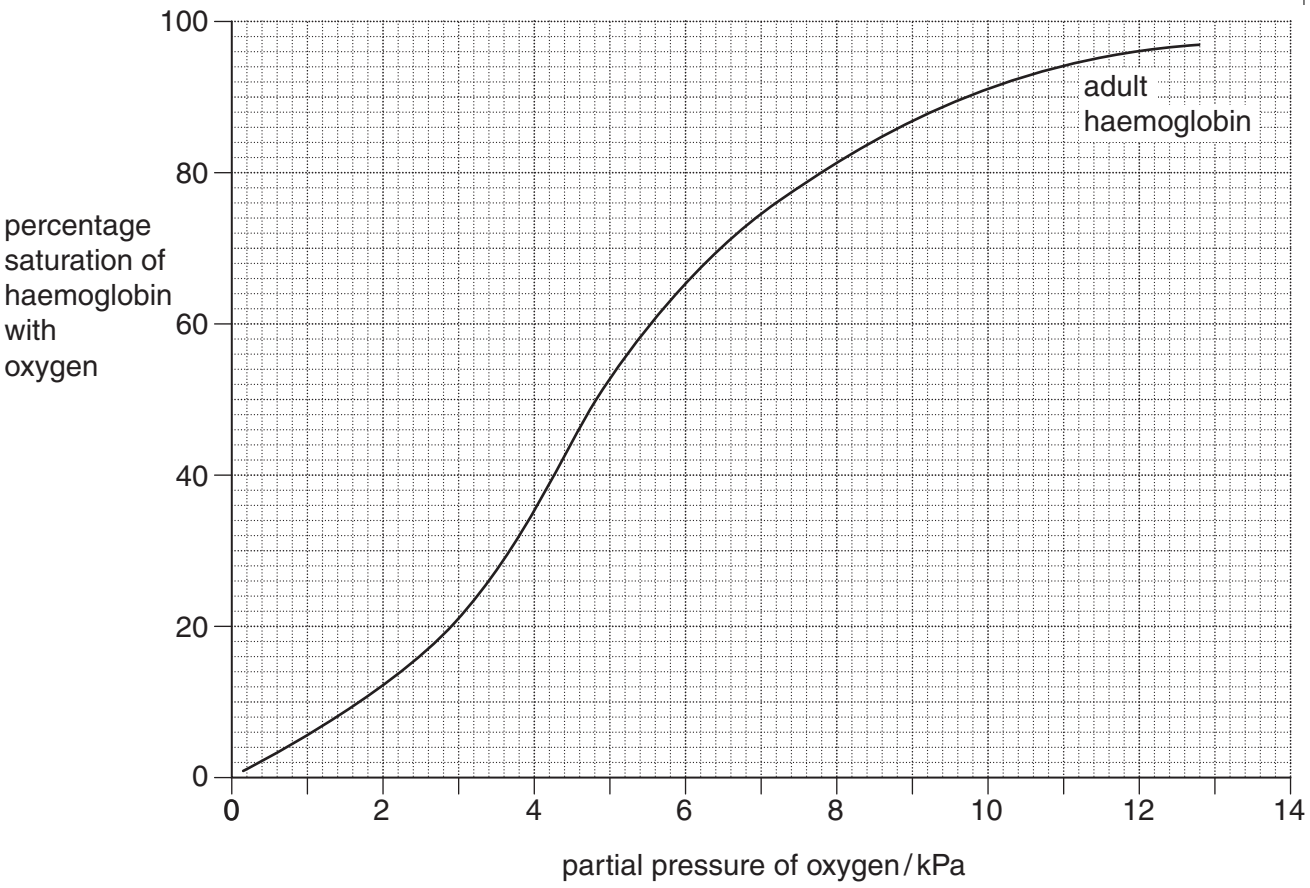


Fig. 4.2

[Total: 9]

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5 Fig. 5.1 is an electron micrograph of a transverse section through part of a plant stem.

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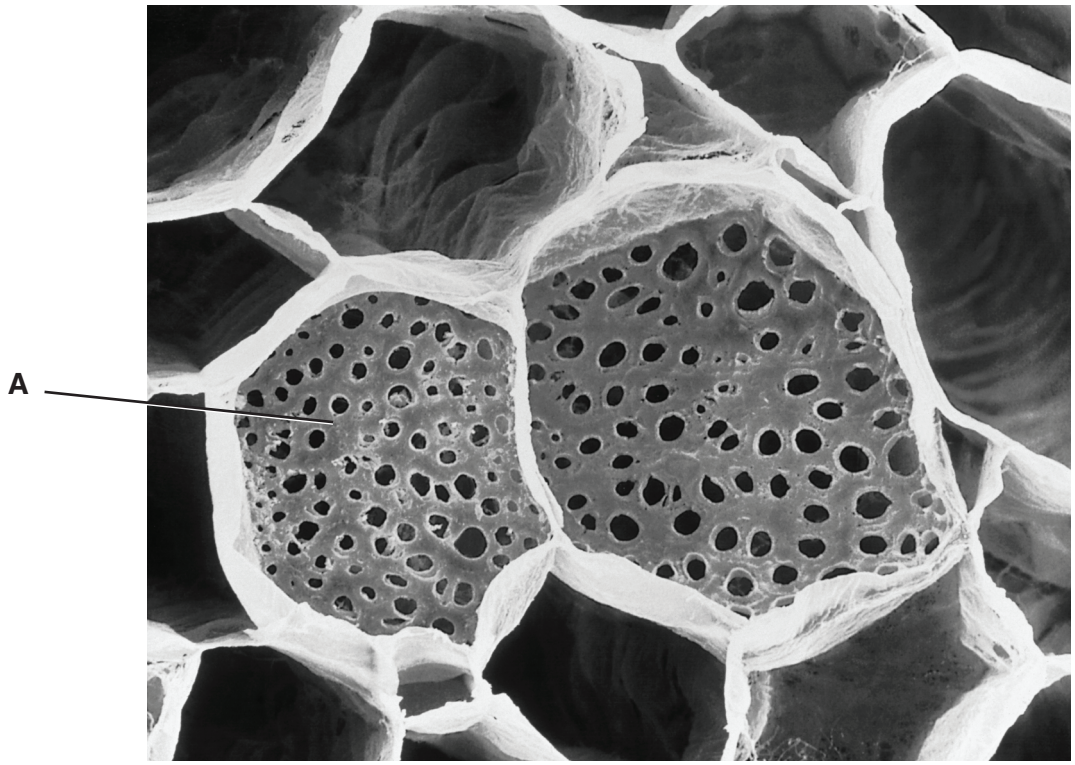


Fig. 5.1

(a) Name structure **A**.

..... [1]

(b) Specialised cells visible in Fig. 5.1 are involved in transporting assimilates through the plant from source to sink.

(i) Name **one** assimilate transported by these cells.

..... [1]

(ii) Give **one** example of a source and **one** example of a sink.

source .....

sink ..... [2]

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(c) Describe how the assimilate you have named in **(b)(i)** is transported from the source to the sink.

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..... [5]

(d) Aphids are insects with mouthparts adapted to penetrating the cells of plants which transport assimilates.

Suggest why aphids feed specifically from these cells.

.....

.....

..... [1]

[Total: 10]

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[Turn over

6 In anaerobic soil, bacteria, such as *Pseudomonas stutzeri*, can use nitrate ions (NO_3^-) as a source of oxygen for their respiration. The word equation below summarises the process:

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glucose + nitrate $\longrightarrow$ water + carbon dioxide + nitrogen

(a) (i) State the name of this process in the nitrogen cycle.

..... [1]

(ii) In agriculture, this reaction can be undesirable. Explain why.

.....

.....

.....

..... [2]

High concentrations of nitrate ions in drinking water obtained from rivers and lakes can be toxic, especially to infants. These nitrate ions enter rivers and lakes dissolved in water which drains from the soil.

(b) (i) Name the process, carried out by soil bacteria, which produces nitrate ions.

..... [1]

(ii) Suggest how bacteria, such as *Pseudomonas stutzeri*, can be used in the process of purifying water for drinking.

.....

.....

.....

..... [2]

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(c) In recent years there has been an increase in flooding of agricultural land worldwide.

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Explain why crop yields are often significantly reduced even after the flood water has drained away.

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.....

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.....

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.....

.....

..... [4]

[Total: 10]

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Fig. 1.1 Michael Abbey/Science Photo Library.
Fig. 5.1 J. C. Revy, ISM/Science Photo Library.

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