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BIOLOGY **9700/21**

Paper 2 Structured Questions AS **October/November 2011**

1 hour 15 minutes

Candidates answer on the Question Paper.

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Answer **all** the questions.

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1 Fig. 1.1 is a diagram of a cell surface membrane.

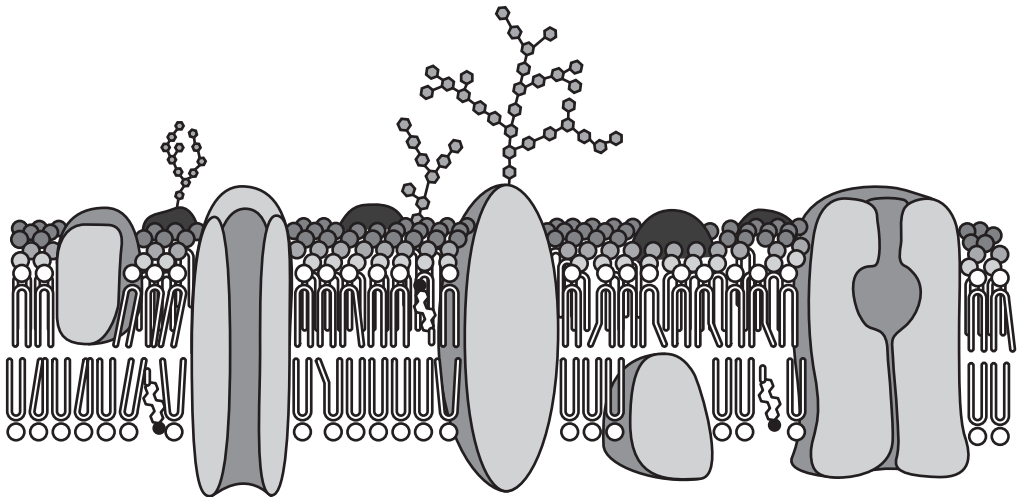


Fig. 1.1

(a) Use a label line and the appropriate letter to label each of the following on Fig. 1.1.

P protein for active uptake of potassium ions

Q protein for facilitated diffusion of polar molecules

R receptor site for a hormone

S hydrophilic heads of phospholipids on the internal surface of the membrane

T molecule that modifies the fluidity of the membrane [5]

(b) Some cells take in bacteria by endocytosis.

Explain how endocytosis occurs at a cell surface membrane.

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.....[3]

[Total: 8]

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2 A student investigated the initial rate of reaction of catalase in breaking down hydrogen peroxide into oxygen and water:

For Examiner's Use

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

The volume of oxygen collected was recorded over a period of 140 seconds. The results are shown in Fig. 2.1.

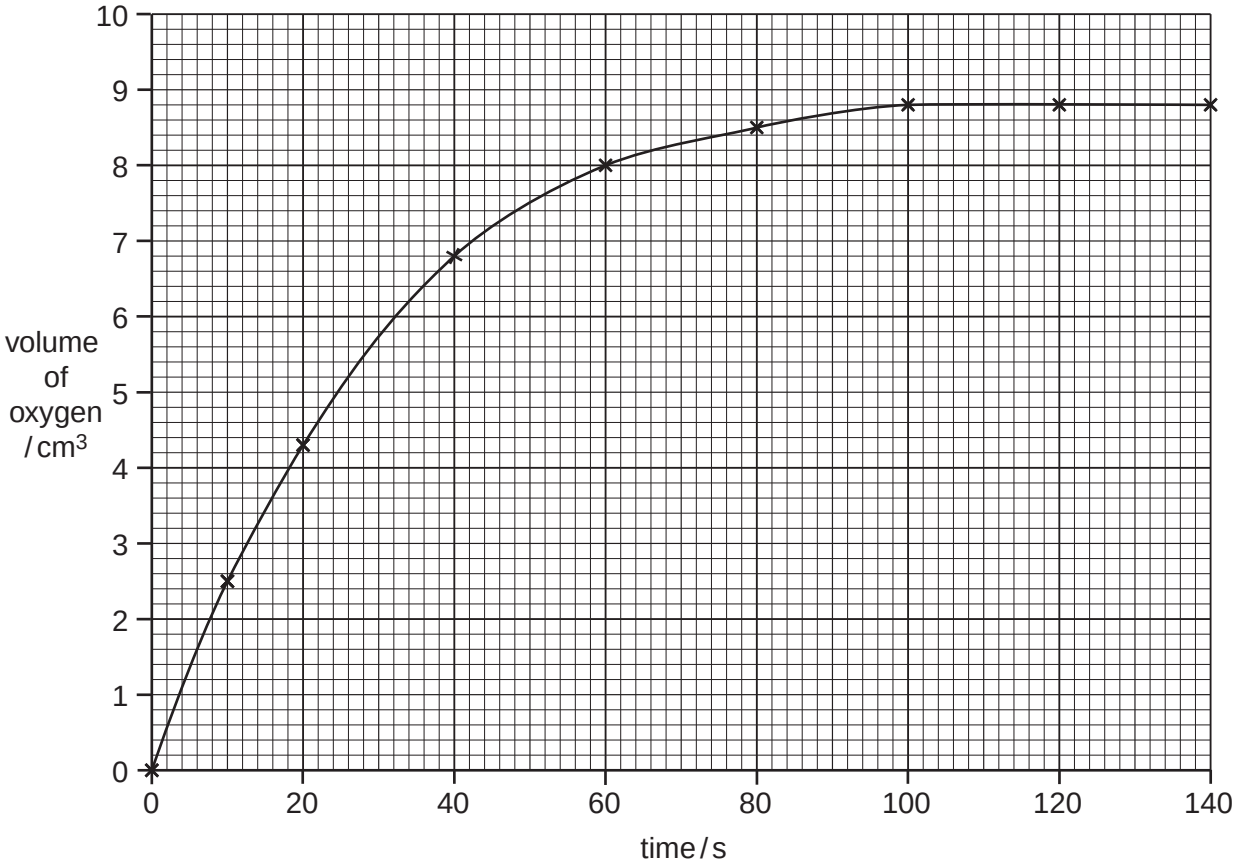


Fig. 2.1

(a) (i) Use the information in Fig. 2.1 to calculate the **initial rate of reaction** in $cm^3\ s^{-1}$.

Show your working.

answer ..... $cm^3\ s^{-1}$ [2]

(ii) Explain the change in volume of oxygen collected as shown in Fig. 2.1.

For Examiner's Use

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.....[3]

The student continued the investigation by determining the initial rates of reaction for five different concentrations of hydrogen peroxide. The line marked **W** in Fig. 2.2 shows the results.

The whole procedure was repeated after adding copper ions to the different concentrations of hydrogen peroxide. The line marked **V** on Fig. 2.2 shows the results.

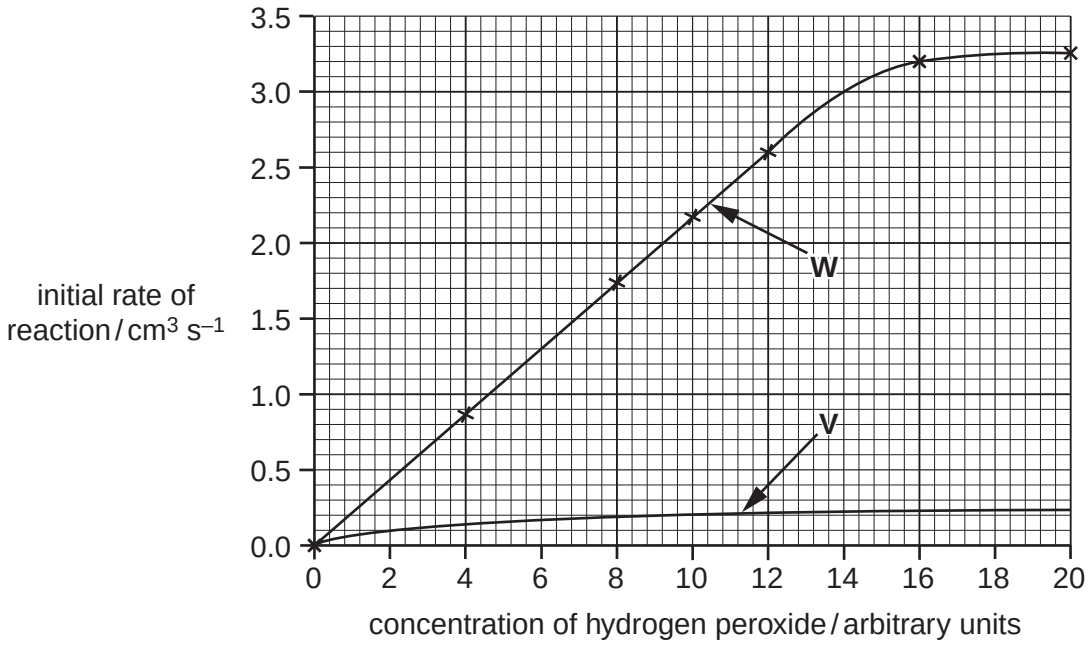


Fig. 2.2

(b) Use the information in Fig. 2.2 to explain the effect of copper ions on the action of an enzyme, such as catalase.

For Examiner's Use

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.....[4]

(c) Enzyme molecules in cells eventually stop working and are broken down.

Outline how cells replace the enzymes that are broken down.

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.....[3]

[Total: 12]

3 Fig. 3.1 shows a molecule of haemoglobin.

For Examiner's Use

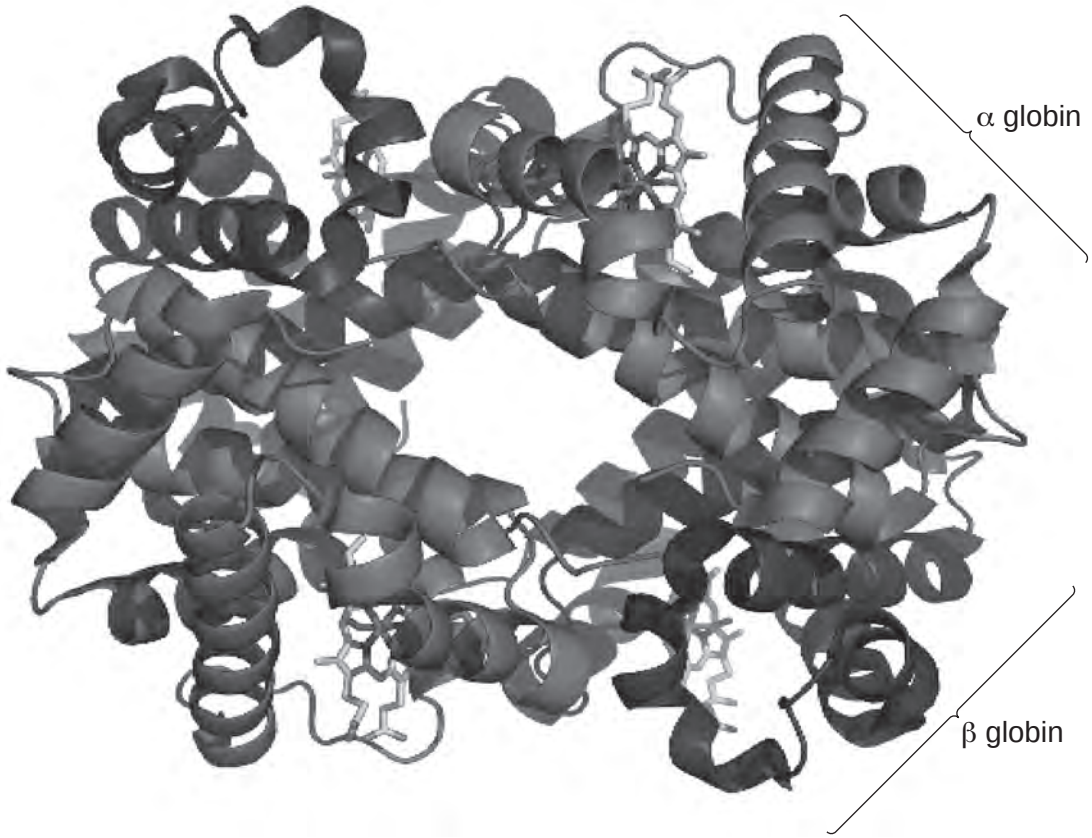


Fig. 3.1

(a) Explain how a molecule of haemoglobin shows the four levels of organisation of protein molecules.

primary structure .....

.....

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secondary structure .....

.....

.....

tertiary structure .....

.....

.....

quaternary structure .....

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.....[4]

For Examiner's Use

There are many different variants of haemoglobin. The sequence of bases in DNA that code for the first seven amino acids in two variants of the β-globin polypeptide are shown in Fig. 3.2.

The genetic dictionary for some of the amino acids is in Table 3.1.

Variant 1

1	2	3	4	5	6	7
CAC	GTG	GAC	TGA	GGA	CTC	CTC

Variant 2

1	2	3	4	5	6	7
CAC	GTG	GAC	TGA	GGA	CAC	CTC

Fig. 3.2

Table 3.1

amino acid	**abbreviation**	**DNA triplets on the coding polynucleotide**
valine	val	CAA, CAC, CAG, CAT
proline	pro	GGA, GGC, GGG, GGT
threonine	thr	TGA, TGC, TGG, TGT
histidine	his	GTA, GTG
glutamic acid	glu	CTC, CTT
leucine	leu	AAC, AAT, GAA, GAC, GAG, GAT

(b) Use the genetic dictionary to describe the similarities and differences between the two variants of haemoglobin.

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.....

.....[3]

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[Turn over

(c) Collagen is a fibrous protein found in many tissues in animals.

For Examiner's Use

(i) State the function of collagen in the walls of arteries.

.....

.....[1]

(ii) State **one** way in which the **structure** of collagen differs from the structure of haemoglobin.

.....

.....[1]

[Total: 9]

4 (a) (i) Name two factors that increase the chances that cancer will develop.

For Examiner's Use

1. .....

2. .....[2]

(ii) State why lung cancer is categorised as a non-infectious disease.

.....

.....[1]

The effectiveness of anti-cancer drugs may be determined by growing different tumours in culture.

For Examiner's Use

The effectiveness of two drugs on two human tumours (**A** and **B**) from different tissues was assessed. The two drugs, T138067 and vinblastine, were added to the tumours in culture on days 5, 12 and 19. The volumes of the tumours were compared with the volumes of tumours that were not treated with any drugs.

The results are shown in Fig. 4.1.

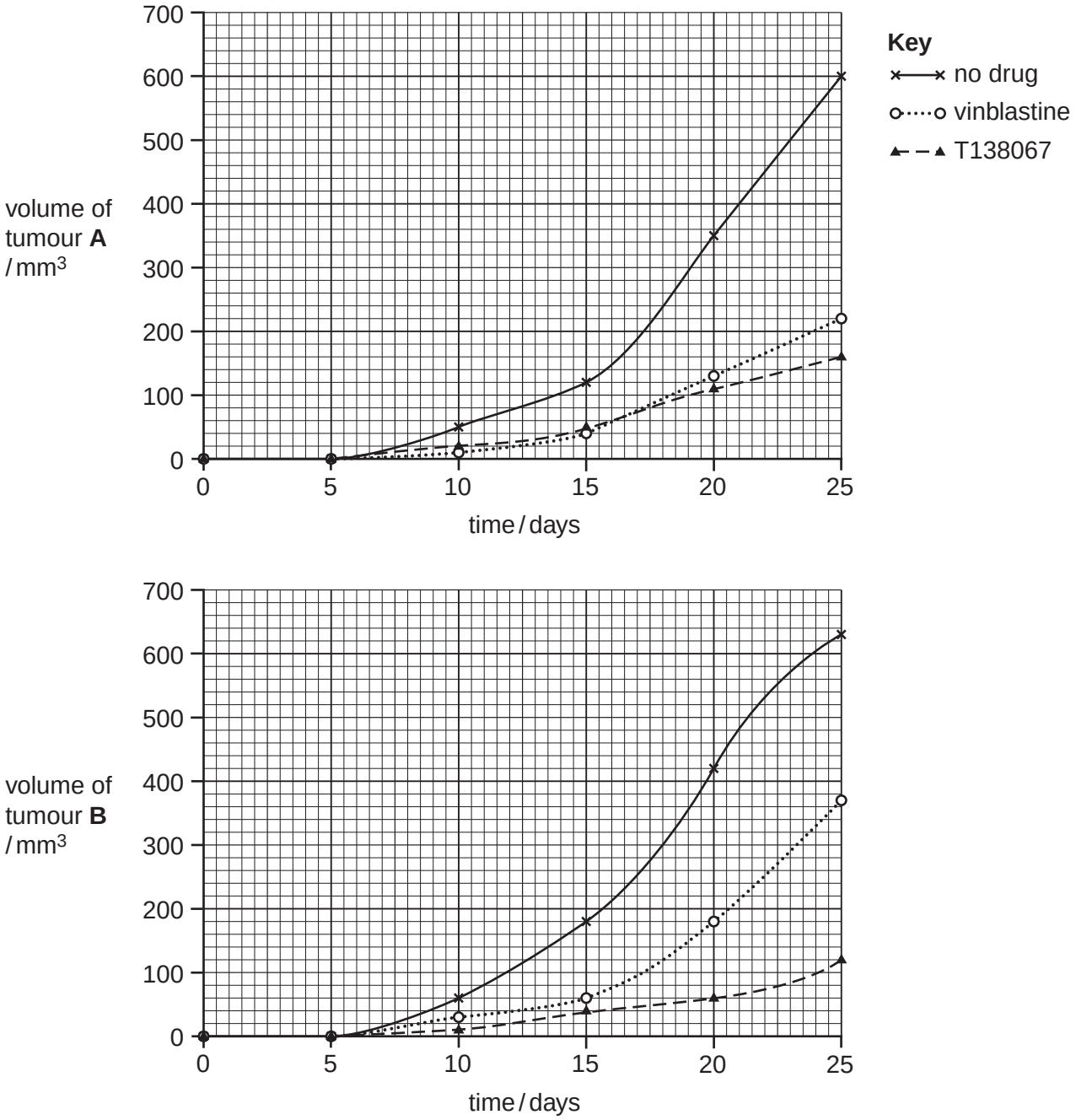


Fig. 4.1

(b) Use the data in Fig. 4.1 to compare the effectiveness of the two drugs used to treat the tumours.

For Examiner's Use

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.....[4]

(c) Vinblastine disrupts the formation of the spindle apparatus during mitosis.

Explain how vinblastine has its effect as an anti-cancer drug.

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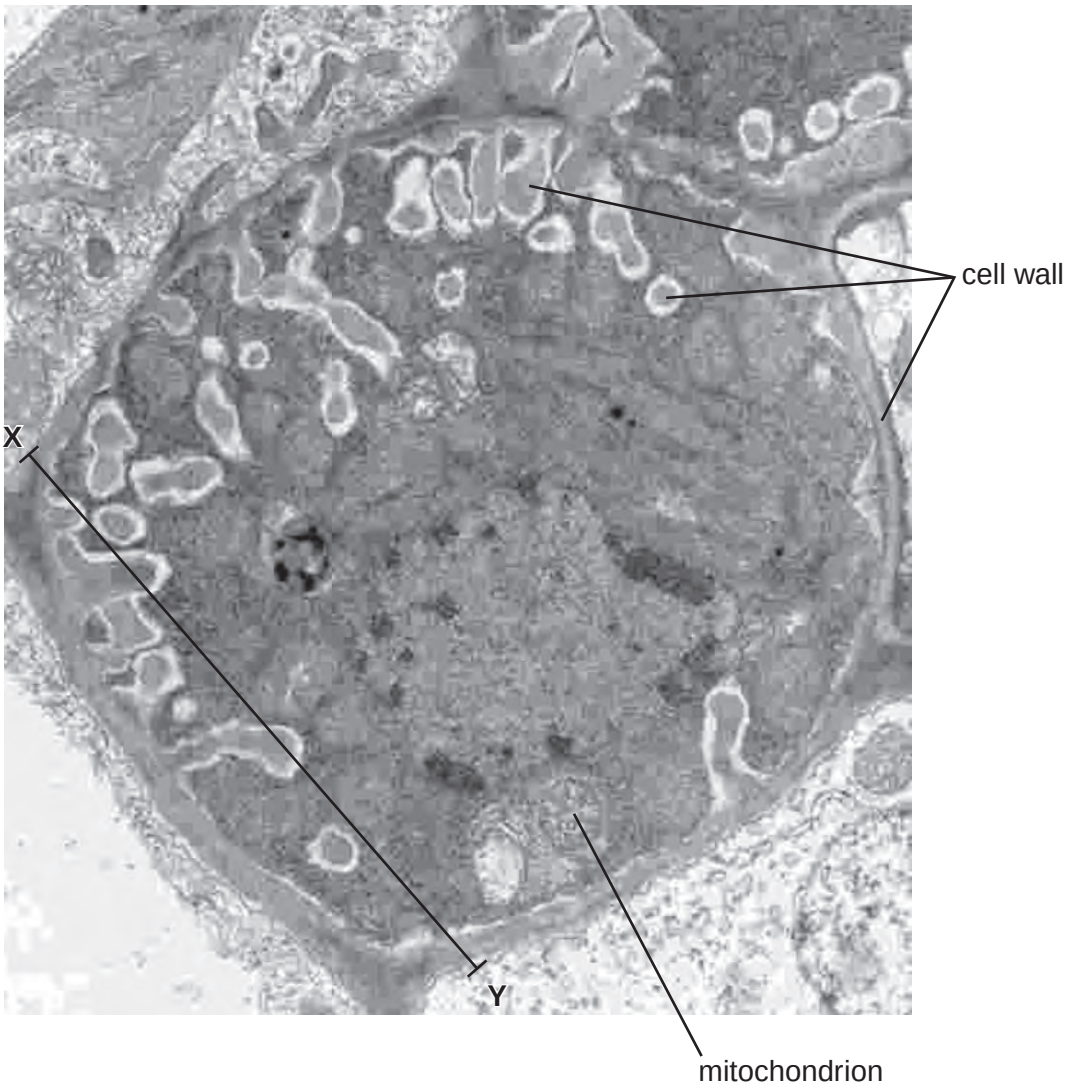
.....[3]

[Total: 10]

5 Phloem transfer cells are modified companion cells that move sucrose and other assimilates from mesophyll tissue into phloem sieve tube elements.

For Examiner's Use

Fig. 5.1 is an electron micrograph of a phloem transfer cell.



magnification = × 10 000

Fig. 5.1

(a) Calculate the actual distance across the transfer cell from **X** to **Y**.

Show your working and express your answer to the nearest micrometre.

answer ..... µm [2]

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(b) With reference to Fig. 5.1, explain how phloem transfer cells help in the movement of sucrose from the mesophyll of a leaf into a phloem sieve tube element.

For Examiner's Use

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.....[5]

(c) Explain how sucrose in the phloem sap is moved from sieve tube elements in leaves to cells in a sink, such as a root.

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.....[4]

[Total: 11]

For Examiner's Use

6 Phagocytes and lymphocytes are part of the body's cellular response to infection by pathogens.

Fig. 6.1 shows the origin and maturation of phagocytes and lymphocytes.

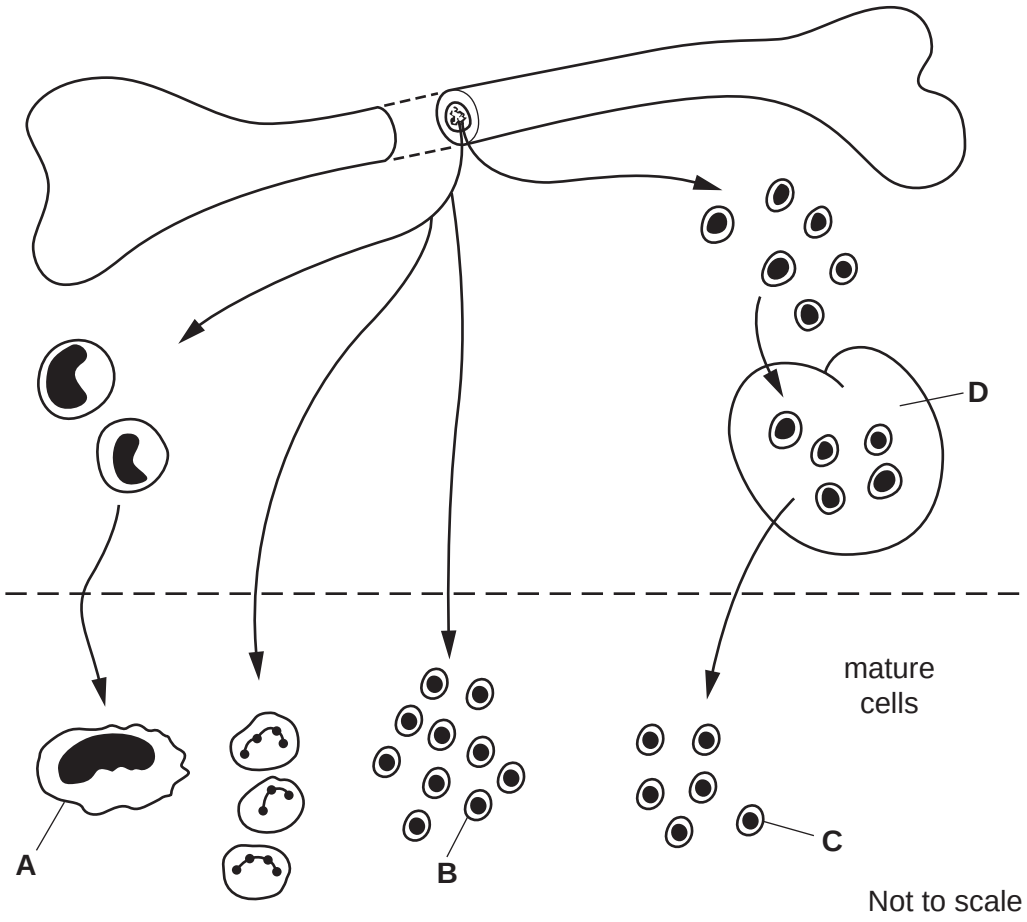


Fig. 6.1

(a) Name the site of origin of phagocytes and lymphocytes.

.....[1]

(b) Name:

(i) cells **A**, **B** and **C**

A .....

B .....

C .....[3]

(ii) organ **D**.

.....[1]

(c) Explain the roles of the cells, **A**, **B** and **C** in an immune response.

In your answer use the terms *antigen* and *non-self*.

For Examiner's Use

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.....[5]

[Total: 10]

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BIOLOGY **9700/22**

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Answer **all** the questions.

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1 Fig. 1.1 is a scanning electron micrograph of part of the wall of the bronchus of a healthy human.

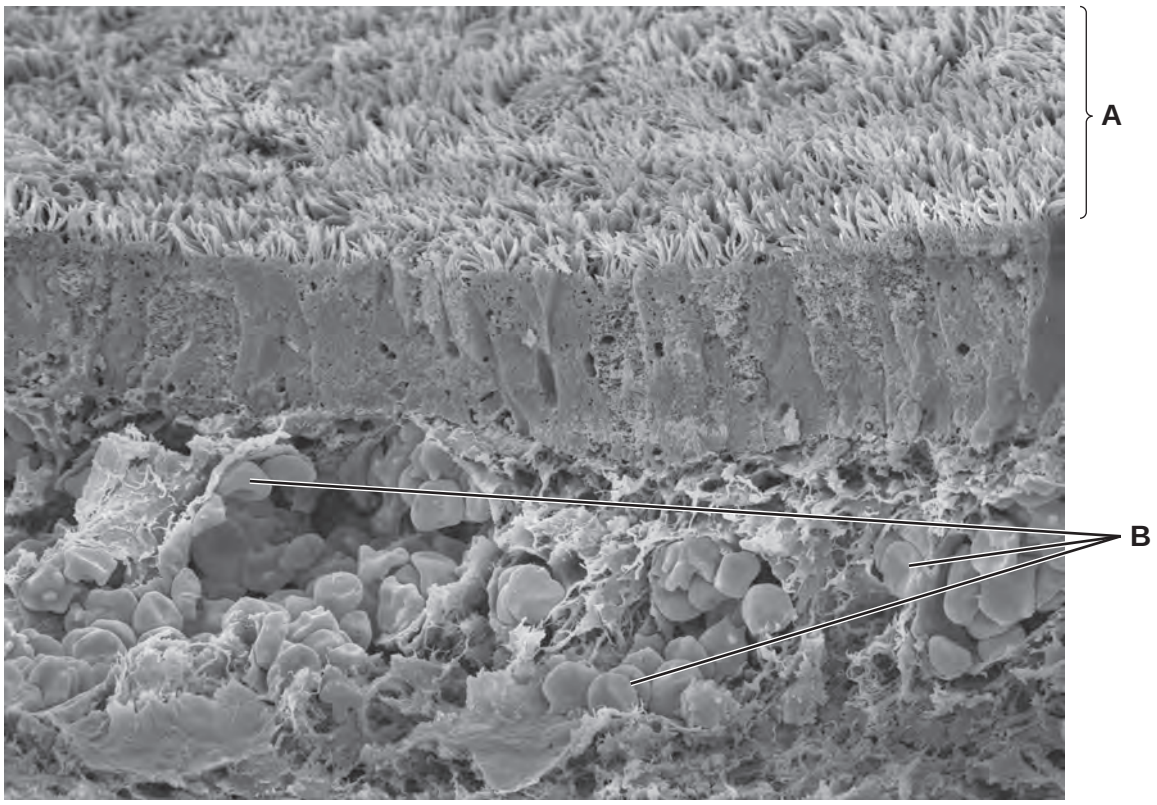


Fig. 1.1

(a) (i) Name the structures labelled **A**.

.....[1]

(ii) State the function of the cells labelled **B**.

.....[1]

(b) Name two tissues found in the wall of the bronchus that are not visible in Fig. 1.1.

1. .....

2. .....[2]

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Chronic bronchitis is one of the conditions that contributes to chronic obstructive pulmonary disease (COPD).

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(c) State the name of the other condition that contributes to COPD.

.....[1]

(d) Describe the appearance of a section through the **wall** of a bronchus in a person with chronic bronchitis.

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.....[4]

(e) Suggest why a person with chronic bronchitis is more likely than a healthy person to suffer from infectious diseases of the gas exchange system.

.....

.....

.....

.....[2]

[Total: 11]

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[Turn over

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2 **(a)** White blood cells play an important role in defence.

State precisely the type of white blood cell that fits each of the descriptions given in **(i)** to **(iv)**.

(i) It is formed in the bone marrow and matures from a monocyte. It contains many lysosomes with hydrolytic enzymes.

.....[1]

(ii) It is formed, and matures in, the bone marrow. It contains a lobed nucleus and has the ability to ingest microorganisms by endocytosis.

.....[1]

(iii) When activated, it differentiates into a cell that secretes a chemical, which causes other cells to lyse (burst). It contains a large, spherical nucleus.

.....[1]

(iv) It is formed as a result of a primary immune response and remains in the body. On activation, it has the potential to produce antibodies during a secondary immune response.

.....[1]

(b) In 1980, it was announced that the highly infectious viral disease, smallpox, had been eradicated. This was mainly due to a worldwide vaccination programme planned by the World Health Organization (WHO).

Attempts have been made to control other diseases, such as measles, sickle cell anaemia and cholera, without the same success as smallpox.

(i) Define the term *disease*.

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.....[2]

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(ii) Describe two features of the vaccine that contributed to the success of the smallpox eradication programme.

For Examiner's Use

1. .....

.....

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2. .....

.....

.....[2]

(iii) Discuss the reasons why vaccination has **not** eradicated cholera **and** sickle cell anaemia.

cholera .....

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sickle cell anaemia .....

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.....[5]

[Total: 13]

For Examiner's Use

3 *Azotobacter vinelandii* is a bacterium found in the soil that is able to fix atmospheric nitrogen. One feature of nitrogen-fixing bacteria is the ability to synthesise the enzyme nitrogenase, a molybdenum- and iron-containing, protein complex.

(a) (i) Molybdenum is a mineral ion found in the soil solution. It enters the cell as molybdate ions, through membrane transport proteins. The proteins have the ability to bind to, and hydrolyse, ATP.

Name **and** describe the mechanism of transport of molybdate ions into the cell.

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.....[3]

(ii) State the structures in the bacterial cell where the protein components of nitrogenase are synthesised.

.....[1]

(iii) Part of the equation for the reaction that is catalysed by nitrogenase in *A. vinelandii* is shown below.

Complete the equation by naming the product of the reaction.

$$\text{atmospheric nitrogen } (N_2) \xrightarrow[\text{ATP and hydrogen}]{\text{nitrogenase}} \text{.....}$$

[1]

(b) Table 3.1 shows the various types of nitrogen fixation that occur throughout the world and gives estimates of the mass of atmospheric nitrogen fixed in a year.

For Examiner's Use

Table 3.1

type of nitrogen fixation		mass of nitrogen fixed / $\times 10^9$ kg yr^{-1}
non-biological	Haber process	50
	combustion	20
	lightning	10
biological	agricultural land	90
	non-agricultural land	50
	sea	35

(i) Using data from Table 3.1, calculate the percentage of nitrogen fixation carried out worldwide by nitrogen-fixing organisms, such as *A. vinelandii*, in **agricultural land**.

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

answer .....% [2]

(ii) Explain why the proportion of nitrogen gas in the atmosphere remains stable at 78%, even though nitrogen fixation removes nitrogen gas from the atmosphere.

.....

.....

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.....[2]

(c) Describe **and** explain the benefits to humans of the presence of nitrogen-fixing bacteria, such as *A. vinelandii*, in agricultural land.

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.....[3]

[Total: 12]

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4 **(a)** Fig. 4.1 shows the structure of deoxyribose sugar.

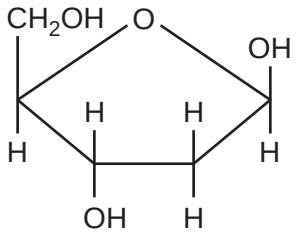


Fig. 4.1

State the differences between the structure of deoxyribose shown in Fig. 4.1 and the ring structure of α-glucose.

You may use the space below to help you in your answer.

.....

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[3]

(b) Match the biological macromolecule with the type of bond that is formed when the molecule is synthesised. Choose from the list below.

amylose cellulose triglyceride protein amylopectin mRNA

type of bond(s)	biological macromolecule
β, 1-4 glycosidic	
α, 1-4 glycosidic **and** α, 1-6 glycosidic	
phosphodiester	
peptide	

[4]

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Semi-conservative replication of DNA and transcription involve the formation of polynucleotide chains.

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(c) State the type of reaction that occurs in the formation of a polynucleotide chain.

.....[1]

(d) Complete Table 4.1 to show **four** differences between DNA replication and DNA transcription.

Table 4.1

	replication	**transcription**
1		
2		
3		
4		

[4]

[Total: 12]

5 In 1954, an article was published in the British Medical Journal entitled, *The mortality of doctors in relation to their smoking habits*.

For Examiner's Use

One aspect of the investigation studied a very large number of male doctors in the UK aged 35 years and older. A survey established the quantity of tobacco smoked per day.

Twenty-nine months later, the cause of any deaths in the study group was recorded.

Table 5.1 summarises the results obtained.

Table 5.1

cause of death	**number of deaths**	**death rate per year per 1000 men in the study**			
		non-smokers	**smokers, tobacco smoked / g day^{-1}**		
			1–14	15–24	25 and above
coronary thrombosis (heart attack)	235	3.89	3.91	4.71	5.15
other cardiovascular diseases	126	2.23	2.07	1.58	2.78
lung cancer	36	0.00	0.48	0.67	1.14
other diseases of the gas exchange system	54	0.86	0.88	1.01	0.77

(a) State which group in the study is most at risk from dying of lung cancer.

.....[1]

(b) Using information from Table 5.1 to support your answer, discuss the evidence linking tobacco smoking to disease and early death.

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.....[4]

[Total: 5]

6 Fig. 6.1 shows a phloem sieve tube element, its companion cell and a mesophyll cell in the leaf of a photosynthesising plant.

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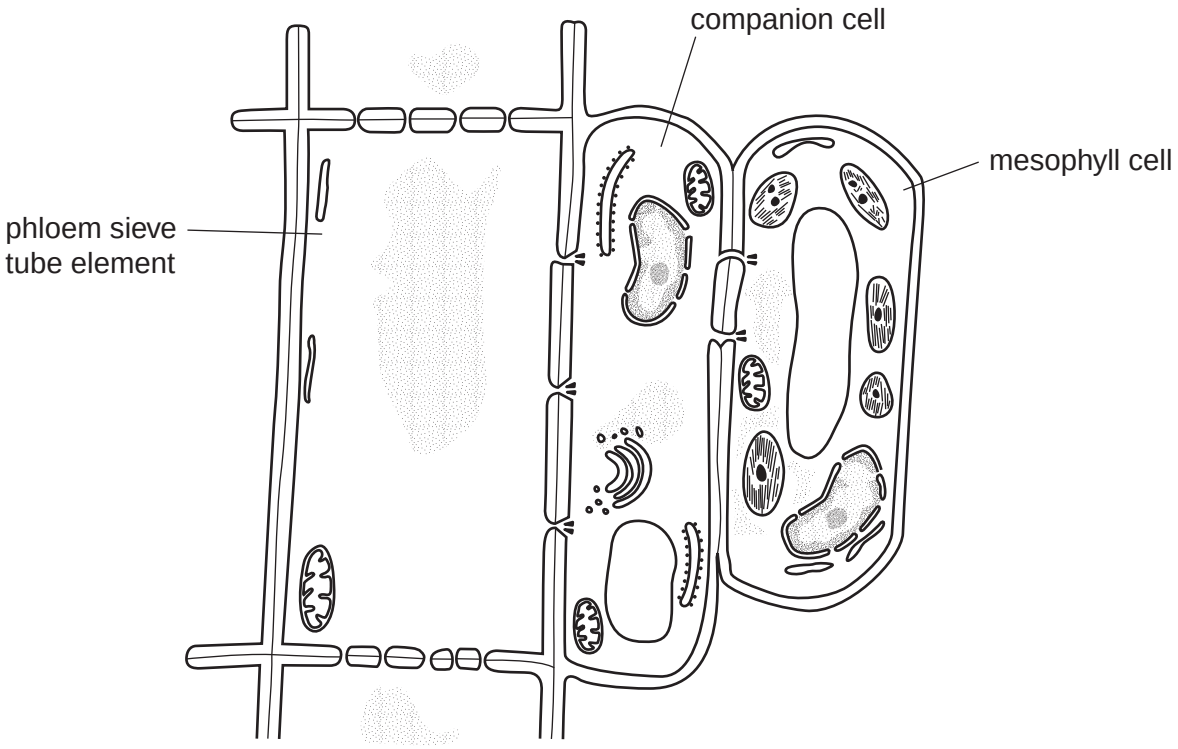


Fig. 6.1

(a) Use label lines and the letters **C** to **E** to identify the following on Fig. 6.1.

C – a structure involved in ribosome synthesis

D – an organelle that is involved in the modification and packaging of proteins

E – an organelle that is involved in aerobic respiration [3]

(b) The concentration of sucrose in the sap of the phloem sieve tube element is much higher than in the cytoplasm of the photosynthesising cell.

Describe **and** explain how sucrose is transported from the photosynthesising cell to the phloem sieve tube element.

.....

.....

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.....[4]

[Total: 7]

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BIOLOGY **9700/23**

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1 Fig. 1.1 is an electron micrograph of three cells of the same species of bacterium, *Erwinia carotovora*.

For Examiner's Use



Fig. 1.1

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

Show your working and give your answer to the nearest 10 000.

magnification × ..... [2]

(b) Name three structures, present in animal cells, which are **not** present in the cells shown in Fig. 1.1.

1. .....

.....

2. .....

.....

3. .....

..... [3]

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(c) *E. carotovora* is a rod-shaped bacterium.

Explain why two of the bacterial cells in Fig. 1.1 do **not** appear rod-shaped.

.....

.....

.....

..... [1]

For Examiner's Use

(d) *E. carotovora* causes a disease in carrot and potato plants.

The bacteria release an enzyme called pectinase which hydrolyses the polysaccharide pectin. Pectin helps plant cells to attach to each other.

(i) Name the type of chemical bond which will be hydrolysed by pectinase.

..... [1]

(ii) Suggest what effect this disease will have on vegetables, such as carrots and potatoes.

.....

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..... [2]

[Total: 9]

For Examiner's Use

2 **(a)** Describe the function of each of the following structures in the human heart:

(i) sinoatrial node (SAN)

.....

.....

..... [2]

(ii) atrioventricular node (AVN)

.....

.....

..... [2]

(iii) left atrioventricular (bicuspid) valve.

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..... [2]

(b) Fig. 2.1 shows the changes in blood pressure in the left atrium, left ventricle and aorta during one complete cardiac cycle.

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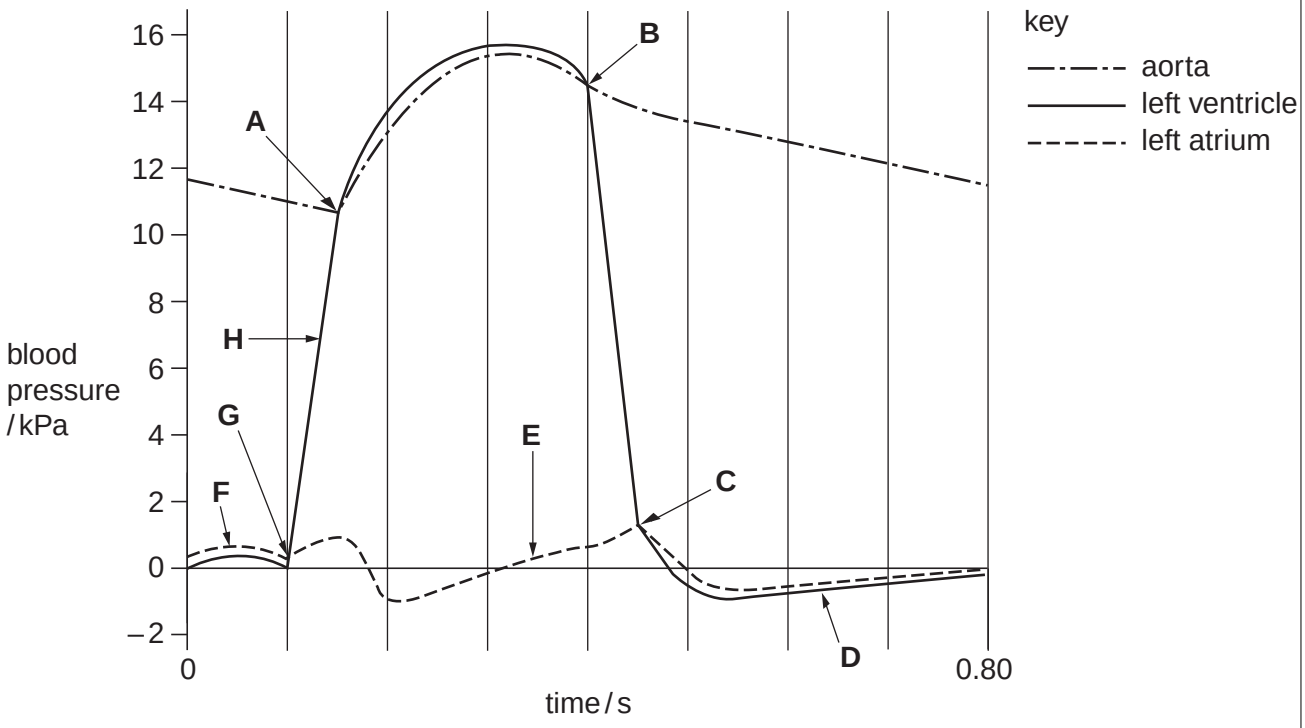


Fig. 2.1

Complete the table below using the appropriate letter, **A** to **H**, to match the points from the graph to the correct statement.

You must only put one letter in each box. You may use each letter once, more than once or not at all.

statement	letter
left atrioventricular (bicuspid) valve starting to open	
left atrioventricular (bicuspid) valve starting to close	
left ventricle starting to contract	
minimum blood remaining in left ventricle	

[4]

[Total: 10]

3 Fig. 3.1 is a photomicrograph of a transverse section through a leaf from a tea plant, *Camellia sinensis*.

For Examiner's Use

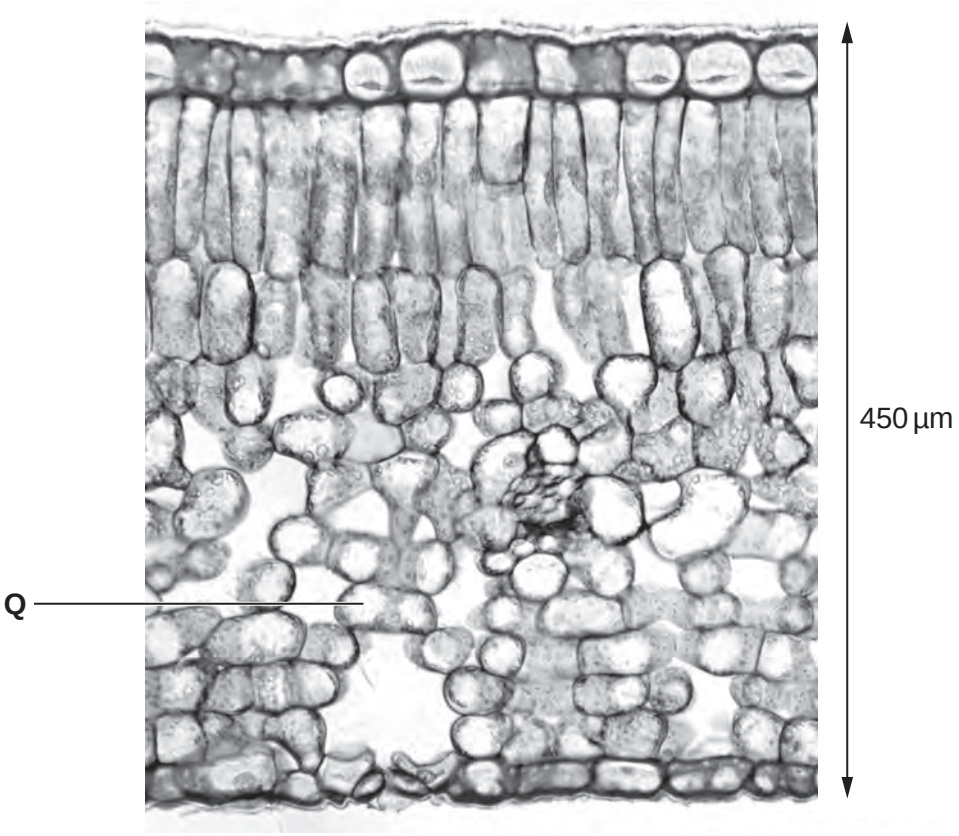


Fig. 3.1

(a) Use label lines and the letters **X**, **Y** and **Z** to label the following features on Fig. 3.1.

X a cell of the upper epidermis

Y a palisade mesophyll cell

Z a guard cell

[3]

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(b) Describe **and** explain how water moves from inside the leaf at point **Q** on Fig. 3.1 to the atmosphere outside the leaf during transpiration.

For Examiner's Use

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..... [4]

(c) The leaf of *C. sinensis*, shown in Fig. 3.1, has developed in a sunny position.

State three features of the leaf, **visible in Fig. 3.1**, which show that it has developed in a sunny position.

1. .....

.....

2. .....

.....

3. .....

..... [3]

[Total: 10]

4 Fig. 4.1 shows a graph of the number of people, worldwide, estimated to be newly infected with the human immunodeficiency virus (HIV) in the years 1990 to 2008.

For Examiner's Use

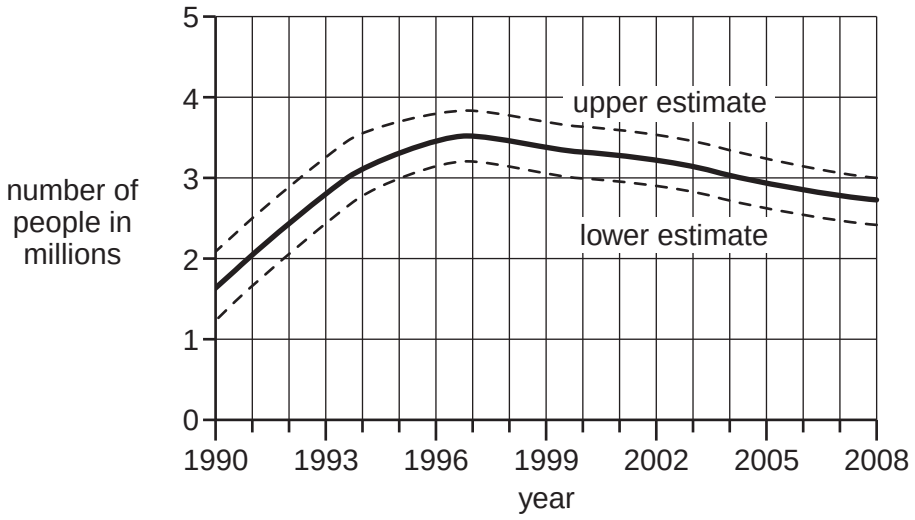


Fig. 4.1

(a) (i) Use the information in Fig. 4.1 to describe the changes in the number of people newly infected with HIV.

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..... [3]

(ii) Suggest possible explanations for the decrease in the number of people newly infected with HIV.

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..... [3]

(b) Explain why it was necessary to include the upper and lower estimates on the graph in Fig. 4.1.

For Examiner's Use

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..... [1]

Fig. 4.2 shows a graph of the total number of estimated deaths due to HIV/AIDS over the same time period as the graph in Fig. 4.1.

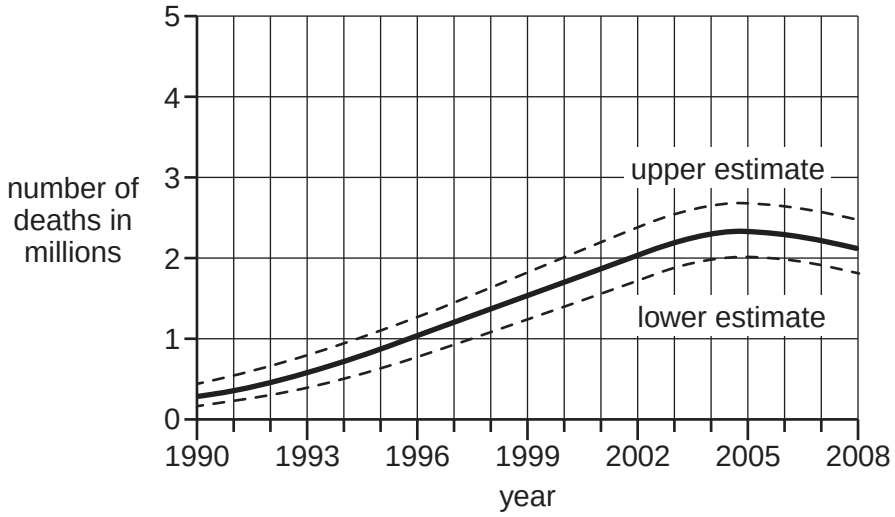


Fig. 4.2

(c) Use the information given in Fig. 4.1 **and** Fig. 4.2 to explain the relationship between new HIV infections and deaths due to HIV/AIDS.

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..... [4]

[Total: 11]

5 Fig. 5.1 represents part of a DNA molecule.

For Examiner's Use

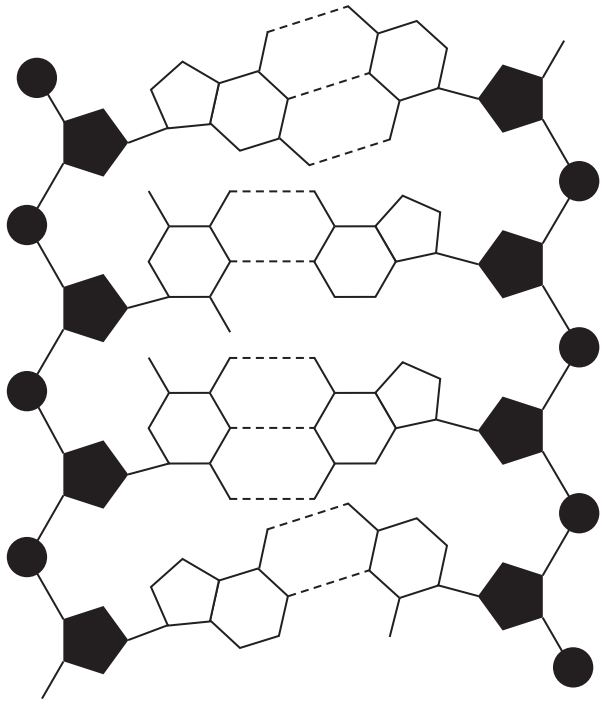


Fig. 5.1

(a) On Fig. 5.1

(i) draw a box around a nucleotide [1]

(ii) label, with the letter **P**, a phosphate group. [1]

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(b) Describe how a DNA molecule replicates.

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..... [5]

(c) DNA codes for polypeptides in cells. Transfer RNA (tRNA) is involved in this process.

Describe the role of tRNA in the production of polypeptides in cells.

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..... [3]

[Total: 10]

For Examiner's Use

6 **(a)** State the term for each of the following:

(i) all organisms of the same species living in a defined area at a particular time.

..... [1]

(ii) the interaction of all living organisms with each other and their non-living environment in a self-contained location

..... [1]

(iii) the process of converting nitrate ions in soil to nitrogen gas in the atmosphere.

..... [1]

Mangroves are trees which grow on tropical coastlines in salt water.

Fig. 6.1 shows part of a food chain from a mangrove area.

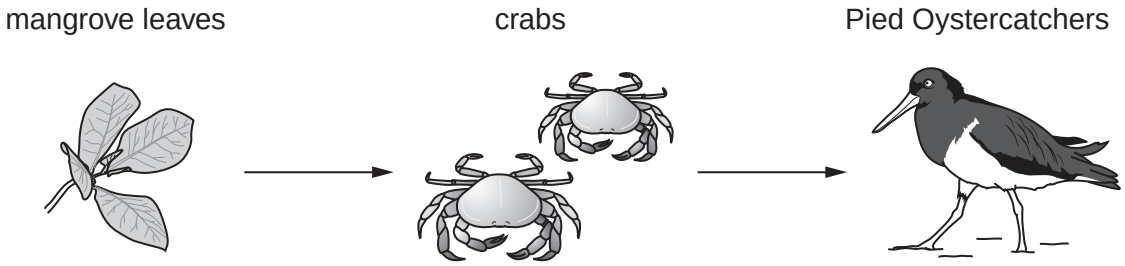


Fig. 6.1

(b) **(i)** Name the trophic level of the Pied Oystercatchers.

..... [1]

(ii) Explain why the energy taken in by the crabs is not all available to the Pied Oystercatchers.

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..... [2]

(c) The crabs in Fig. 6.1 also feed on mangrove leaves that have fallen to the ground. The leaves which are not eaten supply a source of nitrogen for the mangrove trees.

For Examiner's Use

Explain how nitrogen from compounds in the dead leaves is made available to the growing plants.

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..... [4]

[Total: 10]

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