Cambridge International AS & A Level

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BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **October/November 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

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Answer **all** questions.

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Answer **all** the questions.

1 Fig. 1.1 is a transmission electron micrograph of part of an animal cell.

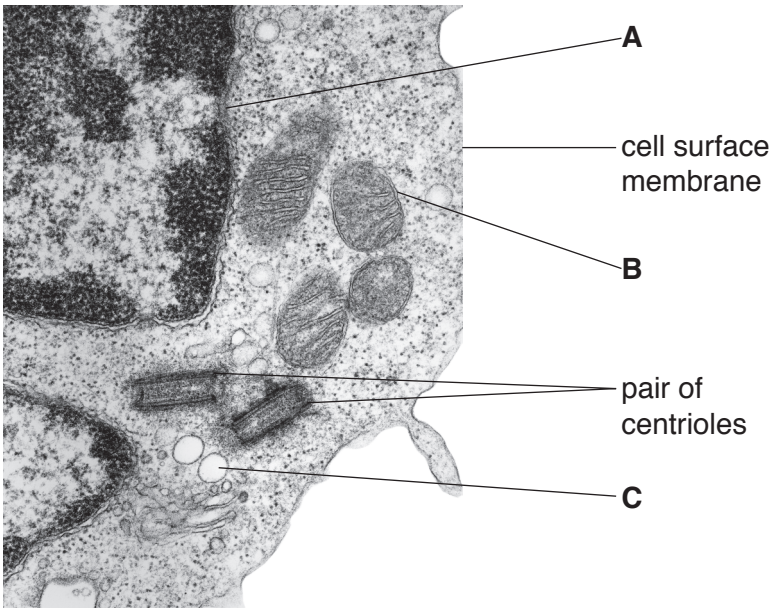


Fig. 1.1

(a) Name the structures **A**, **B** and **C**.

A .....

B .....

C .....[3]

(b) Name **one** structure, visible in Fig. 1.1, that would also be present in a prokaryotic cell.

.....[1]

(c) Cells such as that in Fig. 1.1 can divide by mitosis.

Describe the role of centrioles in mitosis.

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.....[2]

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(d) Sodium ions cross cell surface membranes using facilitated diffusion or active transport.

Explain why sodium ions cross cell surface membranes by these mechanisms and **not** by simple diffusion.

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.....[3]

[Total: 9]

2 (a) (i) Define *transpiration*.

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.....

.....[1]

(ii) State **two** environmental factors that affect the rate of transpiration.

Explain how each factor affects the rate of transpiration.

factor 1 .....

explanation.....

.....

.....

factor 2 .....

explanation.....

.....

.....[4]

(b) Explain how hydrogen bonding is involved in the movement of water through the xylem.

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.....[3]

[Total: 8]

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3 Fig. 3.1 shows the structure of the enzyme lysozyme.

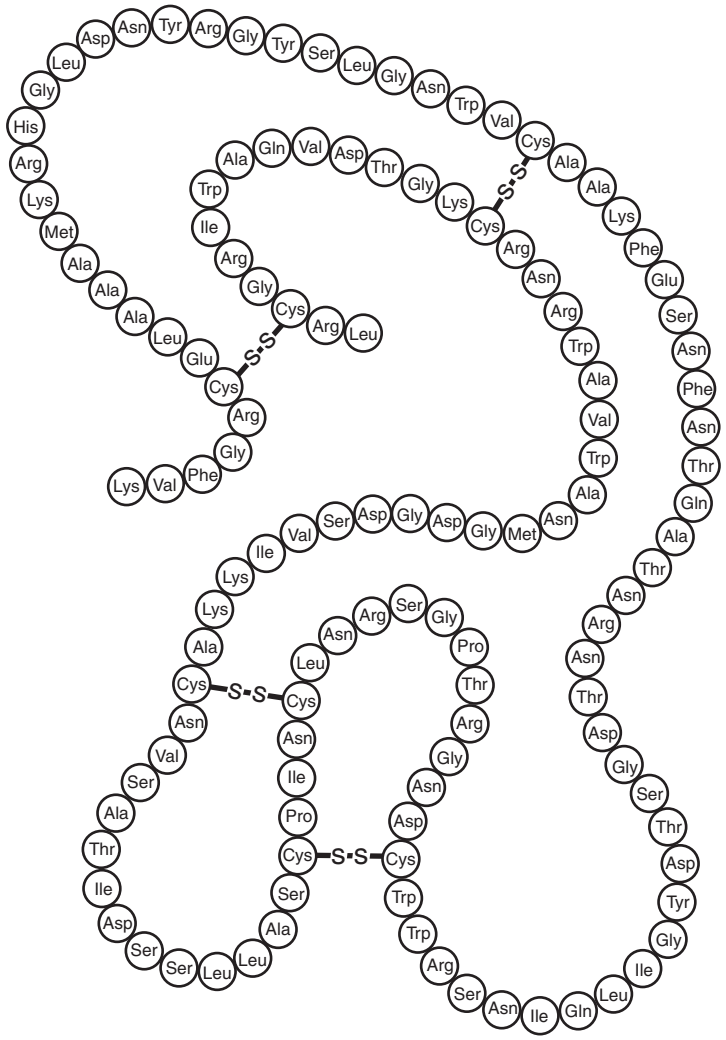


Fig. 3.1

(a) (i) Name the **two** types of covalent bond in the structure in Fig. 3.1.

.....[1]

(ii) The primary structure of lysozyme is shown in Fig. 3.1.

Explain the meaning of the term *primary structure*.

.....

.....

.....[1]

(b) Lysozyme hydrolyses the β-1,4 glycosidic bonds present in compounds found in bacterial cell walls.

(i) State what is meant by the term *hydrolysis*.

.....

.....[1]

(ii) Suggest the type of biological molecule which is the substrate for lysozyme.

.....[1]

(iii) Lysozyme uses the induced fit mechanism.

Explain the mode of action of an enzyme that uses the induced fit mechanism.

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.....[4]

(c) In human tears and saliva, lysozyme acts as an extracellular enzyme.

State what is meant by the term *extracellular*.

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.....[1]

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(d) Fig. 3.2 shows the results of an investigation into the effect of substrate concentration on the rate of reaction catalysed by lysozyme.

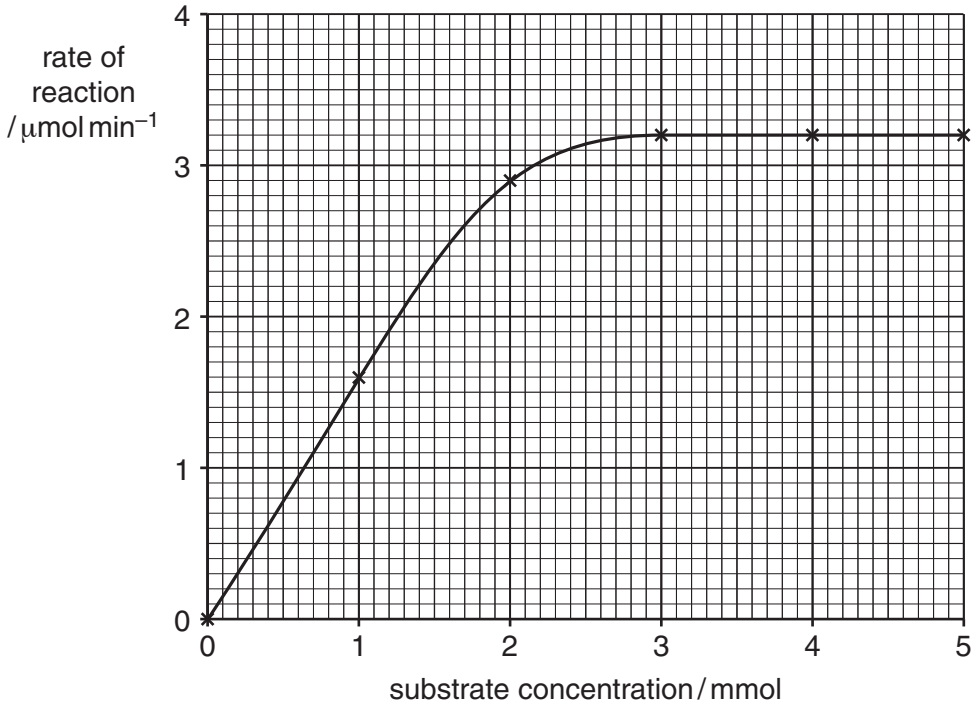


Fig. 3.2

Use Fig. 3.2 to:

(i) state the lowest substrate concentration to give the maximum rate of reaction, V_{max}

.....[1]

(ii) determine the Michaelis-Menten constant, K_m.

K_m = ...[1]

(e) The investigation was repeated in the presence of a competitive inhibitor of lysozyme.

Draw a curve **on Fig. 3.2** to show the expected results. [2]

[Total: 13]

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[Turn over

4 (a) (i) Name the bacterium that causes cholera.

.....[1]

(ii) Describe how cholera is transmitted from an infected person to an uninfected person.

.....

.....

.....

.....

.....

.....[2]

(iii) Suggest **and** explain why cholera outbreaks are common after natural disasters.

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.....

.....[2]

(b) The bacteria that cause cholera can become resistant to antibiotics by a substitution mutation.

A substitution mutation occurs when one nucleotide in the DNA sequence is replaced by a different nucleotide.

(i) Explain how a substitution mutation could result in a change in the amino acid sequence of a polypeptide.

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.....[2]

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(ii) The antibiotic nalidixic acid acts as an inhibitor of an enzyme involved in DNA replication in the bacteria that cause cholera.

The gene *gyrA* codes for this enzyme. A substitution mutation in this gene results in resistance to the antibiotic nalidixic acid.

Suggest how a change in the amino acid sequence of the enzyme results in antibiotic resistance.

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.....[2]

(c) Some of the strains of bacteria that cause cholera are resistant to more than one antibiotic (multiple resistance).

Discuss the consequences of multiple resistance for health authorities.

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.....[4]

[Total: 13]

5 **(a)** Monoclonal antibodies (MAbs) have been used in the treatment of some non-infectious diseases.

MAbs can be designed to bind to a protein on diseased cells, so causing their destruction by cells of the person's immune system.

(i) Name the part of an antibody molecule that will bind to a protein on diseased cells.

.....[1]

(ii) Suggest how the binding of monoclonal antibody to the diseased cells causes their destruction by cells of the person's immune system.

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.....[4]

(b) Myasthenia gravis is an auto-immune disease.

Explain the term *auto-immune disease*.

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.....

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.....

.....[1]

[Total: 6]

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6 **(a)** Complete Table 6.1 to show the features of the human gas exchange system.

Place a tick (✓) where a feature is present and a cross (✗) if a feature is absent.

Table 6.1

	cartilage	cilia	elastic fibres
trachea			
bronchioles			
alveoli			

[3]

(b) Smoking causes changes to the structure of the lining of the bronchi that make smokers more likely to be infected by bacteria.

Describe these changes and explain how this leads to an increased risk of bacterial infection.

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.....[3]

(c) Haemoglobin binds oxygen in the lungs to form oxyhaemoglobin.

Describe what causes oxygen to be released from the oxyhaemoglobin as blood flows through respiring tissues.

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.....[4]

(d) Explain why red blood cells are in blood but not in tissue fluid.

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.....[1]

[Total: 11]

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BIOLOGY **9700/22**

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Answer **all** the questions.

1 Match the description for each of statements **A** to **E** to a correct cell structure.

A Double membrane-bound organelle, absent in animal cells, that produces ATP.

.....

B Partially permeable membrane surrounding the large permanent vacuole of plant cells.

.....

C Formed from microtubules during mitosis.

.....

D Has peptidoglycan as one of its major components.

.....

E Site of assembly of 80S ribosomes.

.....

[5]

[Total: 5]

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[Turn over

2 Phloem sap containing sucrose is transported in phloem sieve tubes from the source to the sink.

(a) A student carried out an experiment using Visking tubing to investigate osmosis. The student prepared a sucrose solution to represent phloem sap at the source. This was put into Visking tubing that was tied at one end, so that the tubing was approximately 75% full.

The rest of the procedure is summarised in Fig. 2.1. The tubing was removed after 20 minutes, dried and re-weighed.

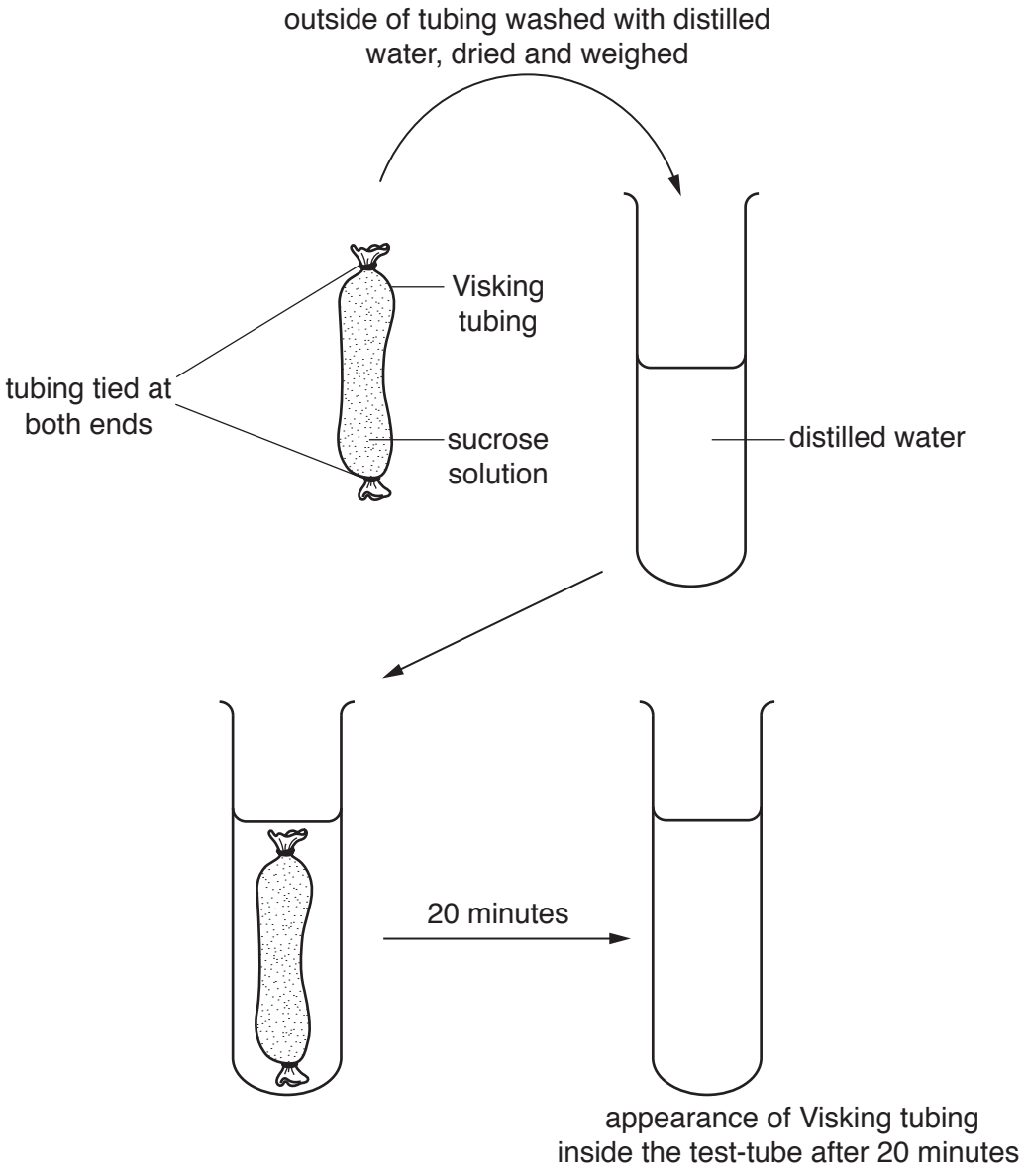


Fig. 2.1

(i) Complete Fig. 2.1 to show the appearance of the Visking tubing inside the test-tube after 20 minutes. [1]

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(ii) State, **with reasons**, whether there would be a change in the mass of the Visking tubing containing the sucrose solution after 20 minutes.

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.....[3]

(b) Explain how osmosis is involved in the mass flow of phloem sap.

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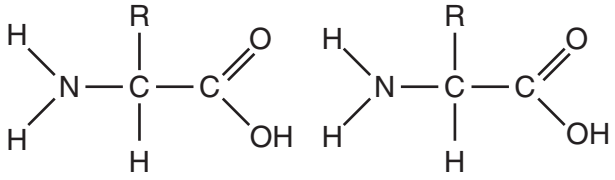
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.....[3]

(c) Amino acids synthesised in the mesophyll cells of leaves are also transported in phloem sap to other locations where they are used to synthesise polypeptides.

Amino acids are joined by peptide bonds to form the polypeptides.

Two amino acids are shown below. Describe the formation of a peptide bond between these two amino acids. You may use the space below.



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.....[2]

[Total: 9]

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3 High fructose corn syrup, made from maize, can be used as a replacement for sucrose to sweeten food and drink products.

Commercial production of high fructose corn syrup involves the enzyme glucose isomerase, extracted from bacteria.

(a) Fructose and sucrose are both sugars.

State two structural differences between fructose and sucrose.

1 .....

.....

.....

2 .....

.....

.....[2]

(b) The glucose isomerase used in the production of high fructose corn syrup is extracted from a strain of a bacterium, *Thermus thermophilus*, which is found in hot springs. The enzyme has an optimum temperature of 95 °C.

Suggest **and** explain the advantages of using glucose isomerase from *T. thermophilus* to produce high fructose corn syrup, rather than using glucose isomerase that has an optimum temperature of 37 °C.

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.....[3]

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(c) The commercial production of high fructose corn syrup uses immobilised glucose isomerase.

Fig. 3.1 shows the effect of pH on the activity of immobilised glucose isomerase compared to glucose isomerase free in solution.

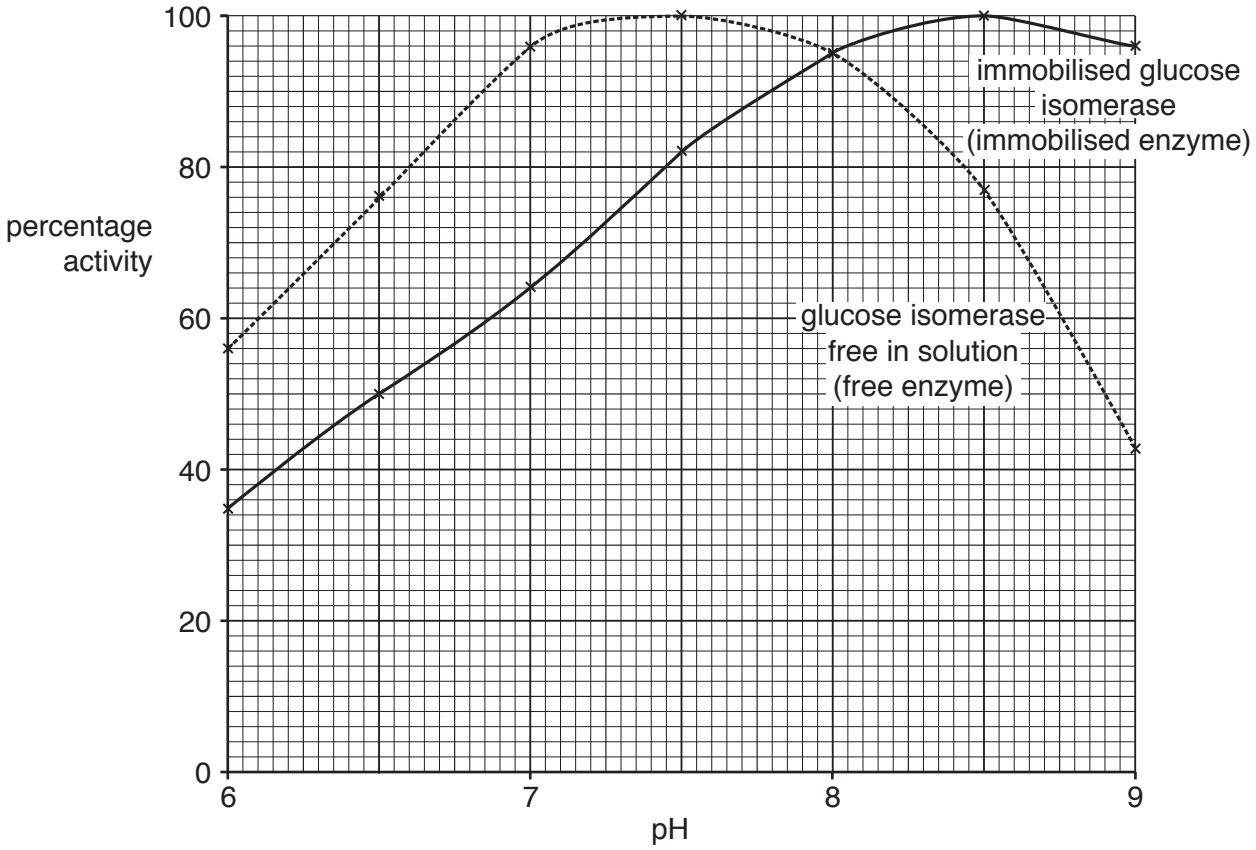


Fig. 3.1

With reference to Fig. 3.1, describe the differences shown between the immobilised enzyme and the free enzyme as pH changes.

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.....[3]

(d) The amino acid sequence of the enzyme glucose isomerase has been determined. The first five amino acids of this sequence are shown in Table 3.1.

Table 3.2 (on page 11) shows the genetic code (mRNA codons).

A student was asked to use Table 3.2 to work out an mRNA nucleotide sequence that would correspond to the first five amino acids of glucose isomerase. The student's sequence is shown in Table 3.1.

Table 3.1

amino acid sequence	met	tyr	glu	pro	lys
student's nucleotide sequence	AUG	UAU	GAC	CCU	UGU
correct = ✓ incorrect = ✗					

(i) Complete Table 3.1 using a ✓ or a ✗ to indicate whether the student has used Table 3.2 correctly to identify the codons for each amino acid in the nucleotide sequence. [1]

(ii) Discuss, with reasons, how an mRNA nucleotide sequence worked out to correspond to the first five amino acids using Table 3.2 may not be the same as the mRNA nucleotide sequence for those amino acids present in the bacterial cell.

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.....[3]

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Table 3.2

first position	second position				third position
	U	C	A	G	
U	phe	ser	tyr	cys	U
	phe	ser	tyr	cys	C
	leu	ser	STOP	STOP	A
	leu	ser	STOP	trp	G
C	leu	pro	his	arg	U
	leu	pro	his	arg	C
	leu	pro	gln	arg	A
	leu	pro	gln	arg	G
A	ile	thr	asn	ser	U
	ile	thr	asn	ser	C
	ile	thr	lys	arg	A
	met	thr	lys	arg	G
G	val	ala	asp	gly	U
	val	ala	asp	gly	C
	val	ala	glu	gly	A
	val	ala	glu	gly	G

[Total: 12]

4 Fig. 4.1 is a cross-section of a human renal artery, a vessel that supplies blood to the kidney.

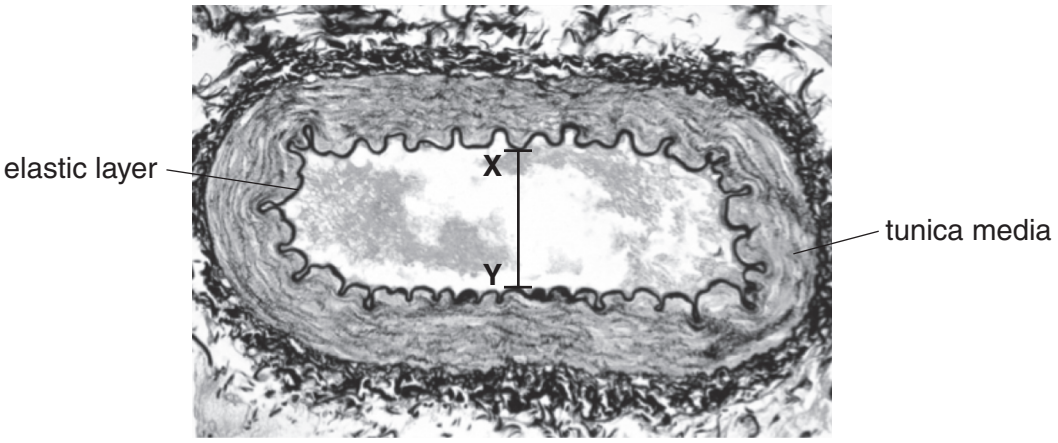


Fig. 4.1

(a) The elastic layer shown in Fig. 4.1, located between the endothelium and the tunica media, is one feature that suggests that the blood vessel is the renal artery and not the renal vein, which may be of a similar size.

Complete the sentence to state **one** additional structural feature, **visible in Fig. 4.1**, that would identify the blood vessel as an artery.

This is an artery because it has .....

.....

.....

.....[1]

(b) Explain the relationship between the structure of the tunica media and the function of an artery, such as the renal artery.

.....

.....

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.....

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.....[2]

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(c) The actual diameter of the lumen of the renal artery at the point **X–Y** in Fig. 4.1 is 5.2 mm.

Calculate the magnification of the image shown in Fig. 4.1. Write down the formula you will use to make your calculation and show your working.

formula

magnification × .....[3]

(d) Blood plasma contains approximately 90% water. Many of the properties of water are due to its ability to form hydrogen bonds.

Outline how the properties of water make it ideal as the largest component of plasma.

.....

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.....[3]

[Total: 9]

5 A disease can be described as infectious or non-infectious.

(a) Lung cancer is a non-infectious disease.

(i) Explain the term *non-infectious disease*.

non-infectious .....

.....

.....

disease .....

.....

.....[2]

(ii) In a person with lung cancer one or more healthy cells undergo changes to produce cancerous cells that can form a tumour.

Suggest **and** explain the cellular changes that occur in the development of lung cancer.

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.....[4]

(b) Fig. 5.1 is a summary of some infectious diseases.

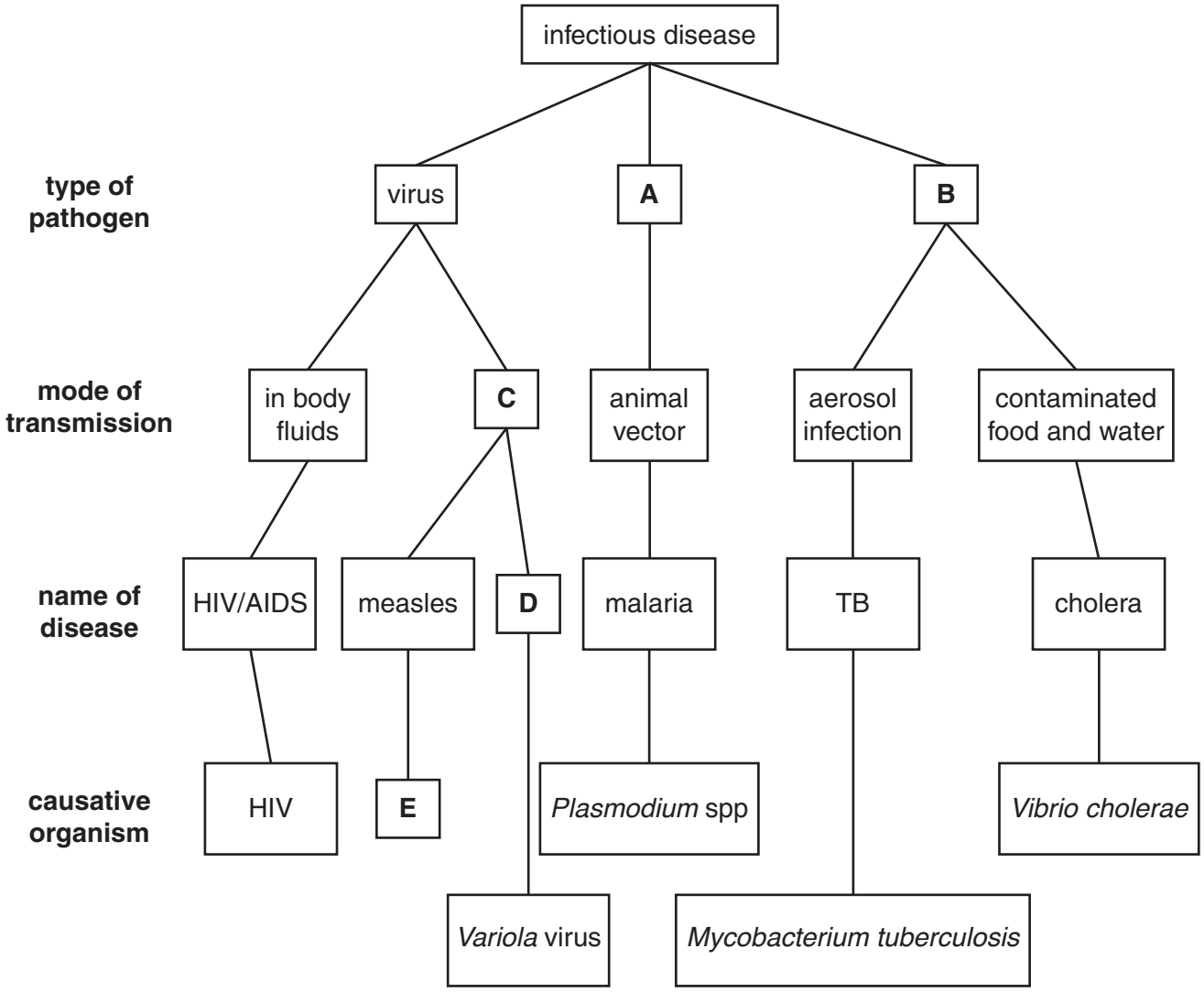


Fig. 5.1

Use the information in Fig. 5.1 to answer parts **(i)** to **(iv)**.

(i) Name the type of pathogen represented by **A** and **B**.

A .....

B ..... [2]

(ii) State the mode of transmission represented by **C**.

.....[1]

(iii) Name the disease represented by **D**.

.....[1]

(iv) Name the causative organism represented by **E**.

.....[1]

(c) Explain how vaccination can control infectious diseases.

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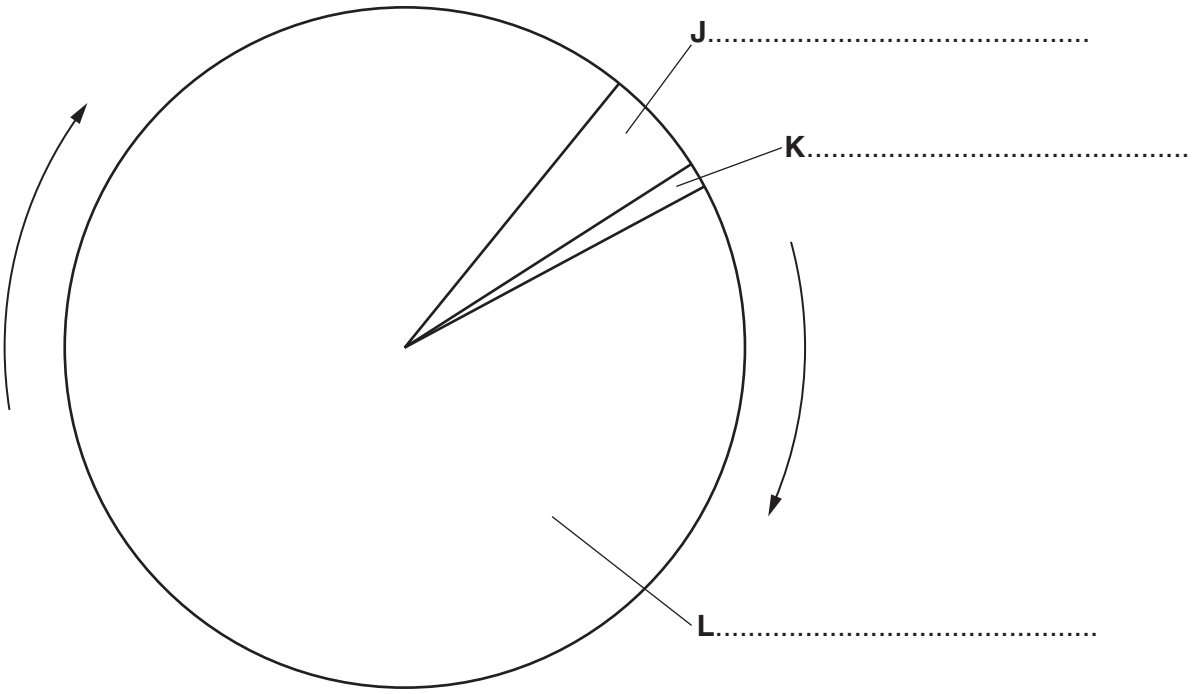
.....[3]

[Total: 14]

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6 **(a)** Fig. 6.1 represents one complete cell cycle for a eukaryotic cell.

(i) Complete Fig. 6.1 by naming the stages represented by **J**, **K** and **L**.



[3]

Fig. 6.1

(ii) Name the stage in the cell cycle in which semi-conservative replication of DNA occurs.

.....[1]

The development of stem cells to become neutrophils occurs in several stages. Some of these stages are capable of cell division.
Fig. 6.2 is a summary of neutrophil development. Some details of cellular structure are included.

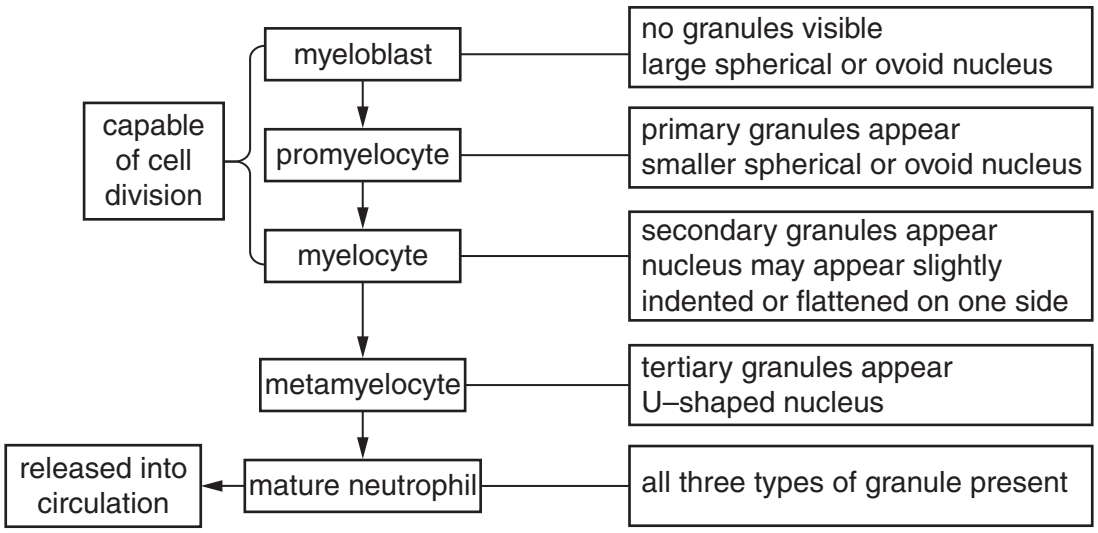


Fig. 6.2

All three types of granule indicated in Fig. 6.2 are membrane-bound cell structures containing hydrolytic enzymes. Each type of granule contains a different group of enzymes and other chemicals that enable the neutrophil to carry out its role.

(b) (i) State the location in the body where development and maturation of the neutrophil occurs.

.....[1]

(ii) Describe the shape of the nucleus in the mature neutrophil.

.....[1]

(iii) State the alternative name of the cell structures described in Fig. 6.2 as “granules”.

.....[1]

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(c) (i) Primary granules contain proteins known as defensins. These bind to cell surface membranes of bacteria and form very small pores in the membrane.

Suggest how defensins contribute to the role of the neutrophil in killing bacteria.

.....

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.....

.....[2]

(ii) Secondary granules contain lysozyme. This is an enzyme that breaks bonds in peptidoglycan molecules.

Explain how the action of lysozyme will lead to the destruction of the bacterial cell.

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.....[2]

[Total: 11]

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CANDIDATE NUMBER

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BIOLOGY **9700/23**

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Answer **all** the questions.

1 **(a)** Table 1.1 shows some features of four biological molecules that are all polymers.

Complete Table 1.1 by using a tick (✓) to indicate the features that apply to each polymer.

Table 1.1

feature	amylopectin	cellulose	RNA	polypeptide
synthesised from amino acid monomers				
contains glycosidic bonds				
polymer is branched				
contains nitrogen				
can be found in both animal and plant cells				

[4]

(b) Fig. 1.1 is a simple diagram of a phospholipid molecule.

Explain how the structure of a phospholipid molecule makes it suitable for its function in cell membranes. You may label and annotate Fig. 1.1 as part of your answer.



Fig. 1.1

.....

.....

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.....[3]

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(c) State two components of a cell surface membrane **other than** phospholipid molecules and describe their function.

component 1 .....

function .....

.....

.....

component 2 .....

function .....

.....

.....[4]

[Total: 11]

2 **(a)** Explain how enzymes lower the activation energy needed to allow reactions to proceed.

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.....[2]

(b) Folic acid is a molecule used by all cells for growth. Bacteria cannot absorb folic acid from their surroundings. Bacteria use an enzyme to make a molecule called PABA. PABA is used to make folic acid.

An investigation was carried out to determine the effect on the production of PABA when the concentration of an enzyme inhibitor is increased. Four different concentrations (1 μM to 30 μM) of the inhibitor were used, together with a control with no inhibitor.

The concentration of PABA produced in each reaction mixture was determined at 10 minute intervals.

The results are shown in Fig. 2.1.

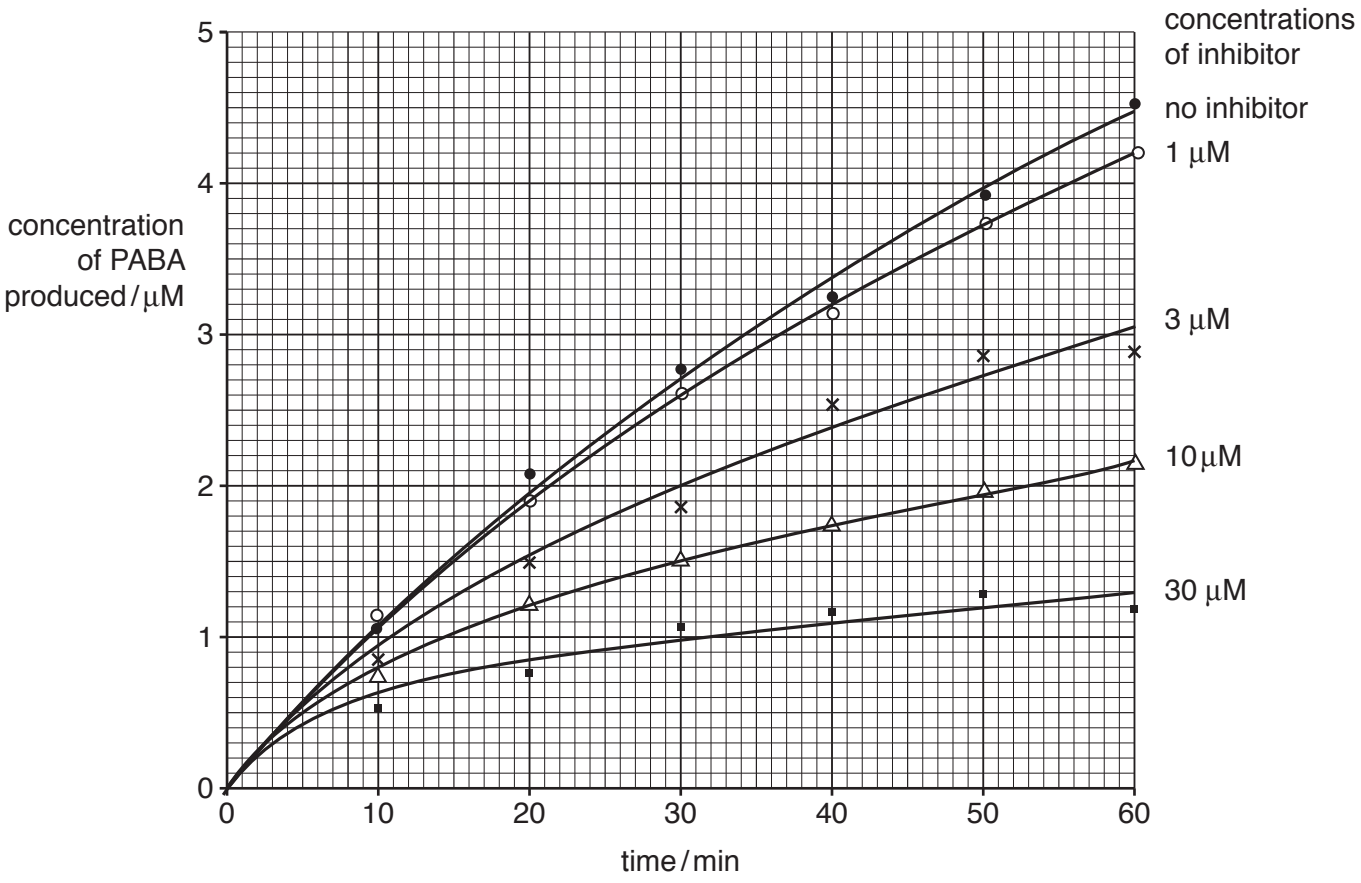


Fig. 2.1

(i) Use Fig. 2.1 to describe the results of the investigation.

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.....[4]

(ii) Outline an experiment that could be carried out to determine whether the inhibitor of the enzyme that catalyses the reaction to produce PABA is competitive or non-competitive.

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.....[3]

(iii) Folic acid from the diet is able to enter human cells, but is **not** able to cross bacterial cell walls. Human cells do **not** have an enzyme to make PABA.

Suggest why the inhibitor of this enzyme could be used as a drug to treat bacterial infections in humans.

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.....[1]

(iv) Suggest why there are few drugs that have any effect on viruses.

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.....[2]

(c) The search for new antibiotics is important because there are many strains of bacteria that are resistant to antibiotics.

Suggest two ways to reduce the spread of antibiotic resistance.

1 .....

.....

2 .....

.....[2]

[Total: 14]

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[Turn over

3 Fig. 3.1 shows part of a transverse section of a root of *Ranunculus repens*.

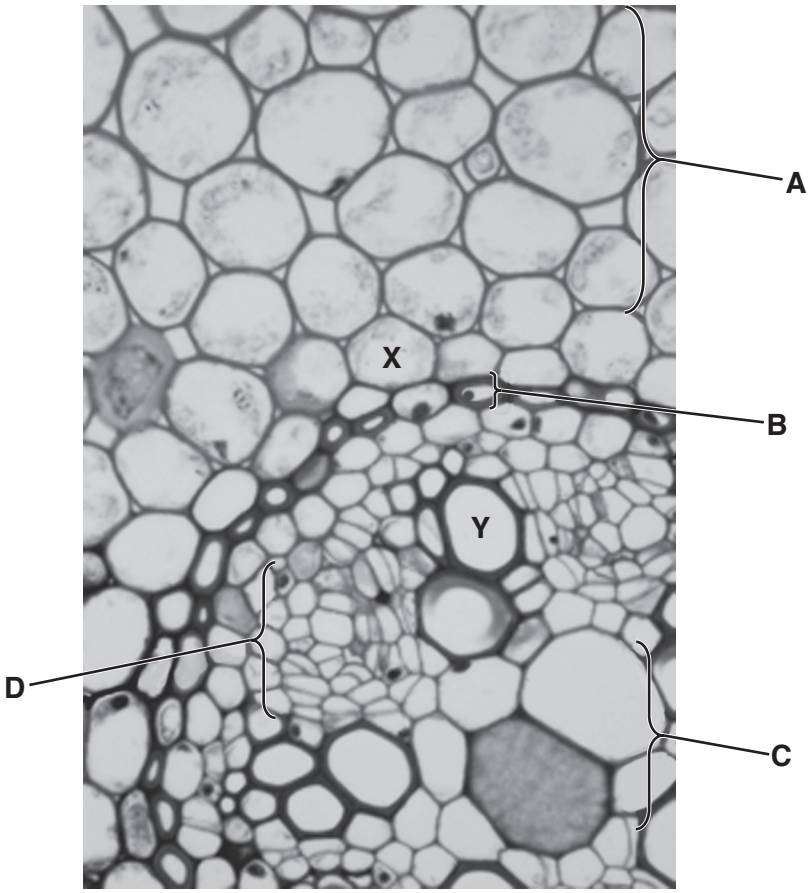


Fig. 3.1

(a) Name tissues **A** to **D**.

A .....

B .....

C .....

D .....[4]

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(b) Explain how water moves from **X** to **Y**.

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.....[4]

[Total: 8]

4 Protein synthesis requires ribosomes, mRNA, tRNA, amino acids and enzymes.

Fig. 4.1 is a diagram of a molecule of tRNA.

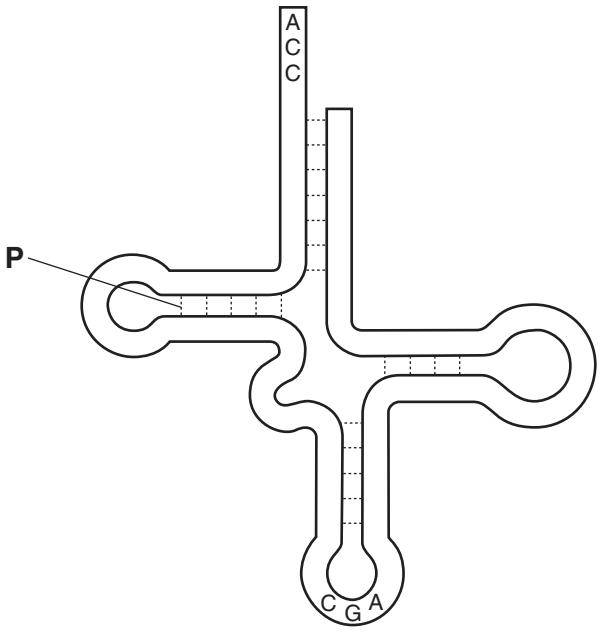


Fig. 4.1

(a) Name the bond labelled **P**.

.....[1]

(b) Use Fig. 4.1 to describe the role of tRNA in protein synthesis.

You may annotate Fig. 4.1 to help your answer.

.....

.....

.....

.....

.....

.....

.....[3]

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(c) tRNA molecules are synthesised inside the nucleus of eukaryotic cells.

Outline the process by which tRNA molecules are synthesised in the nucleus.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 7]

5 In an investigation, the volume of oxygen that combined with haemoglobin at different partial pressures of oxygen was determined. The results are shown in Fig. 5.1.

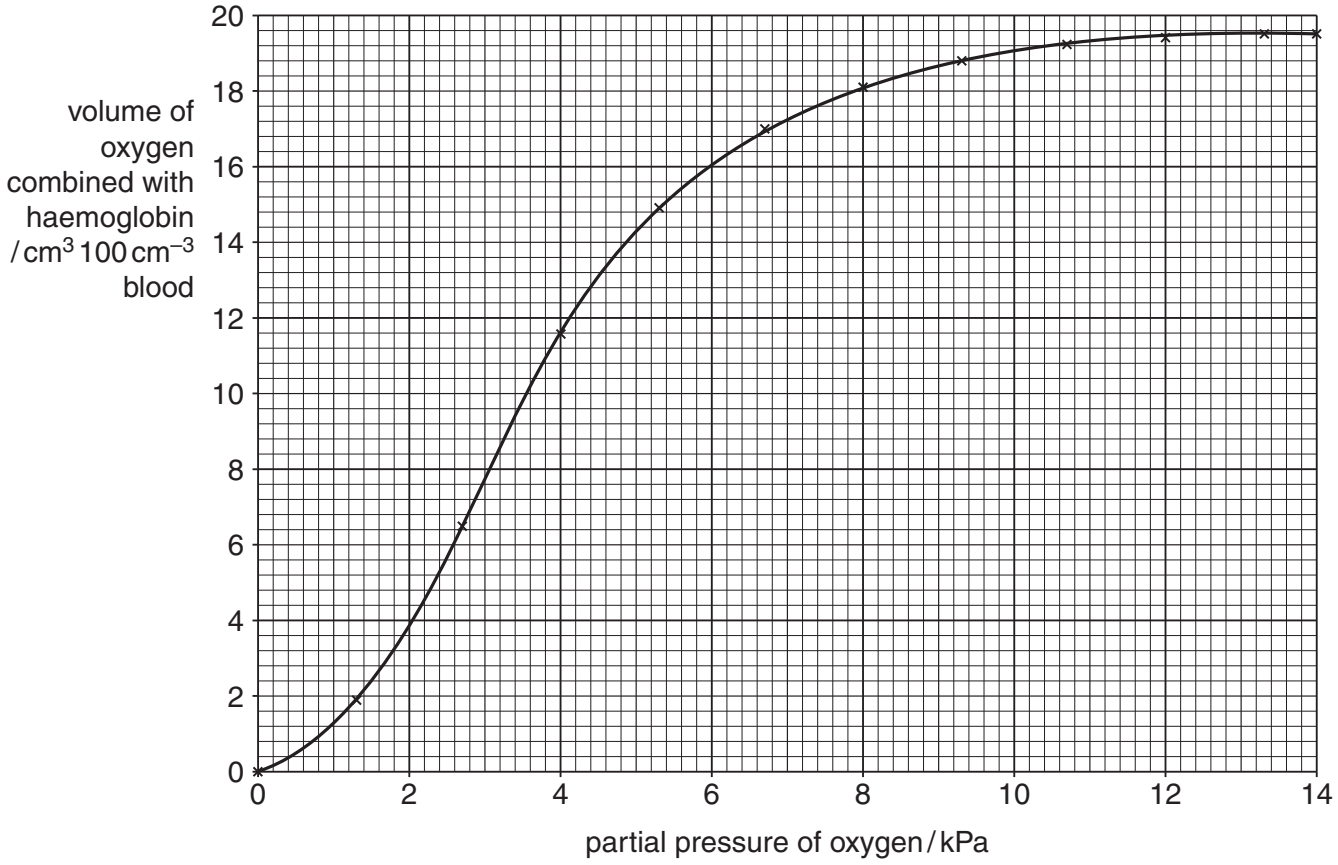


Fig. 5.1

(a) The partial pressure of oxygen in the alveoli is 13.3 kPa. At this partial pressure of oxygen the **total volume of oxygen** that is carried by 100 cm^3 blood is 19.78 cm^3 at pH 7.4 and 37 °C.

The volume of oxygen that combines with haemoglobin at 13.3 kPa is 19.48 cm^3 100 cm^{-3} blood.

(i) Calculate the percentage of oxygen that is combined with haemoglobin in 100 cm^3 blood.

answer .....% [1]

(ii) Suggest how the oxygen that is **not** combined with haemoglobin is transported in the blood.

.....

.....[1]

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(iii) Explain why a long-term smoker would have a lower volume of oxygen combined with haemoglobin in the alveoli at 13.3 kPa.

.....

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.....

.....[2]

(b) Describe the role of carbonic anhydrase in the transport of carbon dioxide.

.....

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.....[3]

(c) The investigation was repeated in the presence of carbon dioxide. The volumes of oxygen combined with haemoglobin at partial pressures of oxygen below 8.0 kPa were less than shown in Fig. 5.1.

Name this effect **and** explain the advantage of this decrease at partial pressures of oxygen below 8.0 kPa.

name .....

advantage .....

.....

.....

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.....

.....

.....[3]

[Total: 10]

6 Measles is a highly infectious disease.

(a) Name the pathogen that causes measles.

.....[1]

The number of cases of measles is reported to the World Health Organization (WHO) by countries throughout the world so that global data are collected.

Fig. 6.1 shows the global data collected between January 2008 and December 2012.

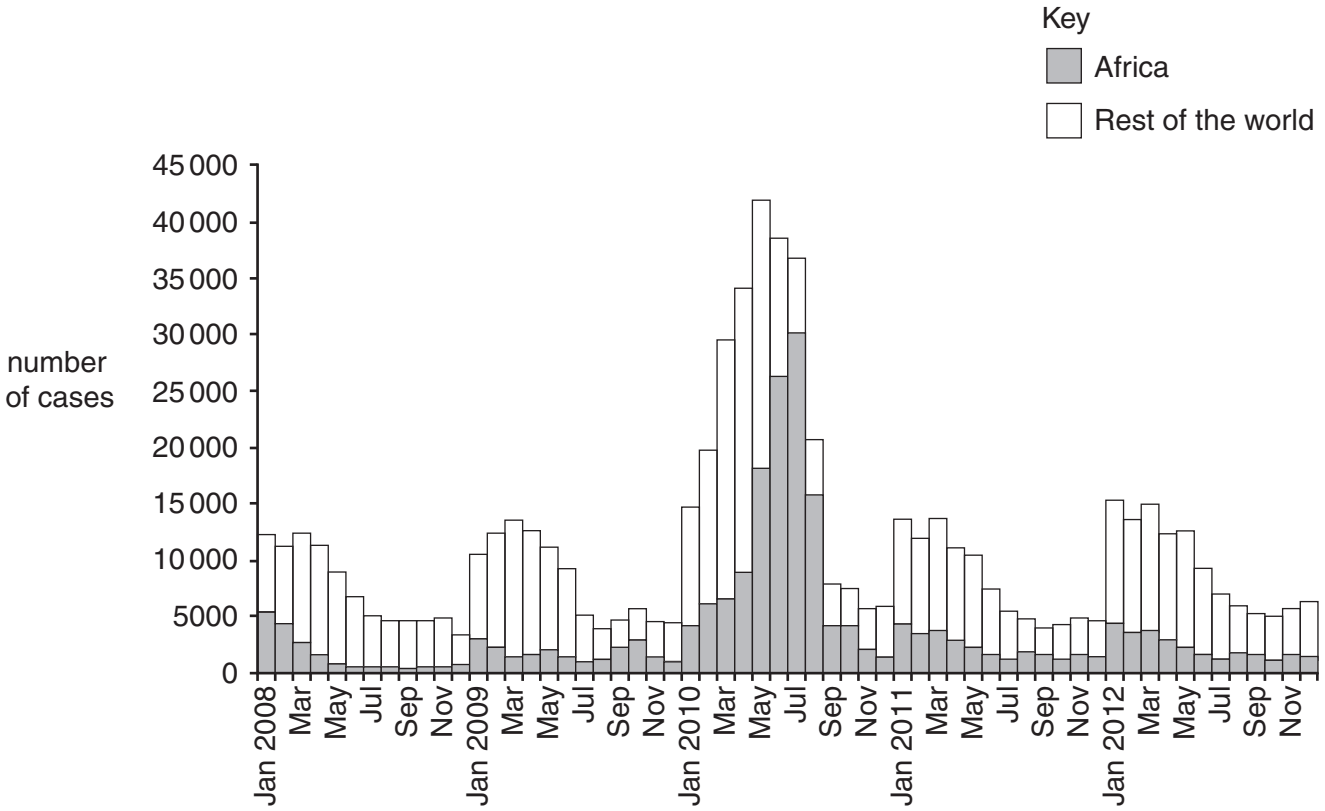


Fig. 6.1

(b) Use the data in Fig. 6.1 to describe the pattern shown in the number of cases of measles reported to the WHO between January 2008 and December 2012.

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.....[3]

(c) The WHO is coordinating a vaccination campaign to reduce the number of cases of measles. Between seven to ten days after receiving the vaccination for measles the concentration of antibodies in the blood begins to increase.

Describe what happens in the body after the injection of a measles vaccine until the concentration of antibodies in the blood begins to increase.

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.....[4]

(d) Explain why countries that have established vaccination programmes still have cases of measles.

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.....[2]

[Total: 10]

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