Cambridge International AS & A Level

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BIOLOGY **9700/21**

Paper 2 Structured Questions AS **May/June 2014**

1 hour 15 minutes

Candidates answer on the Question Paper.

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[Turn over

Answer **all** the questions.

1 *Vibrio cholerae* is a prokaryotic organism.

Fig. 1.1 shows the structure of a cell of *V. cholerae.*

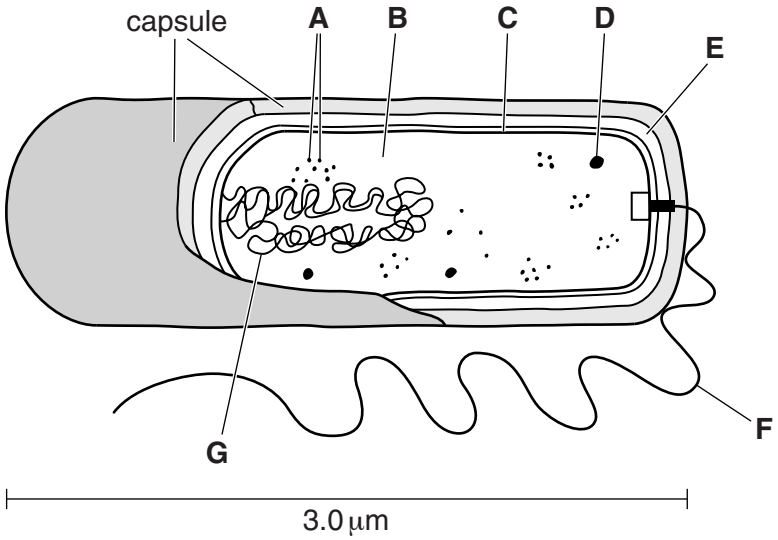


Fig. 1.1

(a) Calculate the magnification of Fig. 1.1.
Show your working and give your answer to the nearest whole number.

magnification × ..... [2]

(b) Locate the structures in Fig. 1.1 that apply to each of the features shown in Table 1.1.
Complete Table 1.1 by writing the appropriate letter and the name of the structure.
You must only give one letter in each case. You may use each letter once, more than once or not at all. The first answer has been completed for you.

Table 1.1

feature	identity	name
provides motility	**F**	flagellum
stores genetic information		
partially permeable		
composed of murein (peptidoglycan)		
site of translation		

[4]

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(c) State three **structural** features that are present in a mesophyll cell in a leaf that are **not** present in a prokaryotic cell such as that of *V. cholerae*.

1. .....

2. .....

3. .....

[3]

(d) Describe how *V. cholerae* is transmitted from an infected person to an uninfected person.

.....

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.....

.....

..... [2]

(e) It is important to know how pathogens are transmitted in order to develop effective control methods.

Explain how this knowledge is used to control the spread of *V. cholerae* in the human population.

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..... [3]

[Total: 14]

2 *Azolla filiculoides* is an aquatic fern that floats on the surface of lakes.

The nitrogen-fixing microorganism, *Anabaena azollae*, lives within the leaves of the fern. The beetle, *Stenopelmus rufinasus*, feeds on *A.filiculoides*.

(a) State the ecological terms applied to each of the following descriptions of these species.

description	ecological term
all the members of the species *A. filiculoides* floating on a lake	
all the organisms, including *A. filiculoides, A. azollae* and *S. rufinasus*, found living in and on the lake	
organisms, such as *A. filiculoides*, that absorb light energy, fix carbon dioxide and make organic compounds available to animals that eat them	
the role of species, such as *A. filiculoides*, *A. azollae* and *S. rufinasus*, in the lake ecosystem	

[4]

(b) Explain the importance of nitrogen-fixing organisms, such as *A. azollae*, in ecosystems.

.....

.....

.....

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.....

.....

.....[3]

[Total: 7]

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3 Starch is composed of two polysaccharides, amylose and amylopectin.

Fig. 3.1 shows a molecule of α-glucose before being added to the end of a molecule of amylose.

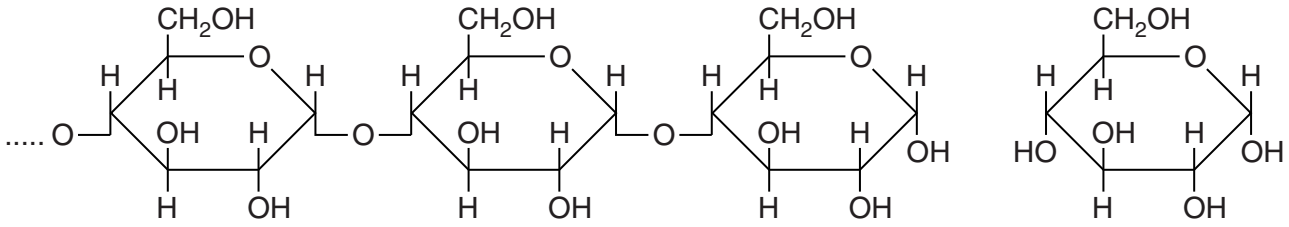


Fig. 3.1

(a) (i) Complete Fig. 3.1 to show how a molecule of α-glucose is added to the amylose. [3]

(ii) Name the bond that forms between glucose molecules in polysaccharides, such as amylose.

.....[1]

(b) Glycogen and cellulose are two other polysaccharides.

Complete Table 3.1 to compare glycogen and cellulose with amylose.

Table 3.1

feature	amylose	glycogen	cellulose
monomer	α-glucose		
branched or unbranched molecule	unbranched		
role in organisms	energy storage		

[3]

(c) Type 2 diabetes (insulin-independent diabetes) is a non-infectious disease.

If not treated, this disease is characterised by large fluctuations in the concentration of glucose in the blood.

Maltase is an enzyme that completes the digestion of starch in humans. Molecules of maltase are bound to the microvilli of epithelial cells in the small intestine.

Ascorbase is a drug used in the treatment of type 2 diabetes. Molecules of ascorbase have a very similar shape to that of the substrate for maltase.

(i) Explain how ascorbase acts to inhibit these membrane-bound enzymes.

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..... [3]

(ii) Suggest why ascorbase can be used to treat people who have type 2 diabetes.

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..... [2]

[Total: 12]

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4 B-lymphocytes respond to the presence of a non-self antigen by dividing as shown in Fig. 4.1.

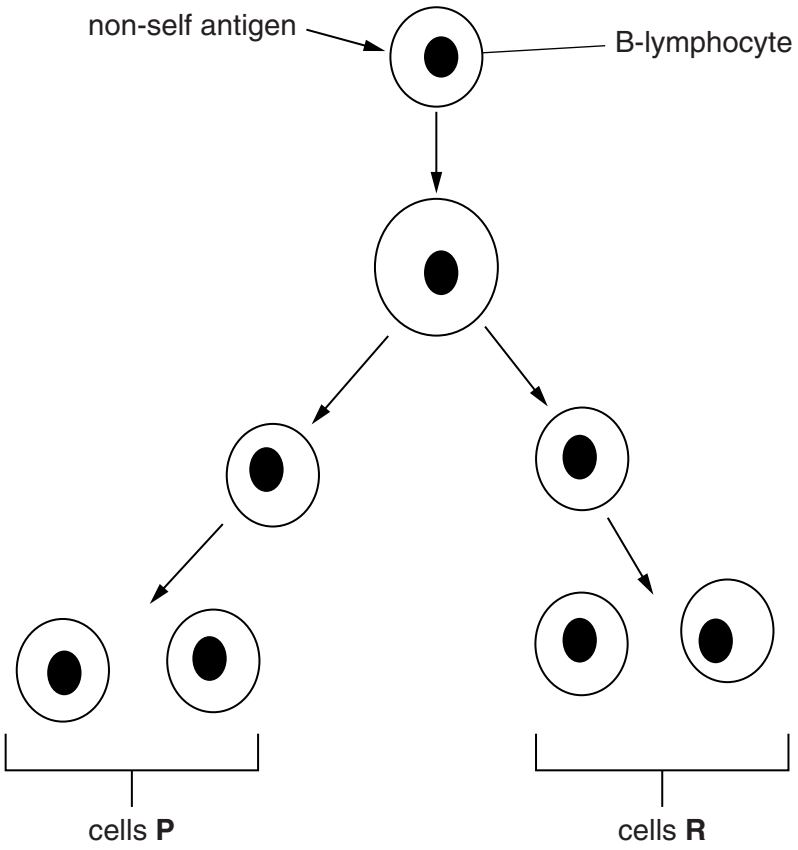


Fig. 4.1

(a) (i) Explain what is meant by the term *non-self antigen*.

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..... [2]

(ii) Outline how B-lymphocytes recognise non-self antigens.

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..... [2]

The cells labelled **P** on Fig. 4.1 continue to divide to give rise to many cells that differentiate into short-lived plasma cells. The plasma cells release antibody molecules.

(b) (i) Outline how plasma cells produce antibody molecules.

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..... [4]

(ii) Describe how antibody molecules are released from the plasma cell.

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..... [2]

(c) The cells labelled **R** on Fig. 4.1 divide to give more cells that do not differentiate into plasma cells. These cells have an important role in the immune system.

Explain the role of these cells.

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..... [3]

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The mass of DNA in the cells shown in Fig. 4.1 was determined. The results are shown in Fig. 4.2.

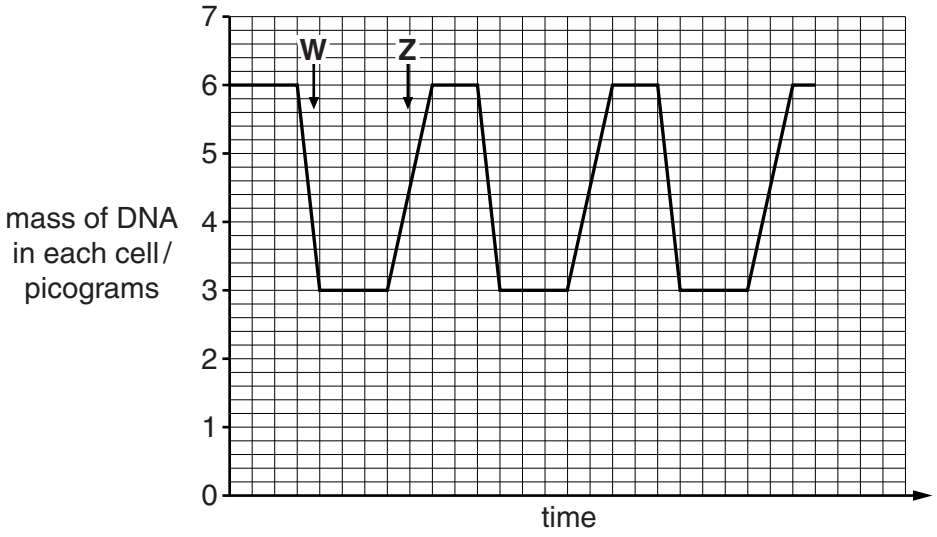


Fig. 4.2

(d) State what happens at **W** and **Z** to change the mass of DNA in each cell.

W .....

Z .....

[2]

(e) Acute lymphoblastic leukaemia (ALL) is a cancer of B-lymphocytes. It is very rare in adults, but more common in children. A study in 2009 found that exposure to tobacco smoke in the home may put children at risk of developing ALL.

Suggest how smoking by adults in the home may put their children at risk of cancers, such as ALL.

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..... [3]

[Total: 18]

5 Fig. 5.1 shows a vertical section of the left side of the heart of a mammal.

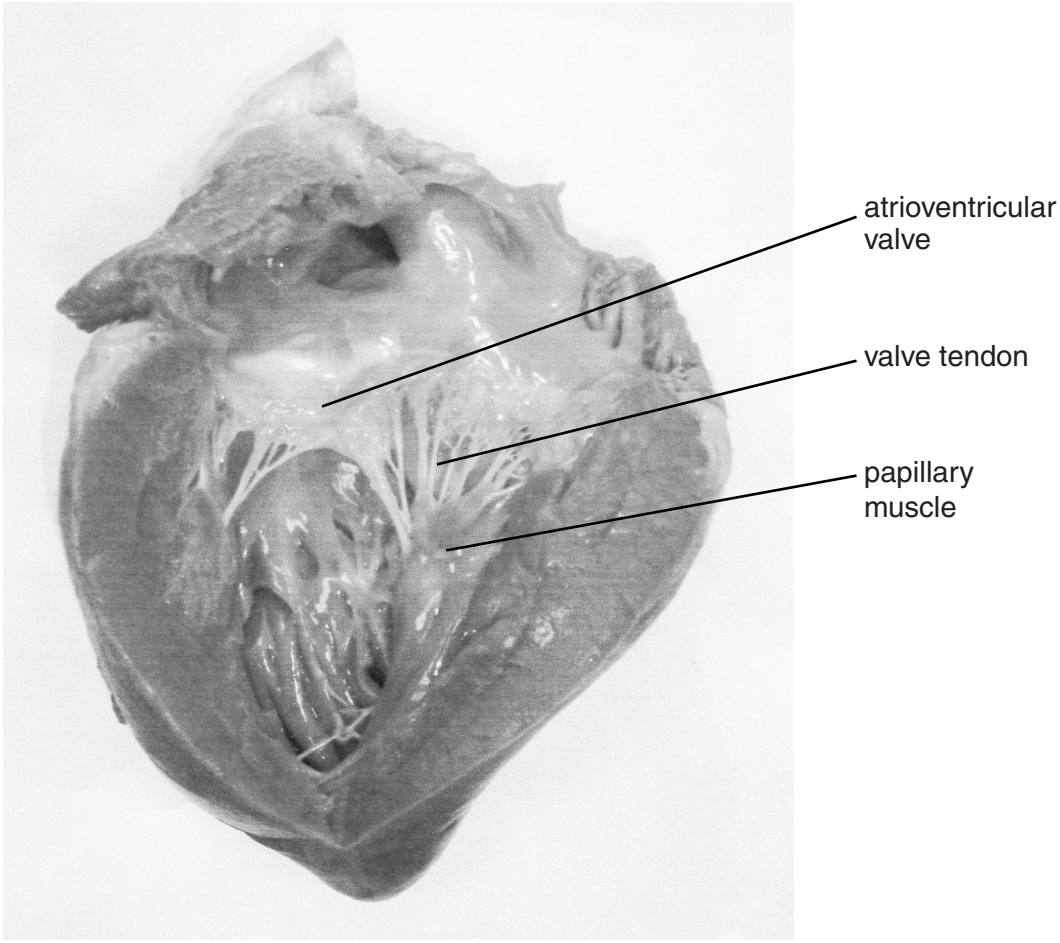


Fig. 5.1

(a) Explain the difference in the thickness of the left ventricle and the left atrium.

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.....[2]

(b) Explain how the structures labelled on Fig. 5.1 ensure that blood flows in the correct direction.

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..... [3]

(c) During one cardiac cycle, blood is pumped from the heart into the pulmonary and systemic circulations.

Explain how the contraction of the four chambers of the heart are coordinated and controlled to enable blood to be pumped simultaneously into both the pulmonary and systemic circulations.

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..... [4]

[Total: 9]

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BIOLOGY **9700/22**

Paper 2 Structured Questions AS **May/June 2014**

1 hour 15 minutes

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[Turn over

Answer **all** the questions.

1 Fig. 1.1 is a summary of energy flow in a forest ecosystem. The width of the arrows is proportional to the energy that flows between each component in the ecosystem.

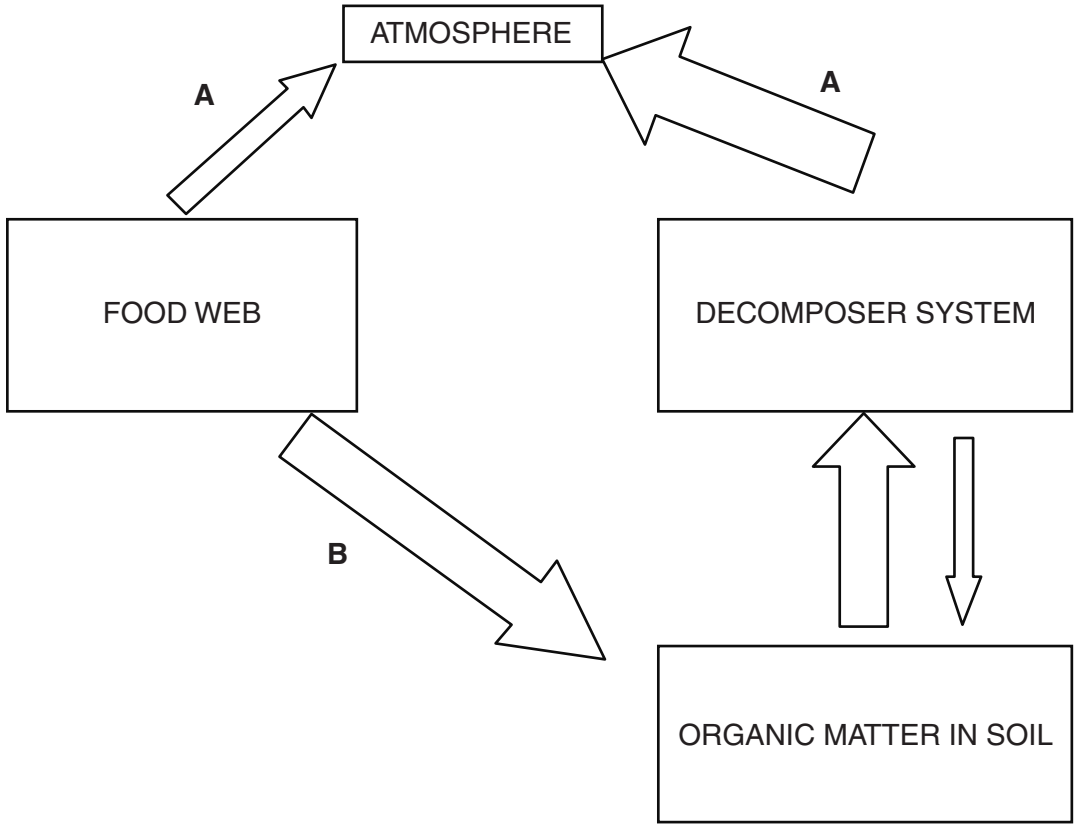


Fig. 1.1

(a) Add an arrow to Fig. 1.1 to show where the ecosystem receives its initial input of energy. [1]

(b) State the process represented by **A**.

.....[1]

(c) State one type of organism that is a member of the decomposer system.

.....[1]

(d) Name two processes represented by arrow **B**.

1. .....

2. .....
[2]

[Total: 5]

2 Fig. 2.1 is a transmission electron micrograph of cells from a spinach leaf.

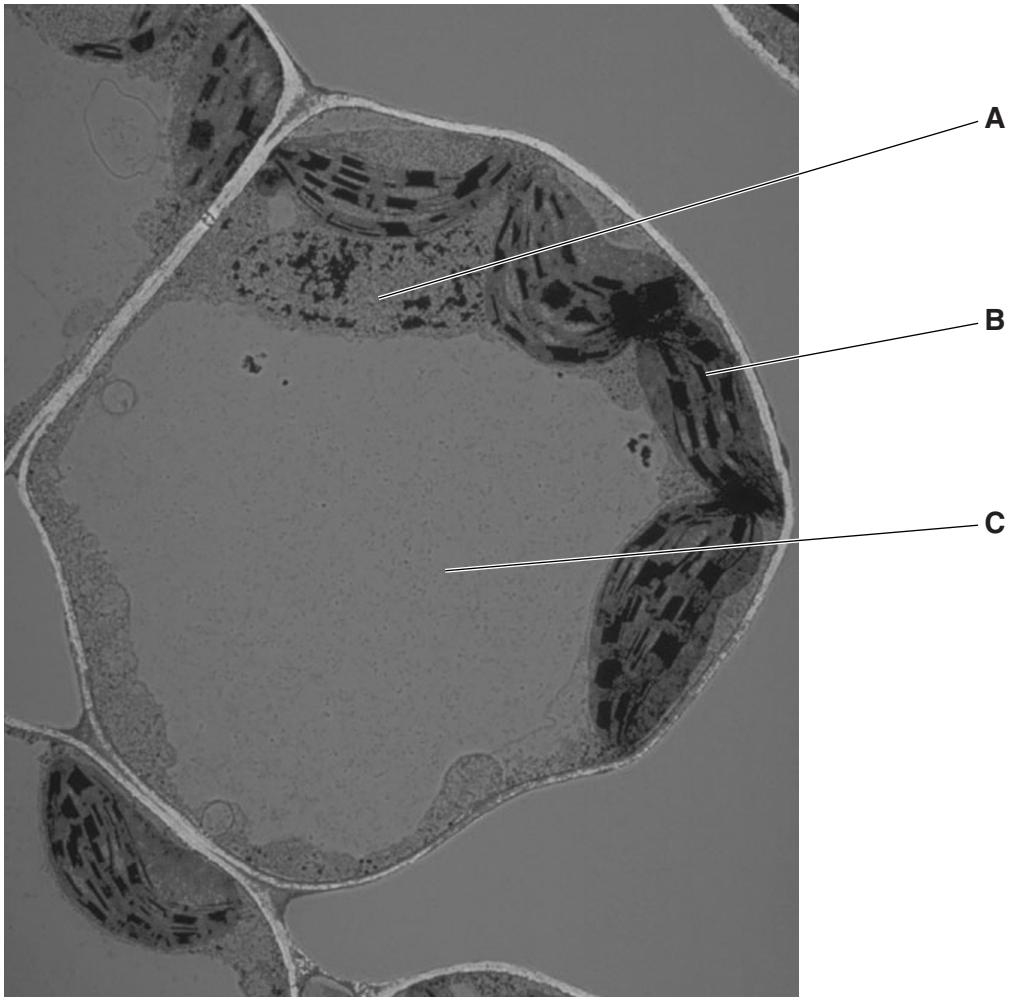


Fig. 2.1

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

A .....

B .....

C .....

[3]

(b) List two cell structures that could be present in animal cells that are not present in plant leaf cells.

1. .....

2. .....

[1]

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(c) Water is transported up the stem, to the spinach leaf, in the xylem. Once it leaves the xylem it moves via the apoplast and symplast pathways, to reach the cells in Fig. 2.1.

Outline the differences between the apoplast and symplast pathways after the water has left the xylem.

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.....[4]

(d) Water, containing dissolved mineral ions such as magnesium, enters spinach leaf cells.

(i) State **two** ways that water is used in the leaf cell.

1. .....

.....

2. .....

.....

[2]

(ii) State **one** role of magnesium ions in the leaf cell.

.....[1]

[Total: 11]

3 **(a)** Cartilage is present in some parts of the gas exchange system to prevent collapse due to pressure changes during inhalation.

State the parts of the gas exchange system in which cartilage is located.

.....[1]

(b) Fig. 3.1 shows the changes that occur in atmospheric pressure and oxygen partial pressure as altitude changes. The highest altitude at which people live permanently is 5100 m.

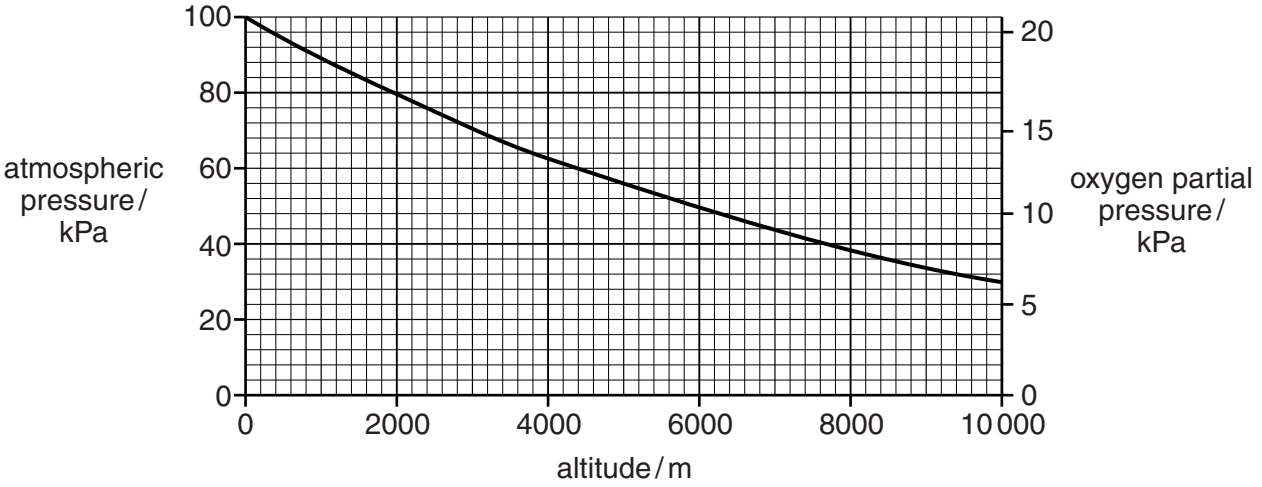


Fig 3.1

With reference to Fig. 3.1:

(i) describe the effect of increasing altitude on both atmospheric pressure and the partial pressure of oxygen

.....

.....

.....

.....

.....[2]

(ii) calculate the change in the atmospheric pressure when a person travels from sea level to an altitude of 3500 m.

Show your working.

answer .....[2]

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(c) When a person travels from 0 m (sea level) to a high altitude, gas exchange in the lungs is affected. A condition known as hypoxia results, where the body tissues do not receive an adequate oxygen supply.

Explain how hypoxia occurs when a person ascends from sea level to a high altitude.

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.....[4]

(d) At high altitudes, short-term responses by the body to hypoxia include:

- a decrease in the volume of plasma in the blood
- a decrease in the volume of blood pumped out of the heart per heart beat
- an increase in the heart rate
- an increase in the breathing rate.

(i) Suggest why a decrease in the volume of plasma in the blood may reduce the effects of hypoxia.

.....

.....

.....[1]

(ii) Explain why an increase in the heart rate occurs in response to hypoxia.

.....

.....

.....

.....

.....

.....[2]

(e) People with sickle cell anaemia have a form of haemoglobin that is unable to bind to oxygen efficiently. The cause of the condition is a mutation in the gene coding for the β-globin polypeptide of haemoglobin.

Outline how this mutation can lead to an altered amino acid sequence of the β-globin polypeptide.

.....

.....

.....

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.....

.....[3]

[Total: 15]

4 Table 4.1 shows some information about five infectious diseases.

Table 4.1

infectious disease	name of causative organism(s)	type of causative organism	main mode of transmission
HIV/AIDS	human immunodeficiency virus (HIV)	virus	sexual contact
cholera	*Vibrio cholerae*		ingestion of contaminated water and food
tuberculosis	*Mycobacterium tuberculosis*	bacterium	
measles		virus	aerosol / droplet infection
	Plasmodium vivax or *P. malariae* or *P. falciparum* or *P. ovale*		

(a) Complete Table 4.1. [3]

(b) In 2011, the World Health Organization (WHO) published recommendations to help countries develop plans to prevent the spread of HIV.

Discuss the factors that should be considered when making recommendations concerning the prevention of sexual transmission of HIV.

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.....[4]

(c) HIV infects cells of the immune system, particularly helper T-lymphocytes (T_h cells). HIV can infect both non-dividing and dividing helper T-lymphocytes, including memory cells.

The onset of disease, which can occur many years later, coincides with a severely lowered primary and secondary immune response, owing to greatly reduced numbers of T_h cells in the body.

(i) An infected T_h cell can still carry out a normal cell cycle and divide to produce two cells.

The following processes occur during one cell cycle:

DNA replication **mitosis** **growth** **cytokinesis**

List the processes in a correct sequence.

1. .....

2. .....

3. .....

4. .....

[1]

(ii) Suggest **and** explain how the destruction of **memory** T_h cells will contribute to a lowered **secondary** immune response.

.....

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.....

.....

.....

.....[3]

[Total: 11]

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Question 5 starts on page 12

5 B-lymphocytes have antibodies located on their external surface. When B-lymphocytes become plasma cells they then secrete antibodies.

Fig. 5.1 shows how the enzyme papain digests an antibody to obtain three fragments.

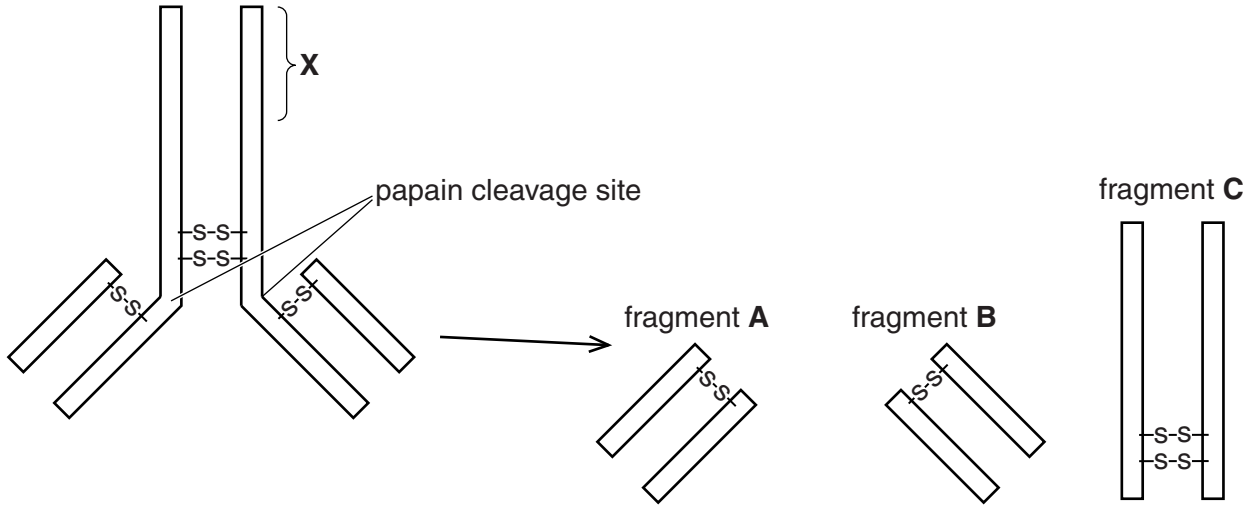


Fig. 5.1

(a) Fig. 5.1 shows the location of the region where papain acts.

State **one** role of this region in the intact antibody molecule.

.....

.....

.....[1]

(b) The three fragments, **A**, **B** and **C** still retain their ability to function.

State the function of:

(i) fragments **A** and **B**

.....

.....[1]

(ii) fragment **C**.

.....

.....[1]

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(c) The region labelled **X** in Fig. 5.1 is hydrophilic in antibodies that are secreted by plasma cells, whereas in antibodies located on the surface of B-lymphocytes, region **X** is hydrophobic.

Suggest reasons for this difference.

.....

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.....

.....[2]

(d) Papain is a globular protein with a tertiary structure but no quaternary structure.

(i) State how many polypeptides there are in a molecule of papain.

.....[1]

(ii) Explain how the tertiary structure of the protein results in papain being globular.

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.....

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.....[2]

[Total: 8]

6 **(a)** Explain the need for transport systems in multicellular plants and animals.

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.....[3]

(b) In mammals, the role of the heart is to pump blood around the body. The events that occur during one heart beat are known as the cardiac cycle. The timing for one cardiac cycle is shown in Fig. 6.1.

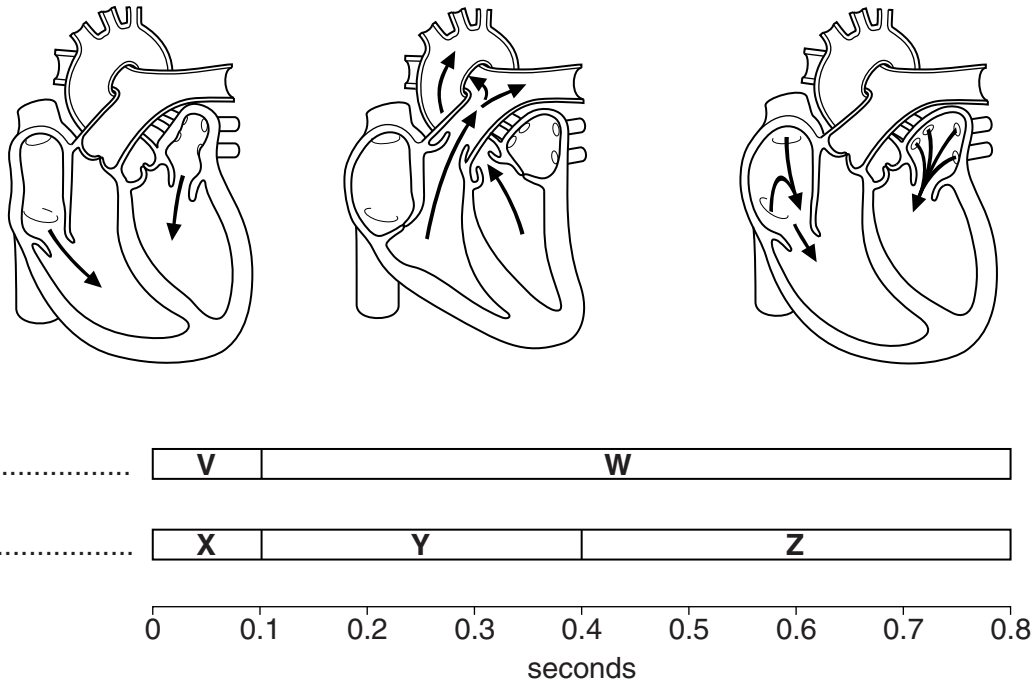


Fig. 6.1

P and **Q** represent the two types of heart chambers.

V, **W**, **X** , **Y** and **Z** represent the systolic (contracted) or diastolic (relaxed) state of the relevant heart chambers.

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(i) In the spaces provided on Fig. 6.1, identify chambers **P** and **Q**. [1]

(ii) Complete the table by writing the letters **V**, **W**, **X**, **Y** and **Z** in the appropriate box to indicate the state of the heart chambers during the cardiac cycle as shown in Fig. 6.1.

systole	
diastole	

[2]

(c) In plants, assimilates are transported in phloem sieve tube elements by a process known as translocation.

Explain how assimilates that arrive in the phloem sieve tubes from mesophyll cells can be translocated to other parts of the plant.

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.....[4]

[Total: 10]

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BIOLOGY **9700/23**

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1 hour 15 minutes

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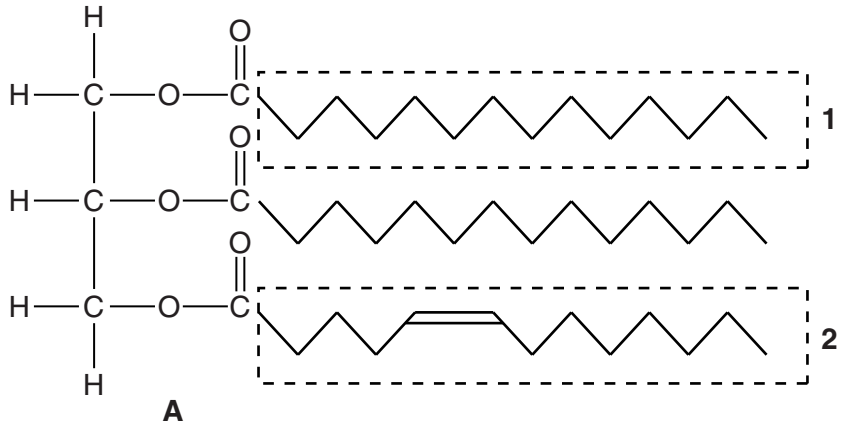
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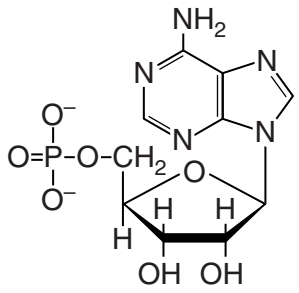
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Answer **all** the questions.

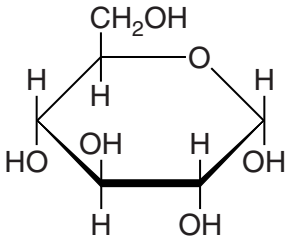
1 Fig. 1.1 shows the structures of four biological molecules **A**, **B**, **C** and **D**.



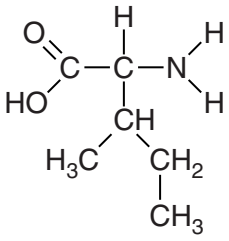
A



B



C



D

Fig. 1.1

(a) Give the letter, **A** to **D**, of the molecule in Fig. 1.1 which:

(i) is a nucleotide .....

(ii) can form peptide bonds .....

(iii) contains ester bonds. ..... [3]

(b) Some of the molecules in Fig. 1.1 can form polymers.

(i) Name a polymer which can be formed only from many molecules of **C**.

..... [1]

(ii) State one way, visible in Fig. 1.1, in which the part labelled **1** of molecule **A** differs from the part labelled **2**.

.....

.....

.....[1]

(iii) Molecule **D** can form macromolecules with other similar monomers.

These macromolecules have three dimensional shapes held in place by interactions or bonds other than those between adjacent monomers.

Name two of these interactions or bonds.

1. .....

2. .....
[2]

[Total: 7]

2 Vaccination can protect against the infectious disease tuberculosis (TB).

(a) Define the terms:

(i) *vaccination*

.....

.....

.....

.....[2]

(ii) *infectious disease.*

.....

.....

.....

.....[2]

(b) TB is an important disease worldwide. Table 2.1 shows recent information about TB cases reported during one year in six different countries.

Table 2.1

country	**region**	**number of cases**	**number of cases per 100 000 population**
Germany	Europe	4000	5
India	Asia	2 300 000	185
Japan	Asia	27 000	21
South Africa	Africa	490 000	981
Swaziland	Africa	15 000	1287
United Kingdom	Europe	7900	13

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With reference to Table 2.1, explain the advantage of calculating the number of cases of TB per 100 000 population rather than stating the number of cases alone.

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.....[2]

(c) Describe how a person may become infected with TB.

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.....[3]

(d) Suggest why TB is more likely to be fatal in people who have HIV/AIDS than in those who do not have HIV/AIDS.

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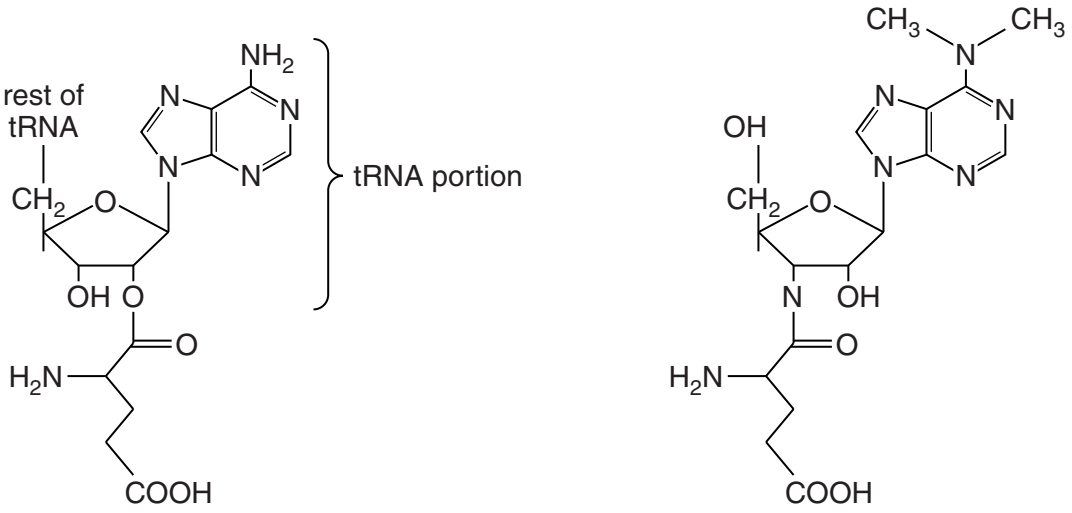
.....[2]

[Total: 11]

3 The enzyme glutamyl-tRNA reductase (GluTR) is present in many bacteria to make a product which is essential to their survival.

GluTR acts on the substrate glutamyl-tRNA, which is composed of the amino acid glutamic acid attached to a tRNA.

Fig. 3.1 shows the structure of glutamyl-tRNA and another compound called glutamycin.



glutamyl-tRNA **glutamycin**

Fig. 3.1

(a) Explain how glutamycin can act as an inhibitor for the enzyme GluTR.

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.....[4]

(b) The bacteria take in glutamic acid by active transport.

Describe the process of active transport.

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.....

.....[3]

(c) In leguminous plants, glutamic acid is also essential for the formation of root nodules containing the bacterium *Rhizobium.*

(i) Name the stage in the nitrogen cycle carried out by *Rhizobium.*

.....[1]

(ii) Suggest advantages of *Rhizobium* living in root nodules of leguminous plants.

.....

.....

.....

.....

.....[2]

(iii) Explain the role of *Rhizobium* in the growth of leguminous plants.

.....

.....

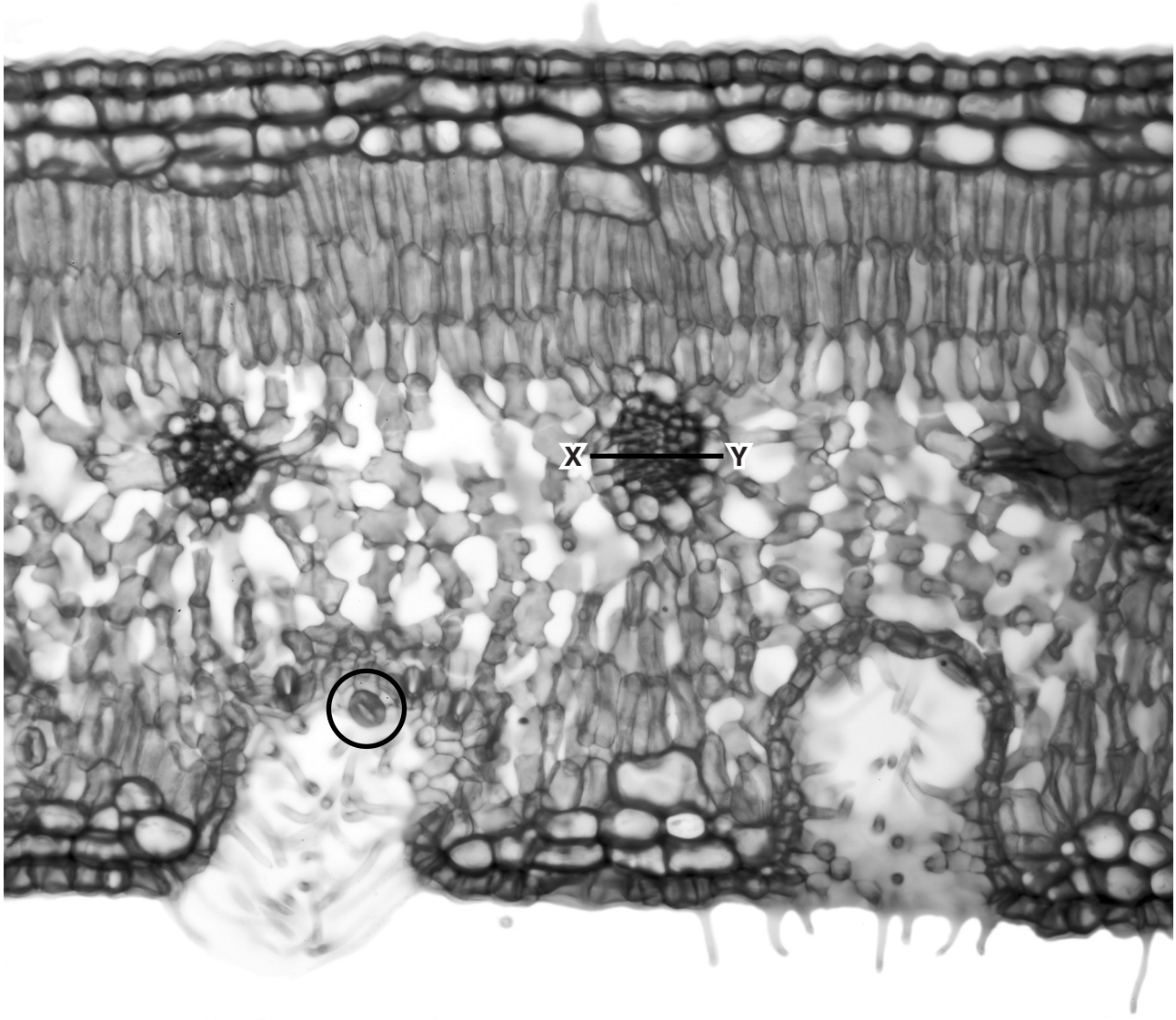
.....

.....

.....[2]

[Total: 12]

4 Fig. 4.1 is a light micrograph of a section through a leaf of the xerophytic plant *Nerium oleander*. An area containing one of the plant's stomata is circled.



Magnification × 60

Fig. 4.1

(a) List three adaptations, visible in Fig. 4.1, which are characteristic of xerophytic plants.

1. .....

2. .....

3. .....

[3]

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(b) Calculate the diameter of the vascular bundle across the line **X-Y**.

Show your working and give your answer to the nearest 100 μm.

answer..... μm [2]

(c) Describe the process of transpiration in plants such as *N. oleander*.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 9]

5 When haemoglobin in red blood cells travels through the capillaries of the lungs it binds with oxygen to form oxyhaemoglobin. When oxyhaemoglobin reaches respiring tissues, it dissociates to release oxygen.

(a) Explain what causes oxyhaemoglobin to dissociate readily in actively respiring tissues.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(b) When people move to high altitudes there is an increased production of red blood cells. Explain why more red blood cells are produced when people move to higher altitudes.

.....

.....

.....

.....

.....

.....[3]

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(c) Some people who move to live at high altitudes can develop chronic mountain sickness. One feature of this condition makes it difficult for the heart to pump blood around the body owing to the increased production of red blood cells.

The *EPAS*1 gene codes for a type of protein called a transcription factor, which helps to regulate the transcription of genes involved in red blood cell production. Some people have a mutated version of this gene that prevents the over-production of red blood cells.

(i) Explain what is meant by *transcription*.

.....

.....

.....

.....

.....

.....[3]

(ii) Describe how a mutated version of the *EPAS*1 gene can cause a change in the transcription factor protein produced.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(iii) Some transcription factors may prevent transcription.

Suggest two ways in which they may do this.

1. .....

.....

2. .....

.....
[2]

[Total: 14]

6 Fig. 6.1 shows a section of diseased artery from a smoker.

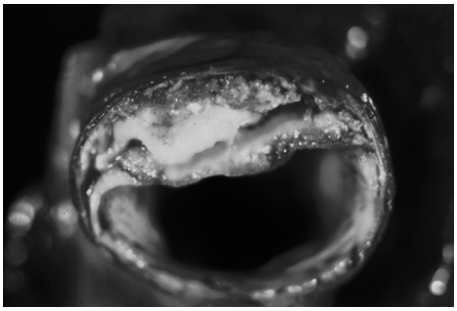


Fig. 6.1

(a) **(i)** With reference to Fig. 6.1, describe how this diseased artery differs in appearance from a healthy one.

.....

.....

.....

.....[2]

(ii) State one way in which nicotine in tobacco smoke affects arteries.

.....

.....[1]

(b) Arteries and capillaries have different structures related to their different functions.

For each type of blood vessel, give **one** structural feature and the function that it provides.

(i) artery:

structural feature .....

function .....

.....
[2]

(ii) capillary:

structural feature .....

function .....

.....
[2]

[Total: 7]

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Fig. 6.1 © BSIP VEM/SCIENCE PHOTO LIBRARY.

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