Cambridge International AS & A Level

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1000849265

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **October/November 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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Answer **all** questions.

1 Fig. 1.1 shows the human gas exchange system.

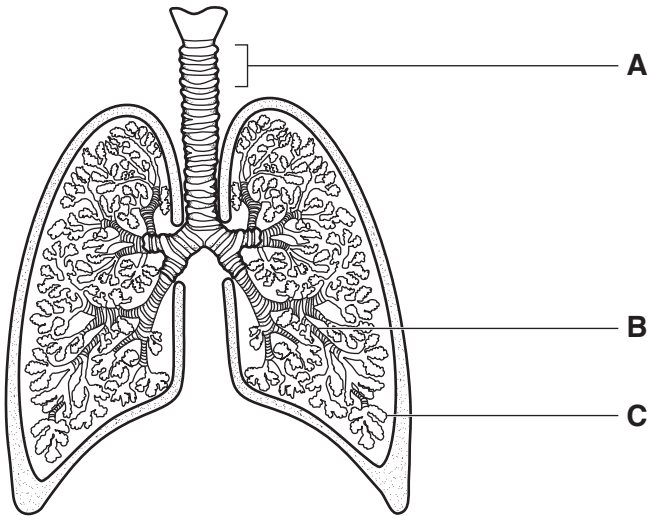


Fig. 1.1

(a) Name the structures labelled **A**, **B**, and **C** in Fig. 1.1.

A .....

B .....

C ..... [3]

(b) Name a **non-infectious** disease that affects the human gas exchange system.

..... [1]

(c) Malaria is an infectious disease.

Name the pathogen that causes malaria.

..... [1]

(d) There are a number of vaccines being developed to help control the spread of malaria.

Explain why vaccination programmes have **not** been able to eradicate malaria.

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..... [3]

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(e) Fig. 1.2 shows the distribution of malaria in the Americas in 2012.



Fig. 1.2

Suggest the factors, **other than** lack of vaccines, that could be restricting the distribution of malaria to area **P**.

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..... [4]

[Total: 12]

2 Fig. 2.1 shows the disaccharide lactose, which is found in milk.

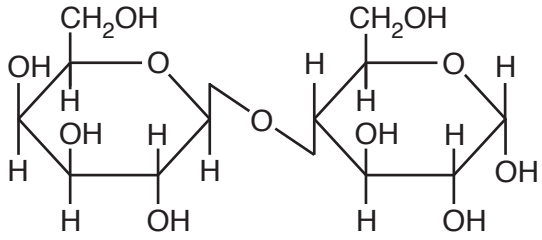


Fig. 2.1

(a) Name the type of bond that joins the two monosaccharides in lactose.

..... [1]

(b) The enzyme lactase catalyses the breakage of the bond between the two monosaccharides in lactose.

(i) Name the type of reaction that breaks this bond.

..... [1]

(ii) Some people do not produce the enzyme lactase, so cannot digest lactose.

The presence of lactose in the lumen of the intestine reduces the volume of water absorbed into the blood, resulting in diarrhoea.

Suggest why the presence of lactose in the intestine reduces the volume of water absorbed.

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..... [2]

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(c) Enzymes, such as lactase, are often immobilised for use in the food industry.

A scientist carried out an investigation to determine the effects of temperature on the activity of lactase when it was immobilised and when it was free in solution.

The scientist produced alginate beads containing lactase for use in this investigation. The beads varied in size. The scientist selected small beads for the investigation and put them into a glass column.

(i) Suggest the advantage of using small beads rather than large beads.

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..... [2]

(ii) Fig. 2.2 shows the results of the investigation to determine the effects of temperature on the activity of lactase when it was immobilised, **I**, and when it was free in solution, **F**.

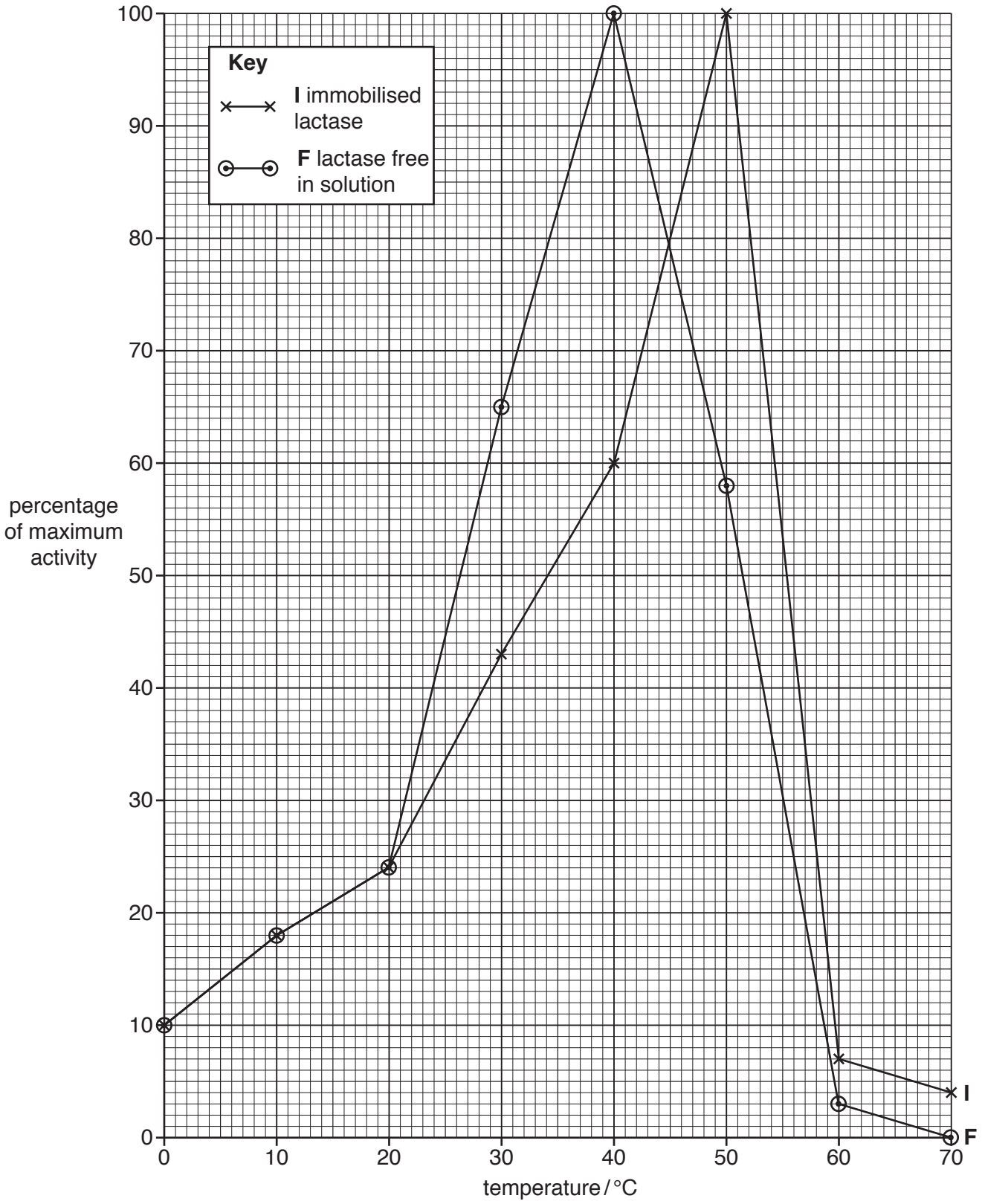


Fig. 2.2

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With reference to Fig. 2.2, compare the effect of temperature on the activity of immobilised lactase, **I**, and lactase free in solution, **F**.

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..... [3]

[Total: 9]

3 **(a)** Fig. 3.1 is a transmission electron micrograph showing two adjacent cells in a leaf.

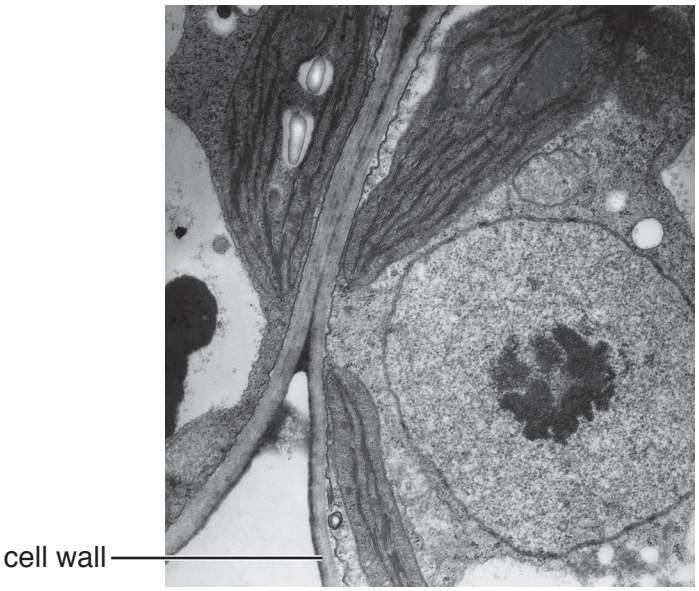


Fig. 3.1

(i) Cellulose is the main polysaccharide in cell walls of plants.

Describe the structure of cellulose.

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..... [3]

(ii) State **one** feature **visible** in Fig. 3.1, other than the cell wall, that identifies the cells as plant cells.

..... [1]

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(iii) Outline the role of ATP in a leaf cell.

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..... [3]

Water is a main component of plant cells.

(b) Fig. 3.2 shows two water molecules linked by a hydrogen bond.

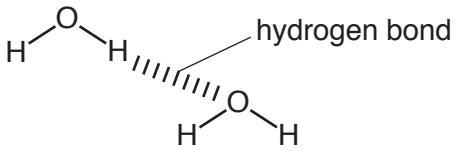


Fig. 3.2

Explain how hydrogen bonding occurs between water molecules.

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..... [2]

(c) Suggest why water is an excellent solvent for ions.

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..... [2]

[Total: 11]

4 Fig. 4.1 is a photomicrograph of a cross-section of a tubular structure in the kidney made from epithelial cells.

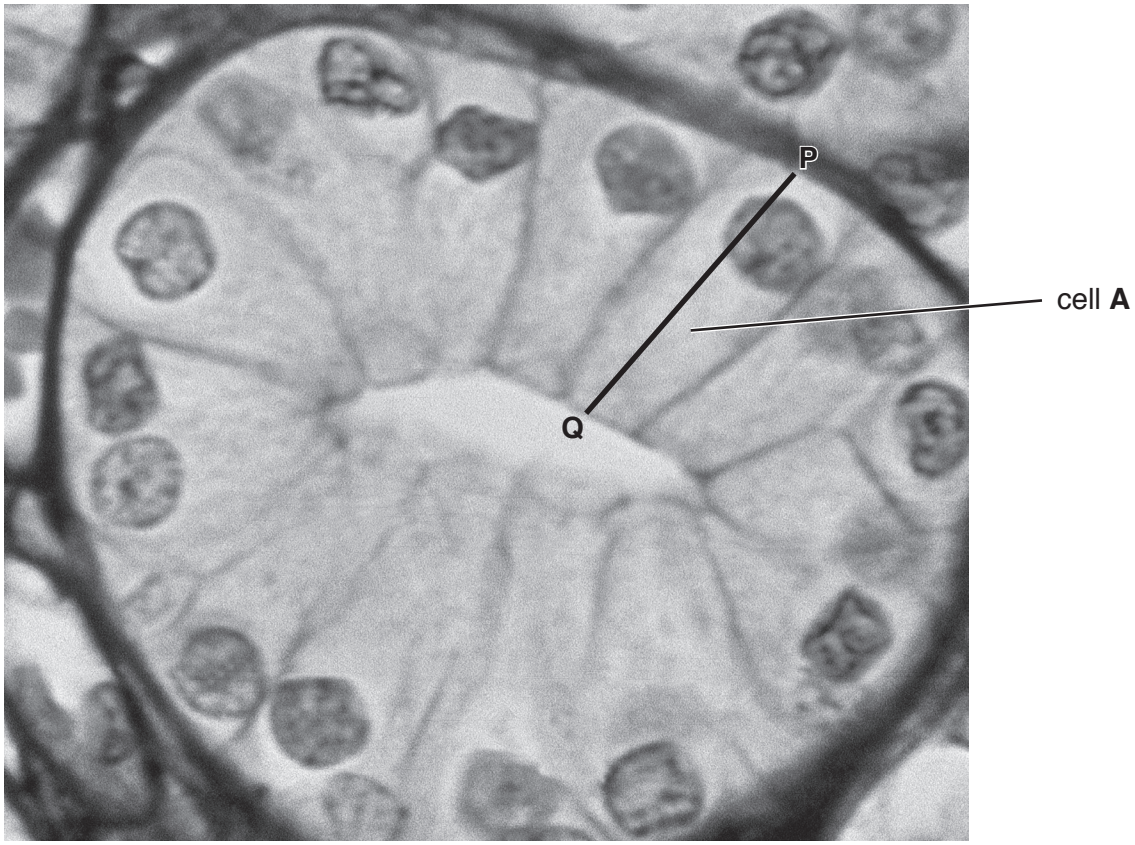


Fig. 4.1

(a) The actual length of epithelial cell **A** along the line **P**–**Q** is 35 μm.

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

formula

magnification × ..... [2]

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(b) Some epithelial cells in the kidney release the protein vascular endothelial growth factor (VEGF). This protein is a cell signalling molecule that stimulates cell division in endothelial cells in blood vessels.

(i) State what occurs during interphase to prepare a cell for division.

.....

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..... [2]

(ii) Explain how a cell signalling molecule, such as VEGF, can lead to a response in a cell.

.....

.....

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..... [2]

(c) Uncontrolled cell division may result in a tumour. Tumour cells in the kidney respond to VEGF.

Kidney cancer can be treated with monoclonal antibodies. These monoclonal antibodies bind to VEGF.

Outline the hybridoma method for the production of monoclonal antibodies that will target the VEGF protein.

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..... [4]

(d) Monoclonal antibodies used as a treatment need to be given more than once. Repeated treatment can cause side effects to the person or can become less effective.

Suggest why repeated treatment with monoclonal antibodies may have these effects.

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..... [1]

[Total: 11]

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[Turn over

5 **(a)** Fig. 5.1 shows the structure of a prokaryotic cell.

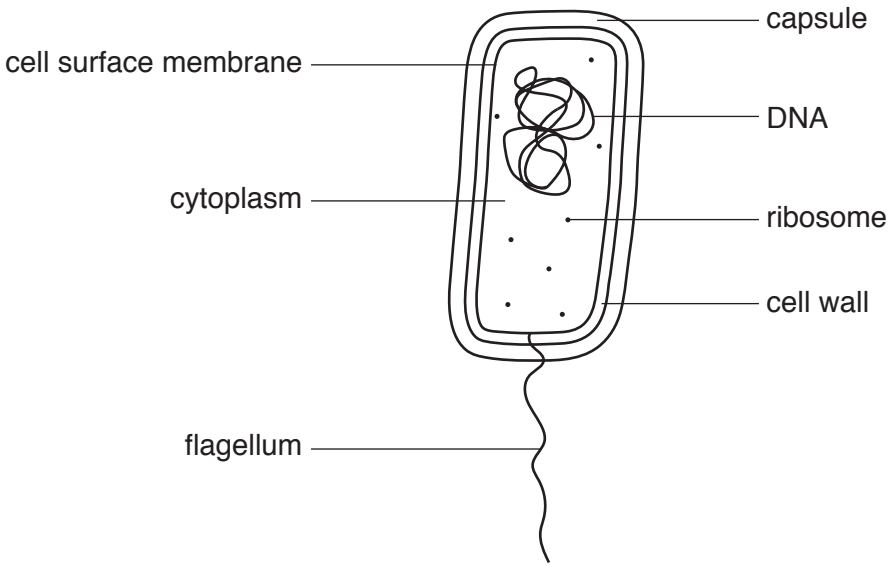


Fig. 5.1

Fig. 5.1 has **not** been fully labelled to confirm that the cell is prokaryotic.

State what **other** information could be added to **two** of the labels to confirm that this cell is prokaryotic and **not** eukaryotic.

.....

.....

..... [2]

(b) Some prokaryotes are plant pathogens.

Liberibacter is a group of prokaryotic plant pathogens that causes severe damage to a variety of plant crops across the world.

Scientists made observations about plants infected with these pathogens compared to uninfected plants:

- starch accumulates in the leaves
- starch does not accumulate in roots and other storage organs
- fruits are smaller
- the pathogen is widely distributed throughout the plant and is found in a number of different organs including the root and leaf.

The scientists deduced that the pathogen infected the phloem tissue.

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Suggest why the scientists were able to deduce that the pathogen infected the phloem tissue.

.....

.....

.....

.....

..... [2]

(c) DNA and RNA both contain nucleotides with adenine.

Complete Table 5.1 to compare:

- a DNA nucleotide with adenine
- an RNA nucleotide with adenine
- ATP.

Table 5.1

feature	DNA nucleotide with adenine	RNA nucleotide with adenine	ATP
contains nitrogen (yes or no)			
contains a pyrimidine base (yes or no)			
number of phosphate groups			
name of the sugar component			

[5]

[Total: 9]

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[Turn over

6 **(a)** Haemoglobin is a globular protein which is able to transport oxygen and is soluble in water.

(i) Explain how the structure of a haemoglobin molecule makes it able to transport oxygen efficiently.

.....

.....

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..... [3]

(ii) Explain how the structure of a haemoglobin molecule allows it to be soluble in water.

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..... [2]

(b) Llamas are mammals that are adapted to live at high altitudes.

Fig. 6.1 shows oxygen dissociation curves for haemoglobin of llamas and humans.

(i) The partial pressure of oxygen in the lungs of mammals at 3500 m is 6.4 kPa.

Use Fig. 6.1 to state the percentage saturation of haemoglobin of llamas and humans at an oxygen partial pressure of 6.4 kPa.

llamas ..... %

humans ..... % [1]

(ii) With reference to Fig. 6.1, explain the advantage to llamas of having an oxygen dissociation curve positioned to the left of the curve for humans.

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.....[2]

[Total: 8]

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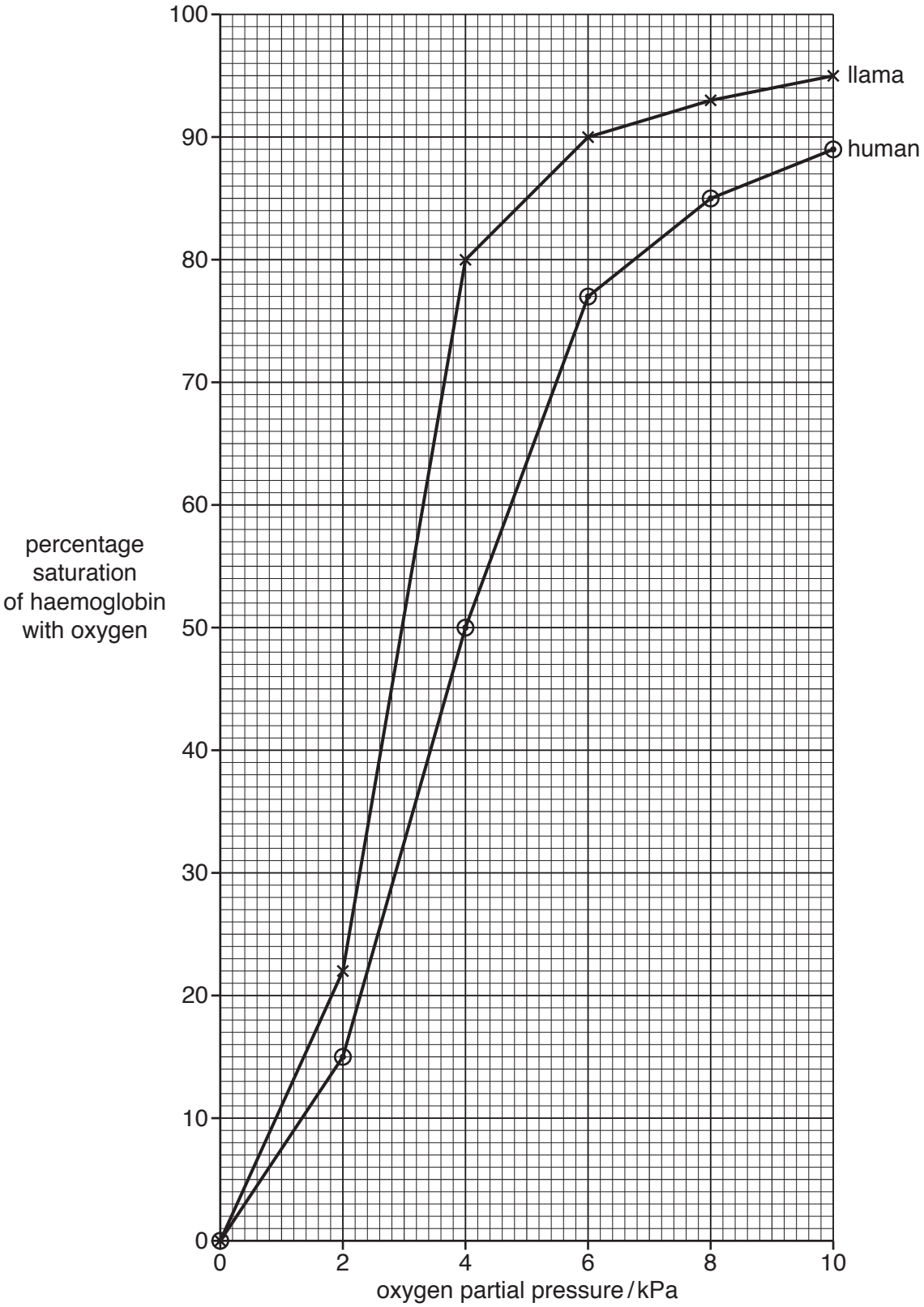


Fig. 6.1

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6170897587

BIOLOGY **9700/22**

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1 hour 15 minutes

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Answer **all** questions.

1 Fig. 1.1**A** is a photomicrograph of healthy lung tissue.

Fig. 1.1**B** is a photomicrograph of lung tissue from a person with emphysema, a chronic obstructive pulmonary disease (COPD). The images are both at magnification ×40.

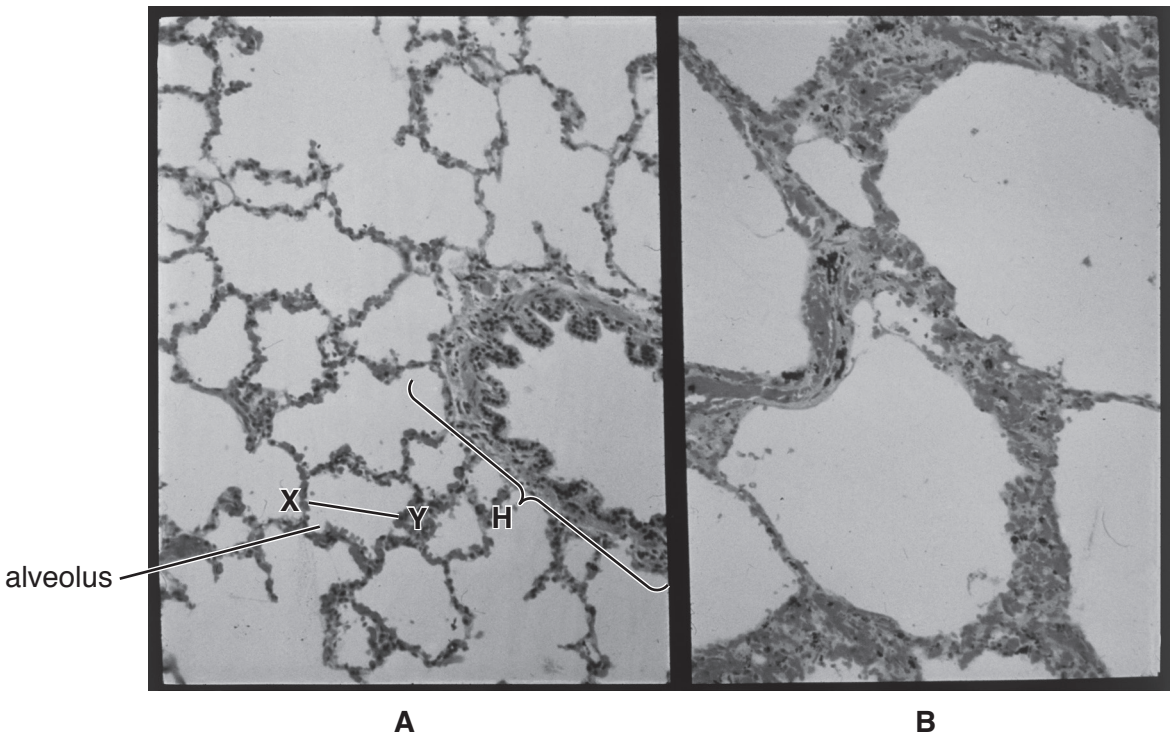


Fig. 1.1

(a) Name the structure labelled **H** in Fig. 1.1**A**.

..... [1]

(b) Calculate the actual diameter of the alveolus at **X**–**Y**.

Write down the formula and use it to make your calculation.

Give your answer to the nearest whole micrometre (μm).

formula

actual size ..... μm [2]

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(c) Gas exchange in the lungs occurs in the alveoli.

Describe the process of gas exchange in healthy lungs **and** suggest how this compares with gas exchange in the diseased lung shown in Fig. 1.1**B**.

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..... [4]

[Total: 7]

2 Woolly foxglove, *Digitalis lanata*, shown in Fig. 2.1**A**, and common oleander, *Nerium oleander*, shown in Fig. 2.1**B**, are plants grown for the attractive flowers that they produce.

Both plants are poisonous, as their leaves produce toxic organic compounds known as cardiac glycosides. Cardiac glycosides have a powerful effect on the action of cardiac muscle.



A



B

Fig. 2.1

(a) *N. oleander* is able to grow in very dry conditions. The leaves have adaptations to reduce water loss by transpiration.

State the term used to describe a plant, such as *N. oleander*, that has adaptations to allow it to grow in conditions where water is in short supply.

..... [1]

(b) Aphids are small insects that feed on plant fluids using piercing and sucking mouthparts. When aphids feed on the sap present in vascular tissue of leaves and stems, a sugary liquid called honeydew is passed out of the gut. The honeydew can be analysed to find out what is present in the sap.

(i) State the name of the vascular tissue from which the aphids feed.

..... [1]

(ii) An investigation found that aphids feeding on *D. lanata* produced honeydew containing cardiac glycosides.

Suggest why cardiac glycosides were present in the sap from the vascular tissue.

.....

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.....

.....

..... [2]

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Cardiac glycosides have an effect on the movement of ions into and out of cardiac muscle cells. The outcome is an increased ability for the cells to contract.

(c) Investigations into the action of the cardiac glycoside oleandrin, extracted from *N. oleander*, have shown that it acts to prevent the correct functioning of Na/K-ATPase, a membrane transport protein.

Na/K-ATPase has a role as an enzyme **and** as a transport molecule.

- ATPase is an enzyme that catalyses the hydrolysis of ATP to ADP and inorganic phosphate.
- Energy released from this hydrolysis is used to transport sodium ions (Na^+) out of cardiac muscle cells and potassium ions (K^+) into the cells.

(i) Explain what is meant by the *hydrolysis of ATP*.

.....

.....

..... [2]

(ii) Name the type of transport mechanism involved in the transport of Na^+ and K^+ across the cell surface membrane of cardiac muscle cells.

..... [1]

(iii) Oleandrin is a non-competitive reversible inhibitor of ATPase.

Describe the mode of action of oleandrin **and** explain how this will affect ion movement through Na/K-ATPase transport proteins of the cell surface membranes of cardiac muscle cells.

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..... [4]

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[Turn over

(d) Digoxin, a cardiac glycoside extracted from *D. lanata* leaves, can be purified and used as a drug to treat some heart disorders.

Examples of these heart disorders are:

- atrial fibrillation, where the normal rhythmic cardiac cycle is disrupted
- heart failure, where cardiac muscle is contracting weakly.

(i) Describe the **sequence** of events occurring in the left side of the heart during one **normal** cardiac cycle. Include reference to blood pressure changes.

The first event in the sequence is described for you.

The left atrium fills with blood during relaxation of the left atrium and left ventricle.

..... [4]

(ii) Suggest how the health of a person with heart failure can be improved by treatment with the drug digoxin.

..... [3]

[Total: 18]

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3 The response of the human body to tissue damage depends on the types of tissues involved. Epithelial tissue, liver tissue and cardiac muscle tissue each respond differently to damage.

- Epithelial tissue of the gas exchange system contains stem cells.
- Liver tissue contains cells in a non-dividing state that can enter a cell cycle when stimulated.
- Cardiac muscle tissue contains cells that cannot divide at all. Damage is permanent and is associated with scar tissue formation.

(a) Explain the importance of mitosis in the repair of damaged tissue.

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..... [2]

(b) Explain why stem cells are important in tissue repair.

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..... [2]

(c) Following liver tissue damage, chemicals are produced and released into the circulation. These chemicals are able to stimulate the liver cells to help tissue repair.

Explain how this is an example of cell signalling.

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.....

..... [3]

[Total: 7]

4 Viruses share common structural features. Some viruses, such as human immunodeficiency virus (HIV), also have an outer envelope as part of their structure.

(a) Outline the key structural features of viruses.

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..... [3]

HIV can remain in a dormant state within infected immune system cells for many years. A person diagnosed as HIV-positive (HIV+) has the virus but does not have symptoms of HIV/AIDS.

The chances of an HIV+ person developing HIV/AIDS can be greatly reduced with a drug treatment programme known as anti-retroviral therapy (ART).

(b) In 2010, the World Health Organization (WHO) published recommendations for the treatment of pregnant women living with HIV. This includes both HIV+ women and women who have developed HIV/AIDS.

The publication recommended that **all** pregnant and breastfeeding women living with HIV should be provided with ART.

Fig. 4.1 shows the number of pregnant women living with HIV, and the number of these receiving ART, between 2005 and 2013, in low and middle income countries.

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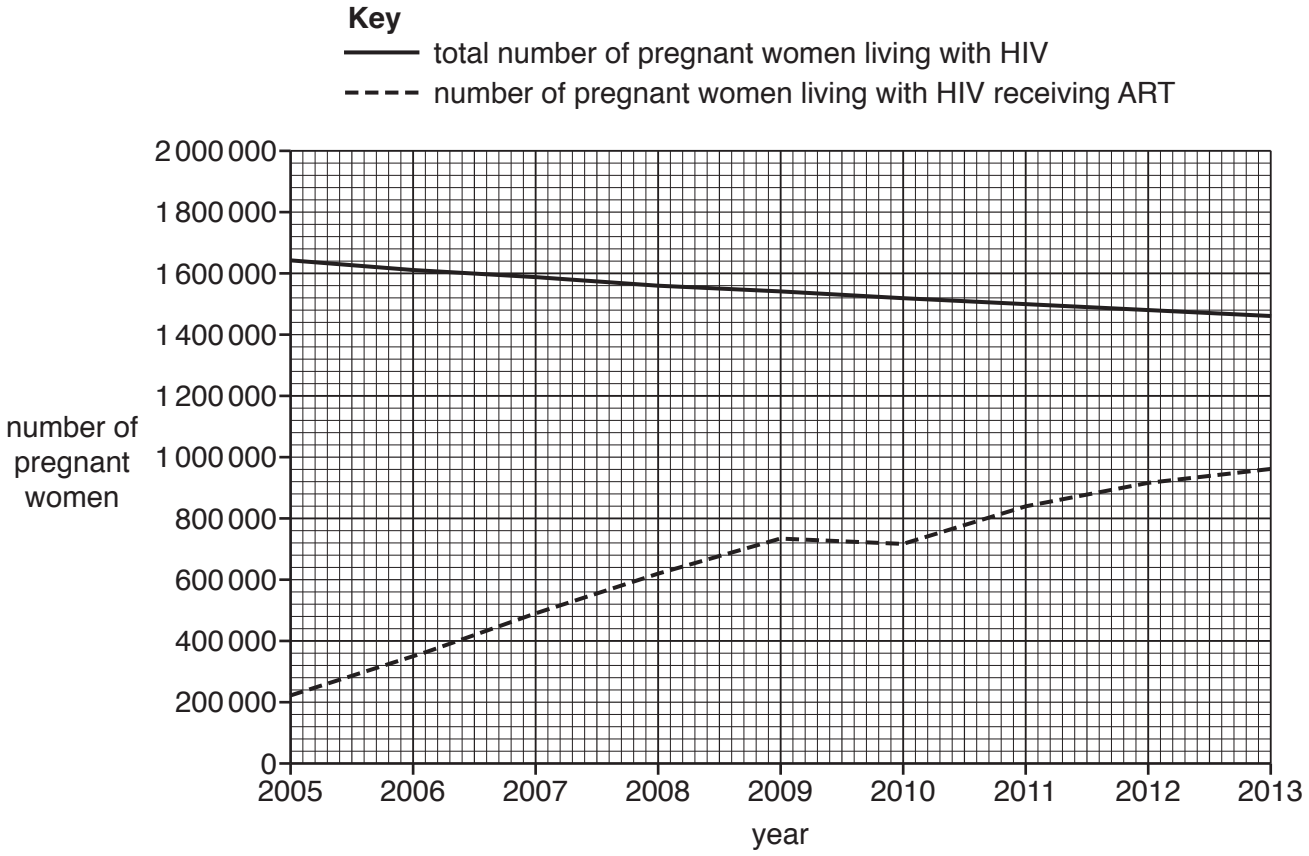


Fig. 4.1

(i) From the data in Fig. 4.1, it can be calculated that 13% of pregnant women living with HIV received ART in 2005.

Calculate the percentage of pregnant women living with HIV that received ART in 2013.

answer = ... % [1]

(ii) Describe the trends shown in Fig. 4.1.

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..... [3]

(iii) Suggest **and** explain the global importance of providing ART to all pregnant and breastfeeding women living with HIV.

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..... [3]

Question 4 continues on page 12

(c) In a person who has been infected with HIV-1, the most common strain of HIV, a sample of blood can be tested for the presence of the virus.
One test that can only be used in the early stages of infection involves a monoclonal antibody specific for p24, a structural protein present in the virus.

Fig. 4.2 is a flow chart outlining the steps in the production of anti-HIV p24 monoclonal antibody.

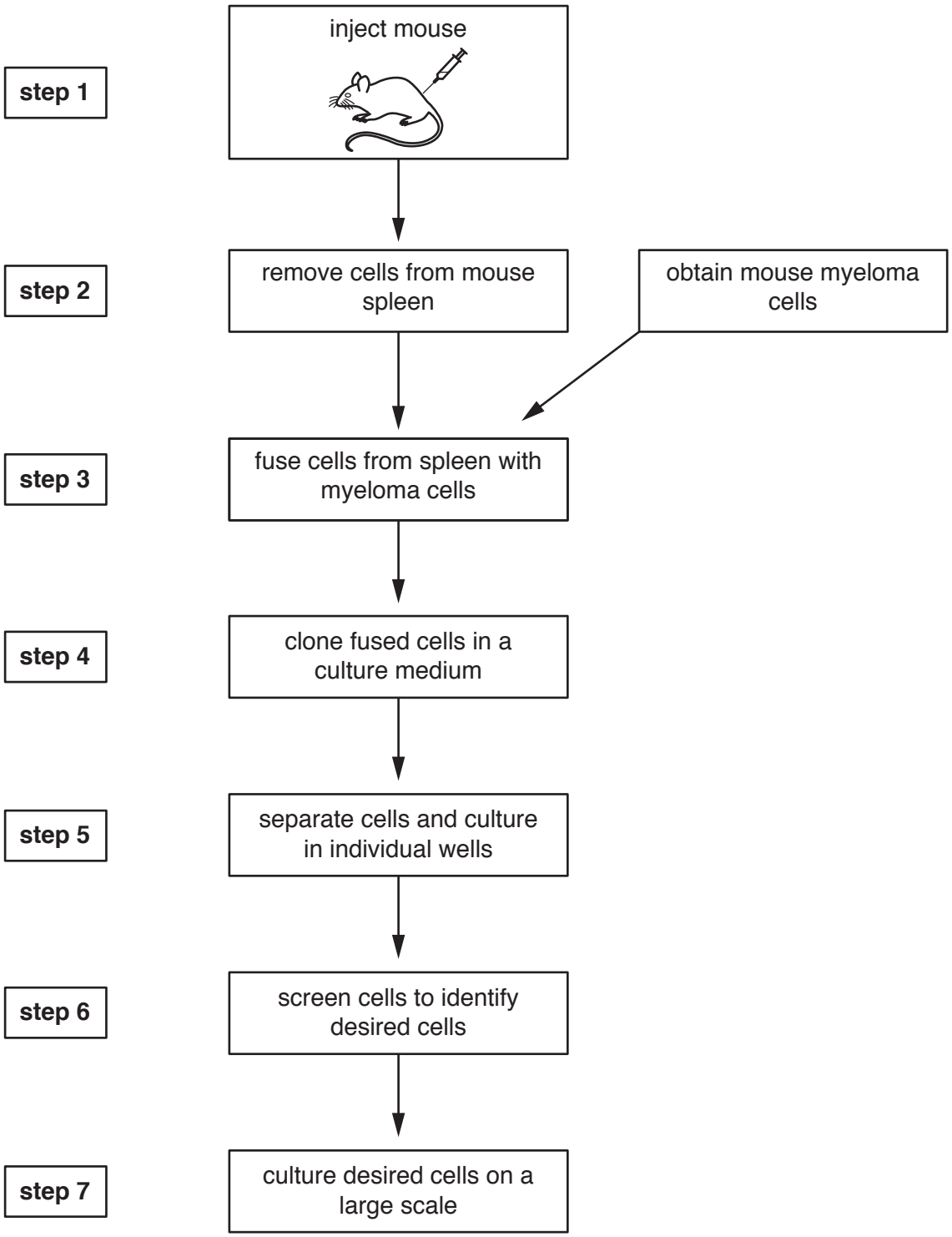


Fig. 4.2

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(i) State what is being injected into the mouse in **step 1**.

..... [1]

(ii) Explain why several weeks, rather than several days, separates **step 1** and **step 2**.

.....

.....

..... [1]

(iii) State **one** feature of the myeloma mouse cells, used in **step 3**, that is essential for this production process.

.....

.....

..... [1]

(iv) Name the fused cells formed in **step 4**.

..... [1]

(v) Suggest why **step 6** is necessary.

.....

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..... [1]

[Total: 15]

5 DNA and RNA are nucleic acids.

(a) Explain why RNA can be described as a polymer **and** as a macromolecule.

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..... [2]

(b) The sugar component of DNA is a reducing sugar.

Outline the test for reducing sugars **and** describe the observations for a positive result.

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..... [2]

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(c) Nucleotides are structural components of nucleic acids. Each nucleotide consists of a pentose sugar, a phosphate group and a nitrogenous organic base.

Complete Table 5.1 to compare DNA nucleotides with RNA nucleotides as structural components of nucleic acids.

Table 5.1

feature	DNA nucleotides	RNA nucleotides
pentose sugar component		
purine bases		
pyrimidine bases		

[3]

[Total: 7]

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[Turn over

6 As a red blood cell matures, cell organelles are lost from the cell. This provides more space for the haemoglobin molecules that have been synthesised.

(a) The red blood cell has a short lifespan due to the loss of the nucleus and other organelles.

State **one** function performed by each of the organelles listed, before they are lost from the developing red blood cell.

rough endoplasmic reticulum

.....

Golgi body

.....

centrioles

.....

[3]

(b) State the most appropriate term to match each of the descriptions **A** to **C**.

A The part of the haem group that binds oxygen in each haemoglobin polypeptide.

.....

B The compound formed when carbon dioxide binds to haemoglobin.

.....

C The compound formed when hydrogen ions (H^+) bind to haemoglobin.

.....

[3]

[Total: 6]

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3467159578

BIOLOGY **9700/23**

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Answer **all** questions.

1 **(a)** Aphids are small insects which feed directly on phloem sap.

The salivary glands of aphids have secretory cells that make and release a variety of proteins that assist in feeding.

Fig. 1.1 is a transmission electron micrograph of a small area of a salivary gland cell of an aphid.

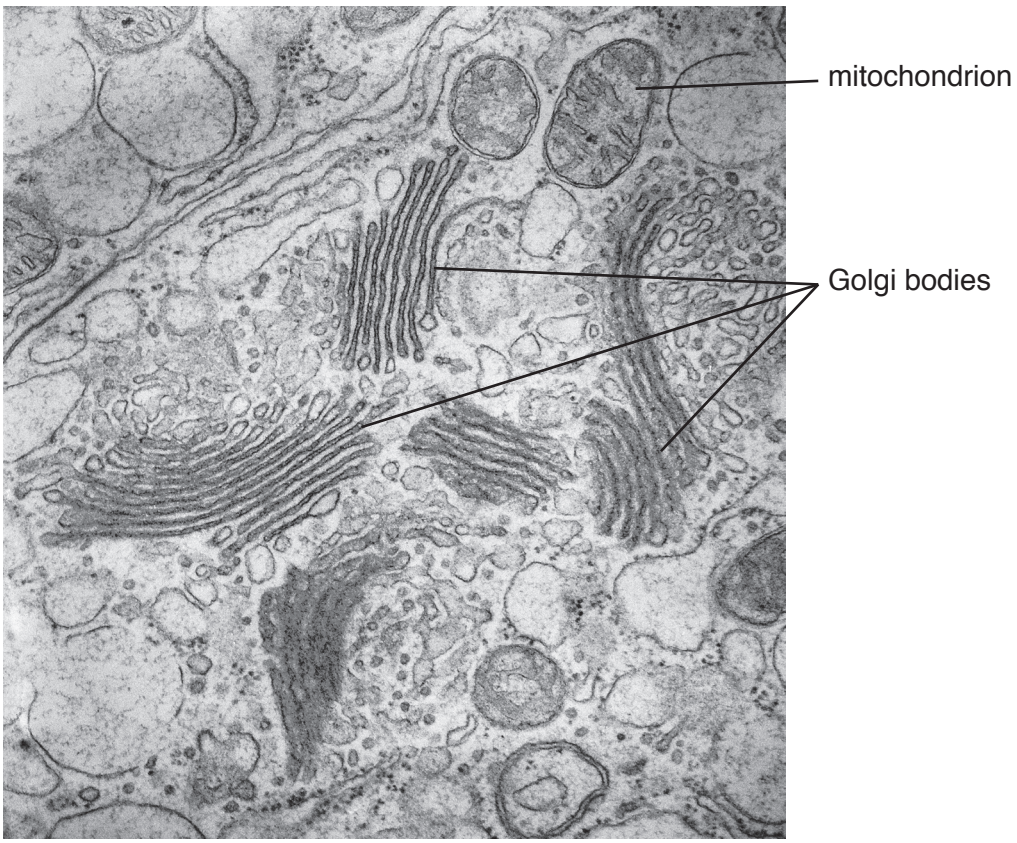


Fig. 1.1

Describe the role of Golgi bodies in secretory cells, such as the salivary gland cells of aphids.

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..... [3]

(b) (i) Explain why secretory cells have large numbers of mitochondria.

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..... [2]

(ii) Mitochondria are partly controlled by the nucleus, but can also function independently.

Suggest the features of mitochondria that allow them to function independently of the nucleus.

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.....

.....

.....

..... [2]

(c) Aphids are important vectors of plant viral diseases.

(i) Describe the structure of a typical virus.

.....

.....

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.....

.....

..... [3]

(ii) Suggest how viruses are able to pass from one plant cell to the next without crossing membranes.

.....

.....

..... [1]

[Total: 11]

2 **(a)** Proteins are macromolecules composed of many amino acids.

(i) Two amino acids are represented in the diagram in Fig. 2.1.

Complete the diagram to show how the two amino acids react together to form a dipeptide.

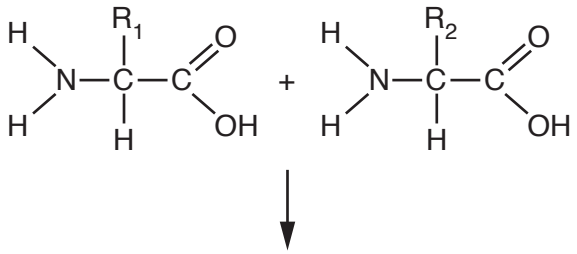


Fig. 2.1

[3]

(ii) State what is represented by R_1 and R_2 in Fig. 2.1.

.....

.....

.....

..... [2]

(b) Amylose and cellulose are polysaccharides.

Fig. 2.2 shows the structure of part of a cellulose molecule.

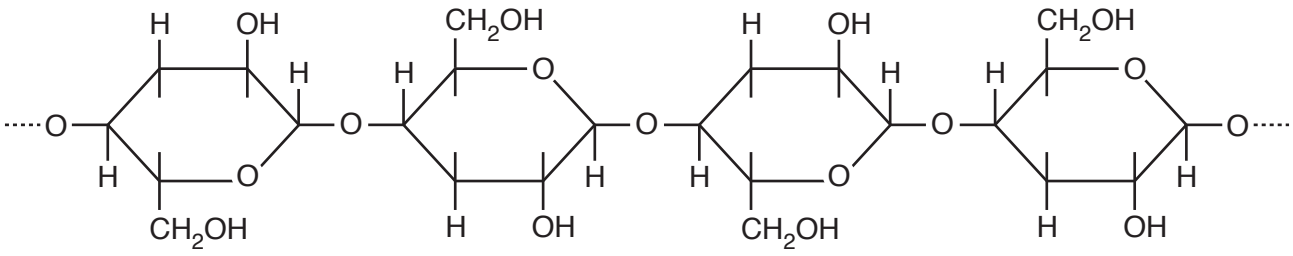


Fig. 2.2

With reference to Fig. 2.2, state how the **structure** of a cellulose molecule differs from the **structure** of an amylose molecule.

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..... [2]

(c) Cellulose is the main component of plant cell walls.

Explain why cellulose is suitable as a component of plant cell walls.

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..... [4]

[Total: 11]

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3 **(a)** Fig. 3.1 is a diagram of a monomer of the nucleic acid, messenger RNA.

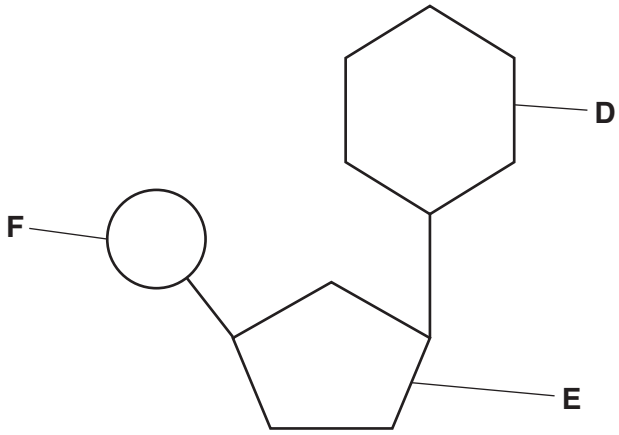


Fig. 3.1

(i) Name **D**, **E** and **F** in Fig. 3.1.

D .....

E .....

F .....

[3]

(ii) State **one** way in which the **structure** of DNA differs from the structure of messenger RNA.

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..... [1]

(b) Telomeres are repeating sequences of bases located at the ends of DNA molecules. These repeating sequences do not code for proteins.

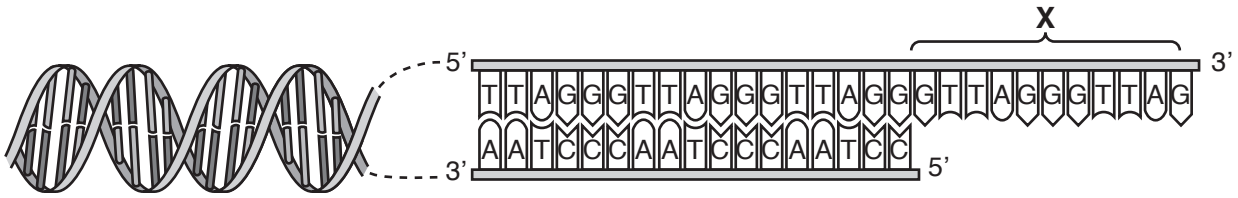
The enzyme telomerase ensures that telomeres do not shorten each time DNA is replicated.

Fig. 3.2**A** shows the end of a DNA molecule during replication. DNA polymerase cannot attach to the region labelled **X**, so it cannot complete the synthesis of the new strand without the action of telomerase.

Telomerase synthesises additional lengths of DNA that are added to the telomere. These additional lengths are used by DNA polymerase to complete the process of replication.

Fig. 3.2**B** is an enlarged view of region **X** to show the action of the enzyme telomerase.

A



B

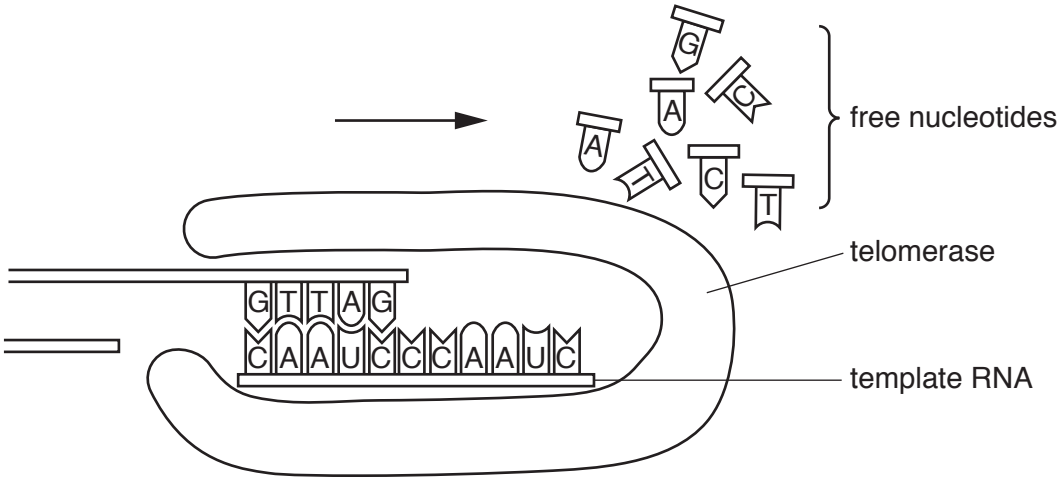


Fig. 3.2

Telomerase contains a short length of RNA that acts as a template for the synthesis of DNA as shown in Fig. 3.2**B**.

Explain how a molecule of telomerase synthesises additional lengths of DNA.

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..... [4]

(c) Telomerase is not present in prokaryotic cells.

Suggest why prokaryotes do not have telomerase.

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..... [1]

(d) One of the ways to diagnose lung cancer is to determine the concentration of telomerase in cells from the lining of the bronchus.

Explain why determining the activity of telomerase may be useful in the diagnosis of lung cancer.

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..... [2]

[Total: 11]

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4 **(a)** Describe the roles of the sinoatrial node (SAN) and the atrioventricular node (AVN) in the initiation and control of the cardiac cycle.

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..... [4]

(b) The Purkyne fibres pass down the septum and extend to the cardiac muscle at the base (apex) of the heart.

Explain why it is important that the Purkyne fibres extend to the base of the heart.

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..... [2]

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(c) The activity of the SAN is controlled by the nervous system. Noradrenaline is released by nerve cells in the SAN.

Fig. 4.1 shows the role of noradrenaline in causing calcium ions (Ca^{2+}) to enter a cell in the SAN.

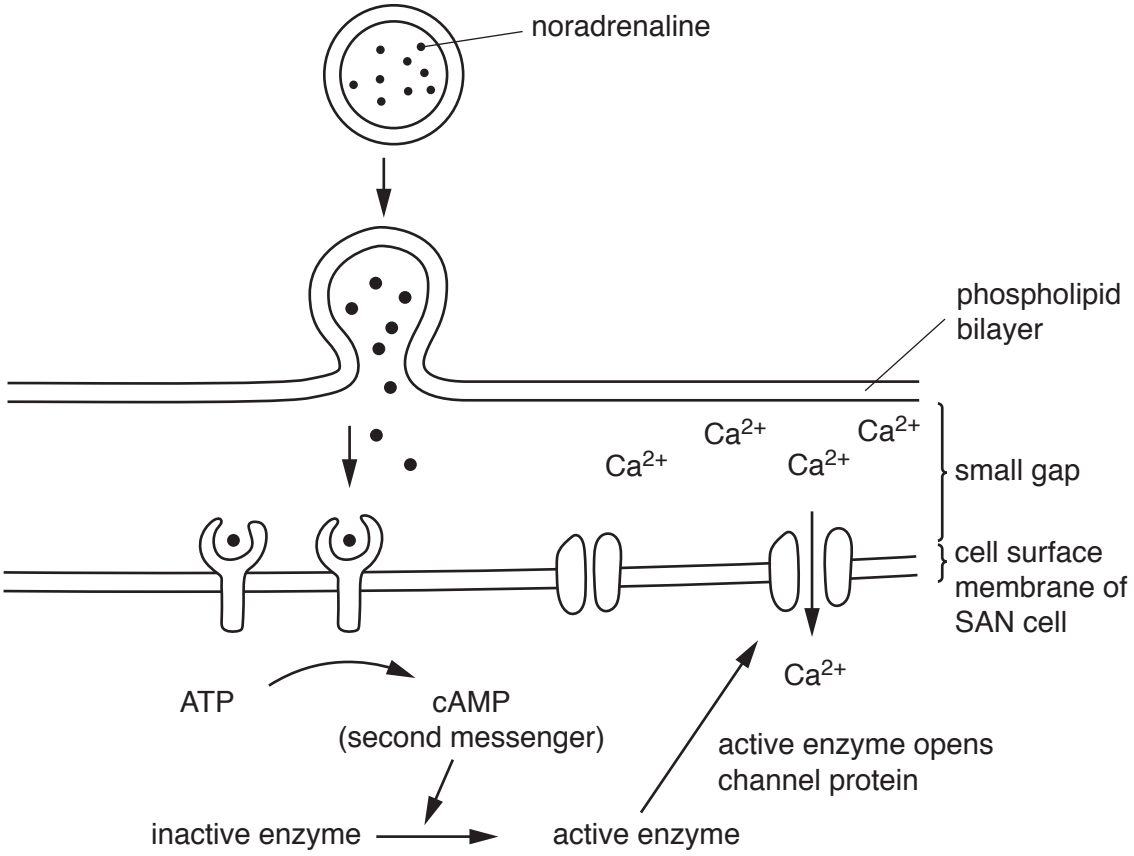


Fig. 4.1

With reference to Fig. 4.1, outline the process of cell signalling.

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..... [4]

[Total: 10]

5 The bacteria that cause tuberculosis (TB) can be found in many parts of the body including the lungs.

(a) (i) State the name of the bacterium that causes TB.

..... [1]

(ii) The presence of the pathogen in the lungs attracts phagocytes to the area of infection. The phagocytes release elastase, which digests elastin.

Many people with TB feel tired all the time.

Suggest **and** explain how the effect of phagocytes on tissues in the lungs leads to people feeling tired all the time.

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..... [3]

(b) Discuss the **biological** factors and **social** factors that make TB a difficult disease to control.

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..... [5]

[Total: 9]

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Question 6 starts on page 14

6 **(a)** As part of a study of the mitotic cell cycle, a student made stained sections of a root tip of onion, *Allium cepa*, and observed them with a light microscope.

The student made drawings of six of the cells, **A** to **F**, using the high power of the microscope, as shown in Fig. 6.1.

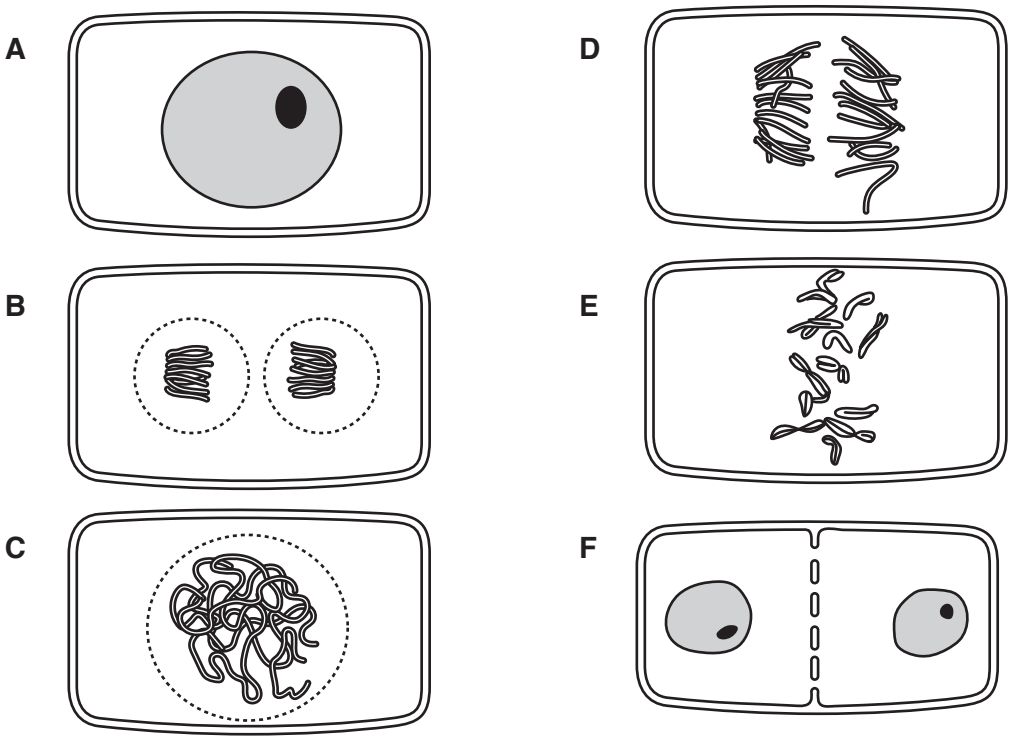


Fig. 6.1

(i) Complete Table 6.1 to show the sequence of stages in the mitotic cell cycle, using the letters, **A** to **F**, as shown in Fig. 6.1.

Table 6.1

sequence of stages	cell
1	**A**
2	
3	
4	
5	
6	

[1]

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(ii) Table 6.2 shows some events that occur during the mitotic cell cycle in *A. cepa*.

Complete Table 6.2 by naming the stage of the cell cycle when each event occurs.

Table 6.2

event in the cell cycle	name of the stage in the cell cycle
DNA replication	
division of centromeres	
condensation of chromatin	
contraction of spindle fibres	
organisation of chromosomes at the equator	metaphase

[4]

(b) Explain the importance of mitosis in the immune response.

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..... [3]

[Total: 8]

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