Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

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0414976389

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

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1 Scientists measured the concentration of sodium ions and potassium ions in the red blood cells and in the blood plasma of a group of people. The results are shown in Table 1.1.

Table 1.1

	mean concentration of sodium ions / mmol dm^{-3}	**mean concentration of potassium ions / mmol dm^{-3}**
red blood cells	10	100
blood plasma	100	4

(a) (i) Use the information in Table 1.1 to identify **and** describe the process by which potassium ions enter red blood cells from the blood plasma.

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..... [3]

(ii) Sodium ions and oxygen molecules enter red blood cells.

State **one** similarity and **one** difference between the processes used by sodium ions and oxygen molecules to enter red blood cells.

similarity .....

.....

.....

difference .....

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.....

[2]

(iii) Chloride ions move across the membrane of human red blood cells in a process called the chloride shift.

Explain why the chloride shift is important in the transport of carbon dioxide from respiring tissues.

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..... [2]

(b) Scientists studied the uptake of a substance, **F**, by human red blood cells.

The red blood cells were immersed in a solution of substance **F** for 30 minutes. After this time the scientists recorded two observations:

- the cell surface membrane of the red blood cells showed infoldings (invaginations)
- an increase in the number of vesicles in the cytoplasm.

Identify the process by which substance **F** entered the red blood cells.

..... [1]

[Total: 8]

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2 Fig. 2.1 is a transmission electron micrograph showing a section of a specialised epithelial cell found in the lining of the stomach. This cell produces extracellular proteins that are released into the bloodstream.

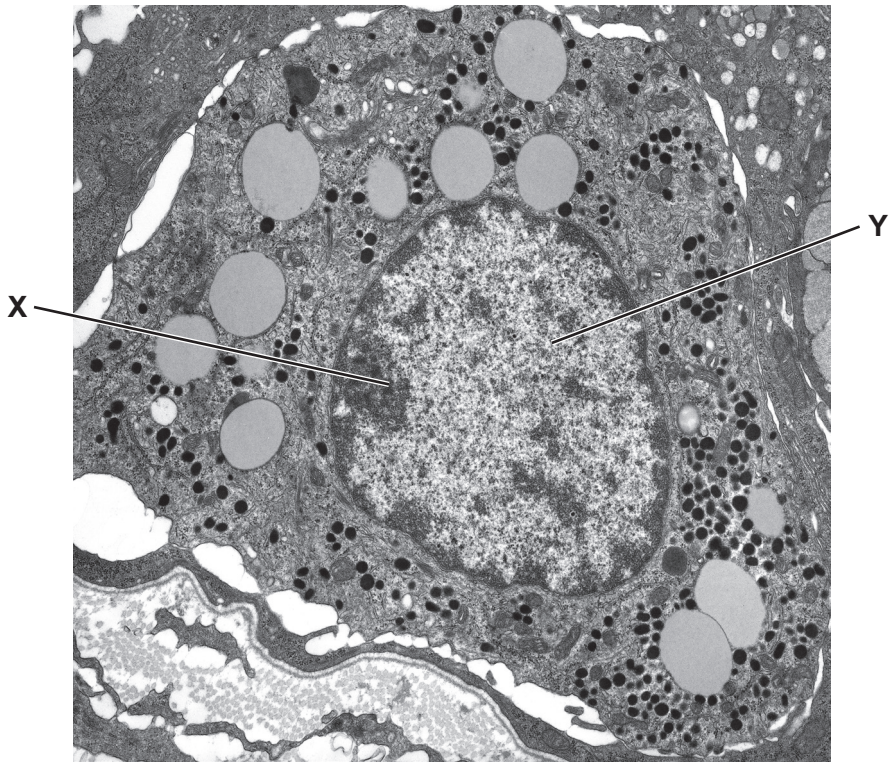


Fig. 2.1

(a) Outline the role of structure **X** and structure **Y**, as shown in Fig. 2.1, in the production of extracellular proteins.

structure **X** .....

.....

.....

structure **Y** .....

.....

.....

[2]

(b) The cell in Fig. 2.1 releases ghrelin, a small protein that acts as a cell signalling molecule.

Fig. 2.2 shows the sequence of amino acids in a ghrelin molecule.

The amino acid serine (Ser) in position 3 in Fig. 2.2 has been modified by the addition of a saturated fatty acid chain.

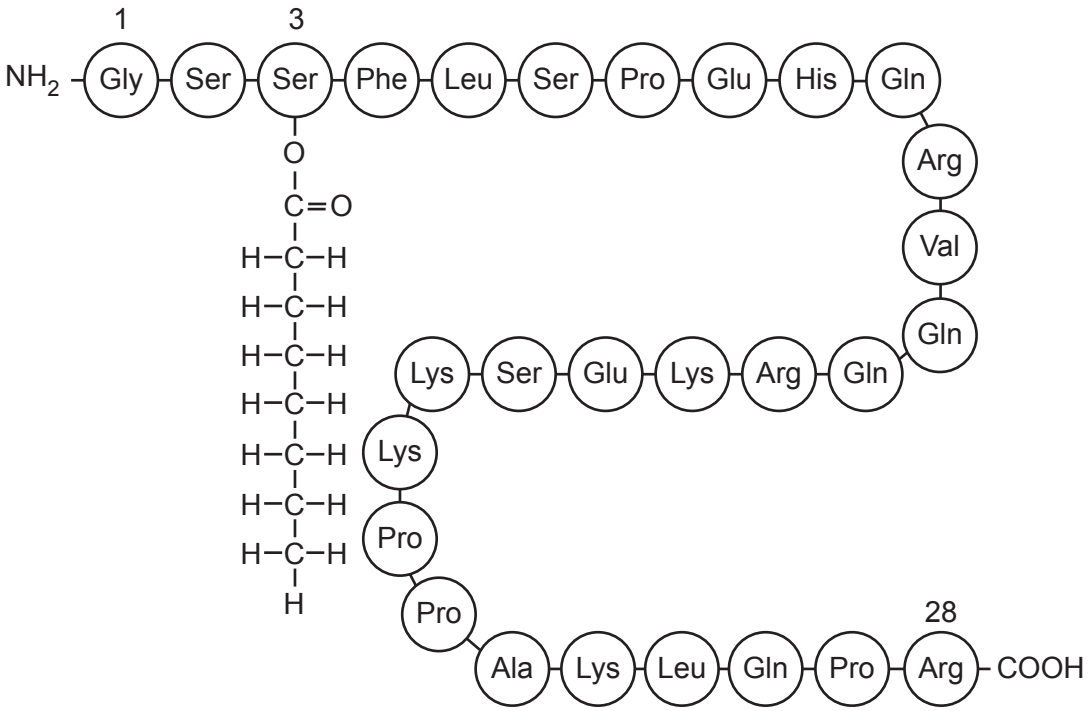


Fig. 2.2

(i) State the level of protein structure shown in Fig. 2.2.

..... [1]

(ii) State **one** similarity between the structure of a saturated fatty acid molecule and an amino acid molecule.

.....

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..... [1]

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(iii) The addition of the fatty acid chain allows ghrelin to function as a cell signalling molecule.

Suggest how the addition of this fatty acid chain allows a ghrelin molecule to act as a cell signalling molecule.

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..... [3]

(c) Scientists have discovered that the gene coding for ghrelin contains 5000 base pairs. This is a much larger number of base pairs than is needed to code for the ghrelin molecule shown in Fig. 2.2.

(i) Calculate the percentage of base pairs found in the gene that codes for the ghrelin molecule shown in Fig. 2.2.

Show your working and give your answer to one decimal place.

..... [2]

(ii) The primary transcript produced from the ghrelin gene is a longer molecule than the mRNA found in the cytoplasm.

Explain how the primary transcript is modified before translation.

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..... [2]

[Total: 11]

3 Plants have specialised cells for the efficient transport of assimilates.

(a) Table 3.1 shows some of the features of two different types of cell found in plant tissue, which are adapted for the efficient transport of assimilates.

Table 3.1

feature of cell	cell type A	cell type B
cytoplasm	✓	✓
nucleus	✗	✓
mitochondria	few	many
cellulose in the cell wall	✓	✓
ribosomes	✗	✓

Key
✓ present
✗ absent

Many plasmodesmata connect type **A** cells with type **B** cells.

Identify cell type **A and** explain why the plasmodesmata are important.

cell type **A** .....

explanation .....

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[3]

(b) The polysaccharide callose is found in the cell walls of cells close to plasmodesmata.

Fig. 3.1 is a simplified diagram showing the structure of callose. Not all hydrogen atoms are shown.

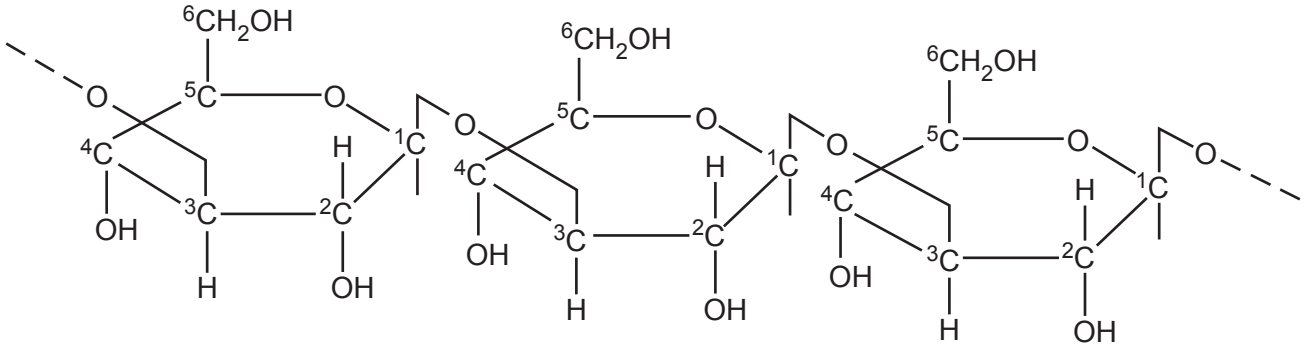


Fig. 3.1

Complete Table 3.2 to compare the structure of a callose molecule with a cellulose molecule.

Table 3.2

feature of polysaccharide	callose molecule	cellulose molecule
monosaccharide used to synthesise the polysaccharide	β-glucose	
bond connecting the monomers		1,4 glycosidic bond
shape of molecule	helix	
orientation of monosaccharides in the molecule		alternate glucose molecules are rotated by 180 °

[4]

(c) Hydrogen bonding is important for movement of water through xylem vessels in a plant.

Describe the roles of hydrogen bonding in the movement of water through xylem vessels.

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..... [3]

(d) Water that has travelled through xylem vessels reaches the leaves. Cooling of the leaf occurs as a result of the evaporation of water during transpiration.

Water has a high latent heat of vaporisation because water molecules form hydrogen bonds.

With reference to hydrogen bonding, suggest why cooling of the leaf occurs as a result of evaporation of water during transpiration.

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..... [2]

[Total: 12]

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Question 4 starts on page 12

4 Some people who are infected with HIV develop HIV/AIDS.

(a) Fig. 4.1 shows the number of people that have been newly infected with HIV (new infections) in 2018 across the world and the percentage changes in the number of new infections since 2010.

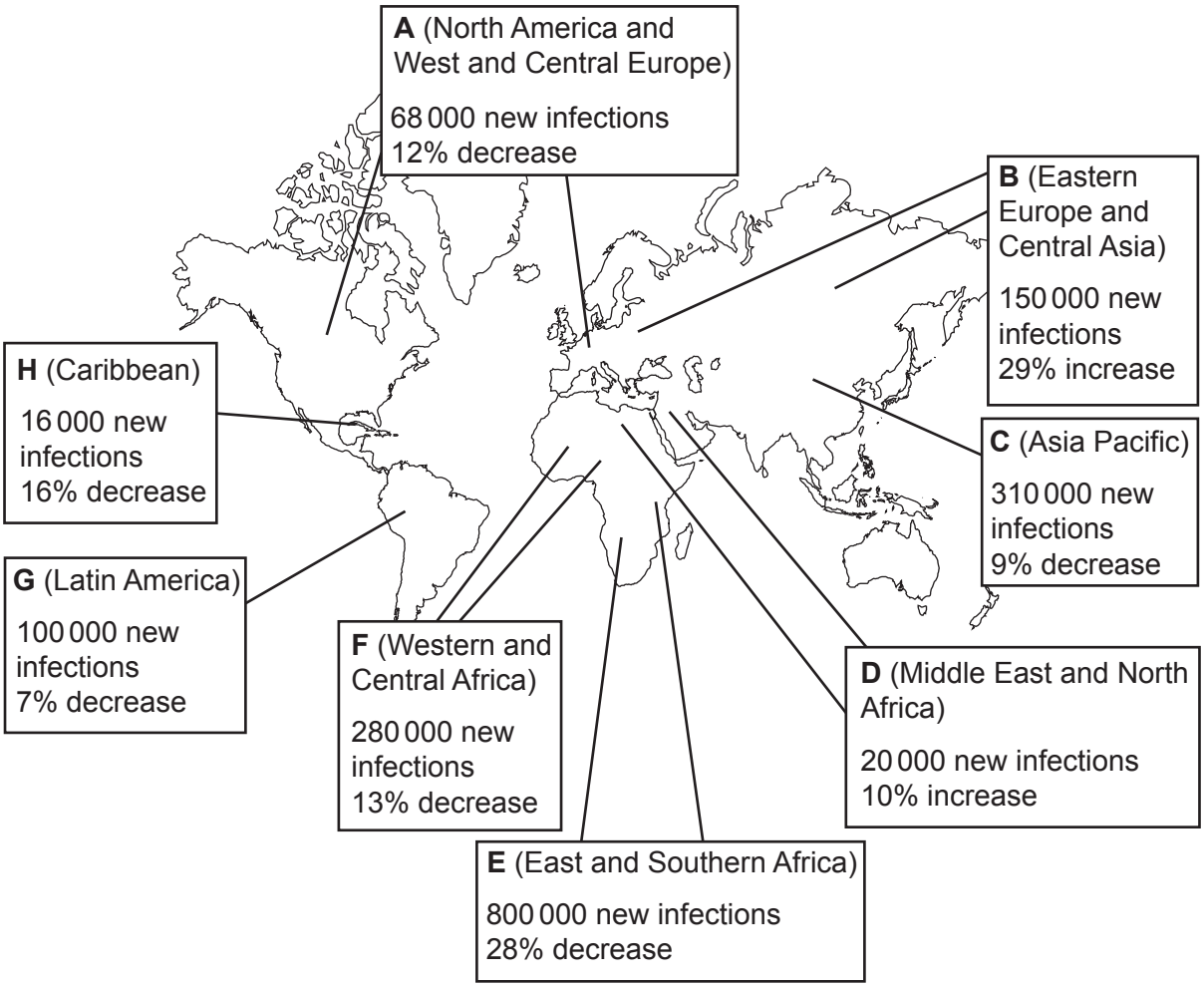


Fig. 4.1

(i) State the full name of the pathogen HIV.

..... [1]

(ii) Using **only** the data in Fig. 4.1, state what can be concluded about the change in number of new HIV infections across the world between 2010 and 2018.

You may use the letters in Fig. 4.1 to identify the regions of the world.

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..... [4]

(b) People who develop HIV/AIDS have fewer T-helper cells as the pathogen destroys these cells. This makes them more susceptible to tuberculosis (TB).

Explain why people with HIV/AIDS are more likely to develop TB.

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..... [4]

(c) A person infected with HIV may develop a heart condition called cardiac tamponade.

The pericardium is a thin sac surrounding the heart, as shown in the healthy heart in Fig. 4.2. When a person develops cardiac tamponade, the pericardium starts to fill with blood. This prevents the ventricles functioning efficiently.

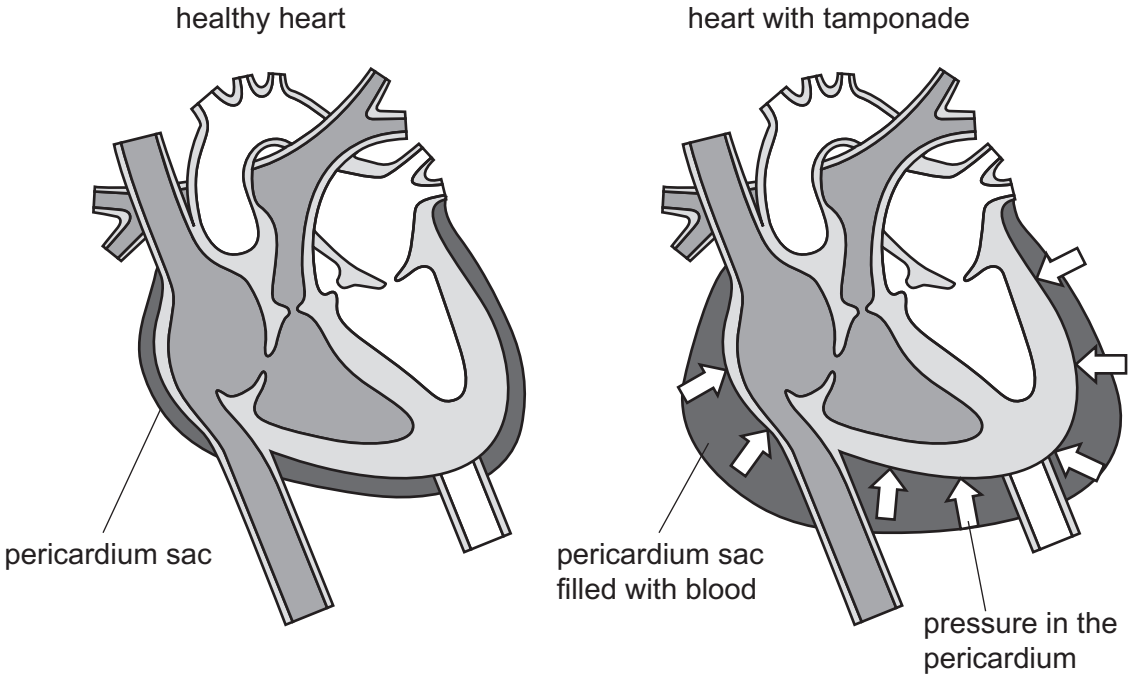


Fig. 4.2

People with cardiac tamponade experience a variety of symptoms including low blood pressure and an increased breathing rate.

Suggest why a person with cardiac tamponade would experience symptoms of low blood pressure and an increased breathing rate.

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..... [4]

[Total: 13]

5 Fig. 5.1 is a photomicrograph of a transverse section of a bronchus in the lungs.

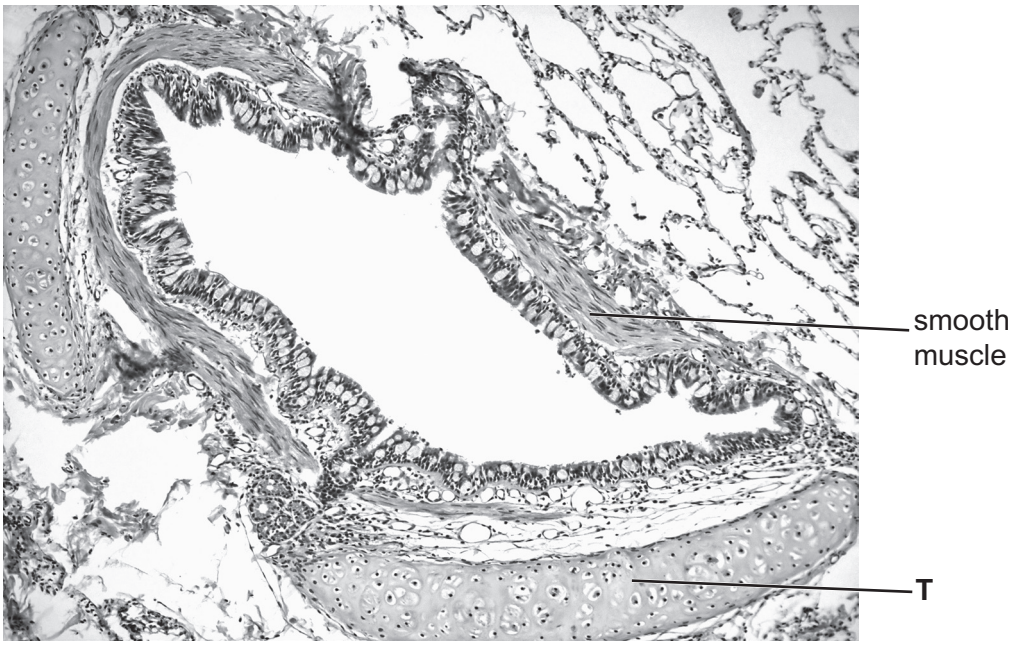


Fig. 5.1

(a) (i) Identify the tissue labelled **T** in Fig. 5.1.

..... [1]

(ii) Describe the function of smooth muscle in the bronchus.

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..... [2]

(b) The walls of alveoli contain some specialised epithelial cells called type II epithelial cells. These cells secrete surfactant. Surfactant helps to prevent the alveoli collapsing during breathing.

Surfactant contains phospholipid, cholesterol and protein.

The components of surfactant are synthesised in the rough endoplasmic reticulum and smooth endoplasmic reticulum and then passed to the Golgi body.

The surfactant that is produced is stored in secretory organelles called lamellar bodies.

The surfactant in the lamellar bodies is released onto the surface of the alveolar epithelium by exocytosis, as shown in Fig. 5.2.

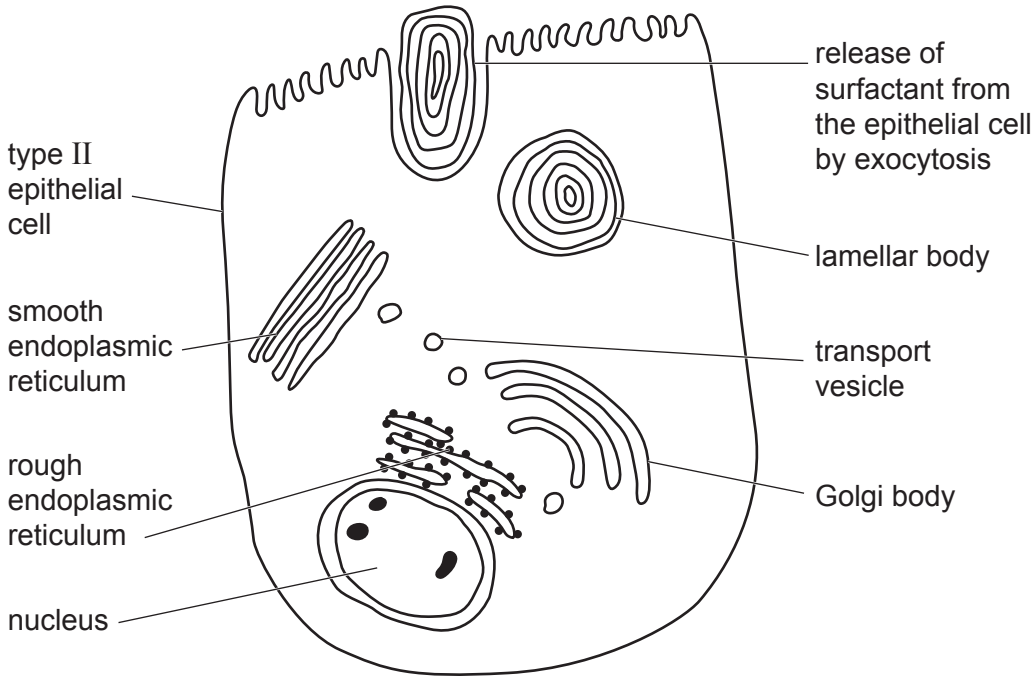


Fig. 5.2

(i) Each lamellar body is surrounded by a single membrane.

Draw a diagram to show the arrangement of phospholipid molecules in the membrane surrounding the lamellar body.

[2]

(ii) Scientists studying the production and secretion of lung surfactant have discovered that a reduction in cholesterol in the cell surface membrane of type II epithelial cells reduces the secretion of surfactant.

Suggest why secretion of surfactant is affected by a reduction in cholesterol in the cell surface membranes of type II epithelial cells.

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..... [2]

(iii) Lung surfactant is engulfed by macrophages that are in close contact with the type II epithelial cells.

Suggest why macrophages engulf surfactant.

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..... [1]

[Total: 8]

6 (a) (i) State the name of the phase of the mitotic cell cycle during which DNA replication occurs.

..... [1]

(ii) During research, scientists can use modified nucleotides to prevent elongation of a polynucleotide chain during DNA replication.

Fig. 6.1 shows the structure of a DNA nucleotide found in the nucleus of a cell.

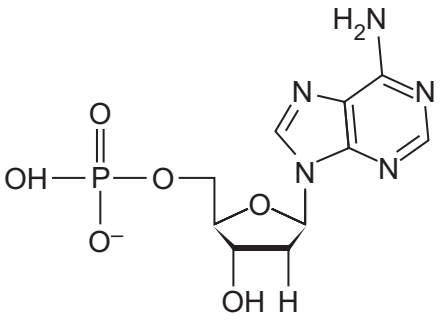


Fig. 6.1

Fig. 6.2 shows the structure of a modified nucleotide.

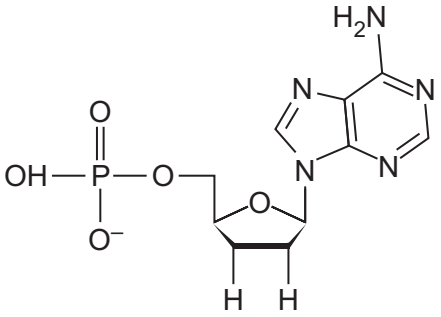


Fig. 6.2

Suggest how the structure of the modified nucleotide prevents DNA polymerase joining it to another nucleotide.

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..... [2]

(b) RNA aptamers are short, single-stranded RNA molecules that can be used to study some infectious diseases.

Scientists studying an infectious disease in animals investigated the effect of RNA aptamers on the activity of RNA polymerase that is produced by the pathogen.

The aptamers bind to a specific region of the RNA polymerase.

Table 6.1 shows the effect of two aptamers, F47 and F52, on the activity of RNA polymerase produced by the pathogen.

Table 6.1

aptamer present	V_{max} of RNA polymerase / arbitrary units	K_m of RNA polymerase / arbitrary units
none	1664	346
F47	1072	508
F52	1467	523

(i) With reference to Table 6.1, compare the effect of the aptamers on the affinity of RNA polymerase for its substrate.

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..... [2]

(ii) With reference to Table 6.1, suggest explanations for the effect of the presence of an aptamer on the rate of transcription catalysed by the RNA polymerase.

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..... [3]

[Total: 8]

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BIOLOGY **9700/22**

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1 hour 15 minutes

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INFORMATION

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1 During interphase and mitosis of the cell cycle, the chromosomes within a cell go through a number of changes. Each chromosome is composed of DNA complexed with proteins.

(a) In interphase, individual chromosomes are too diffuse (long and thin) to be visible using a microscope. In this stage, the chromosomal material is known as chromatin.

State the term used to describe the proteins that are complexed with DNA and form part of chromatin.

..... [1]

(b) When viewed through a microscope, a chromosome is most clearly visible during the metaphase stage of mitosis.

Complete Fig. 1.1 to produce a labelled diagram of the metaphase stage of mitosis in an **animal** cell with **two** chromosomes.

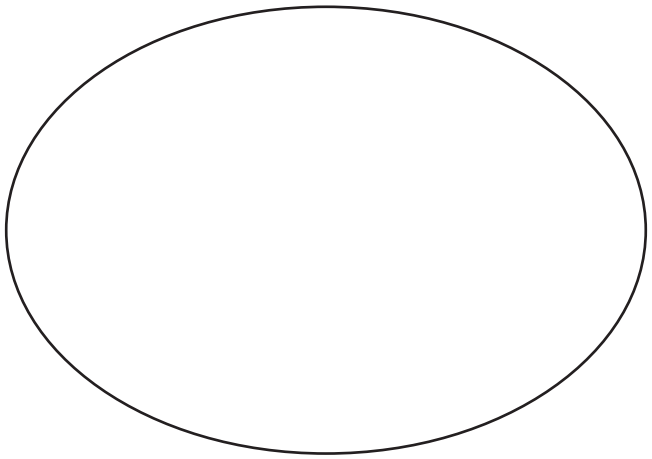


Fig. 1.1

[3]

(c) Outline the changes that occur to the structure and behaviour of a chromosome:

- from the start of the S phase to the end of interphase
- during prophase of mitosis.

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..... [3]

[Total: 7]

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2 Keratin is the structural protein in feathers of birds. Keratin polypeptides are composed of a high proportion of cysteine amino acids, which have sulfur-containing R groups.

Keratin polypeptides form filaments. The two main types of keratin in feathers are α-keratin, which consists of many α-helices, and β-keratin, consisting of many β-pleated sheets.

(a) Keratin can be classified as α-keratin or β-keratin based on a study of protein structure.

Suggest the level of protein structure used to classify a protein as α-keratin or β-keratin.

..... [1]

(b) Protease enzymes hydrolyse proteins. Many proteases are able to hydrolyse more than one type of protein.

Suggest why it is possible for a protease to act on different types of protein.

.....

.....

..... [1]

(c) Proteases known as keratinases vary in the extent to which they can hydrolyse keratin.

Feathers are not easily degraded (broken down) because keratin is a very stable protein.

Suggest features of keratin structure that contribute to its stability.

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..... [3]

Keratinases are used to degrade the large quantities of waste feathers from chickens and turkeys that are processed in the food industry. The products of feather degradation can be used in animal feed.

Scientists investigated whether three different keratinases, K12, A22 and P3, were suitable as industrial enzymes. These enzymes were extracted from three different soil bacteria.

The effects of temperature and pH on the activity of each keratinase were investigated.

The results are shown in Fig. 2.1 and Fig. 2.2.

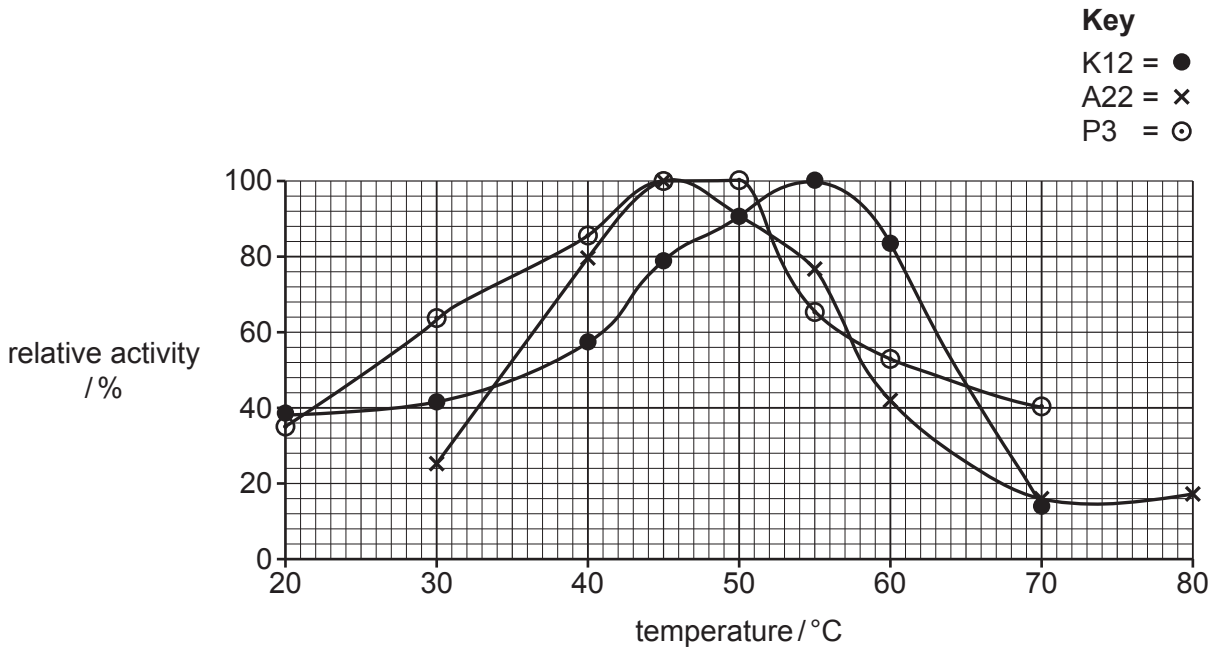


Fig. 2.1

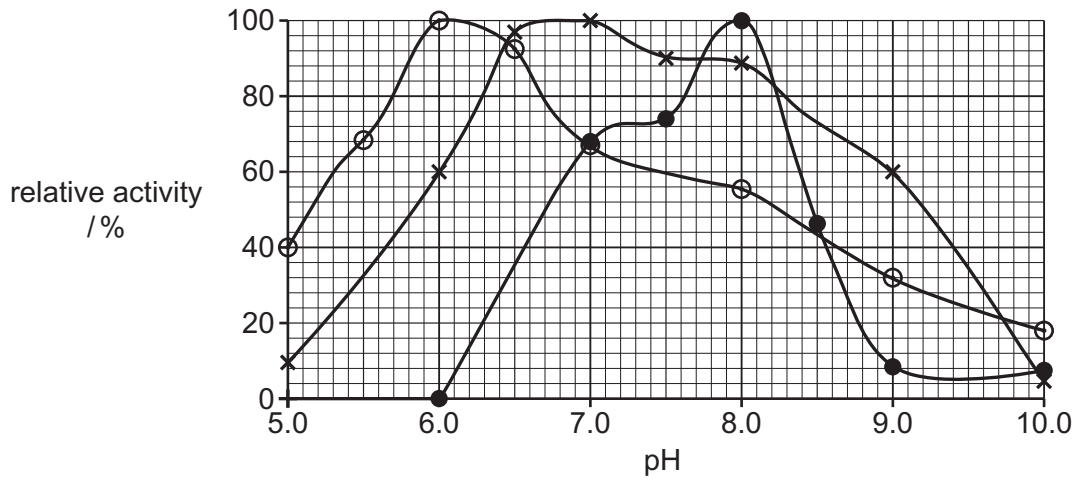


Fig. 2.2

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(d) To degrade feather waste from industry, it is an advantage to use keratinases that show at least 60% relative activity in conditions where temperature and pH can vary widely.

Table 2.1 shows, for each keratinase, the working range of temperature and pH where at least 60% relative activity is obtained.

Use Fig. 2.1 and Fig. 2.2 to complete Table 2.1 **and** use the completed table to:

- name the keratinase that has the widest working range of temperature
- name the keratinase that has the widest working range of pH.

Table 2.1

keratinase	temperature range with at least 60% relative activity / °C	pH range with at least 60% relative activity
K12	41–63	
A22		6.0–9.0
P3	29–56	5.3–7.5

Keratinase with a relative activity of at least 60% that has:

- the widest working range of temperature .....
- the widest working range of pH .....

[4]

(e) Some detergents contain proteases to remove stains from clothes. These enzymes have a high relative activity in alkaline conditions.

The scientists reported that K12 and A22 could be suitable for use in the detergent industry.

With reference to Fig. 2.1 and Fig. 2.2, discuss the advantages **and** disadvantages of using K12 and A22 in the detergent industry.

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..... [3]

[Total: 12]

3 The liver receives blood from the hepatic artery and from the hepatic portal vein. The hepatic portal vein transports blood from the digestive system.

Hepatocytes are the main cell type of the liver. They have a wide range of functions, including:

- the synthesis of triglycerides and plasma proteins
- detoxifying waste
- energy storage.

(a) The hepatic artery branches from the main artery that transports blood from the heart.

Name the main artery that transports blood to the hepatic artery.

..... [1]

(b) Blood arriving at the liver enters specialised blood vessels known as sinusoids.

Fig. 3.1 is a diagram of part of a sinusoid and surrounding hepatocytes. A second type of cell found in the liver, a Kupffer cell, is also shown.

Kupffer cells are phagocytic cells of the immune system.

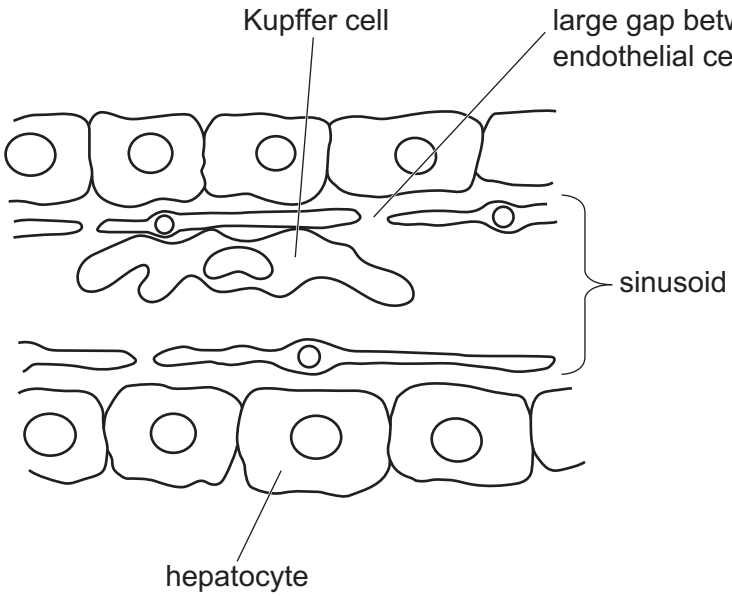


Fig. 3.1

(i) Suggest **one** advantage of having large gaps between the endothelial cells of the sinusoid, as shown in Fig. 3.1.

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..... [1]

(ii) In addition to removing bacteria present in the blood inside the sinusoid, Kupffer cells are also able to remove old or damaged red blood cells.

Describe the mode of action of a Kupffer cell in removing and breaking down a damaged red blood cell.

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..... [4]

(c) Fig. 3.2 is a transmission electron micrograph of part of a hepatocyte showing some cell structures.

The peroxisome shown in Fig. 3.2 is a spherical organelle bound by a single membrane. It carries out a variety of enzyme-catalysed metabolic reactions, including detoxification. Some of these reactions require oxygen.

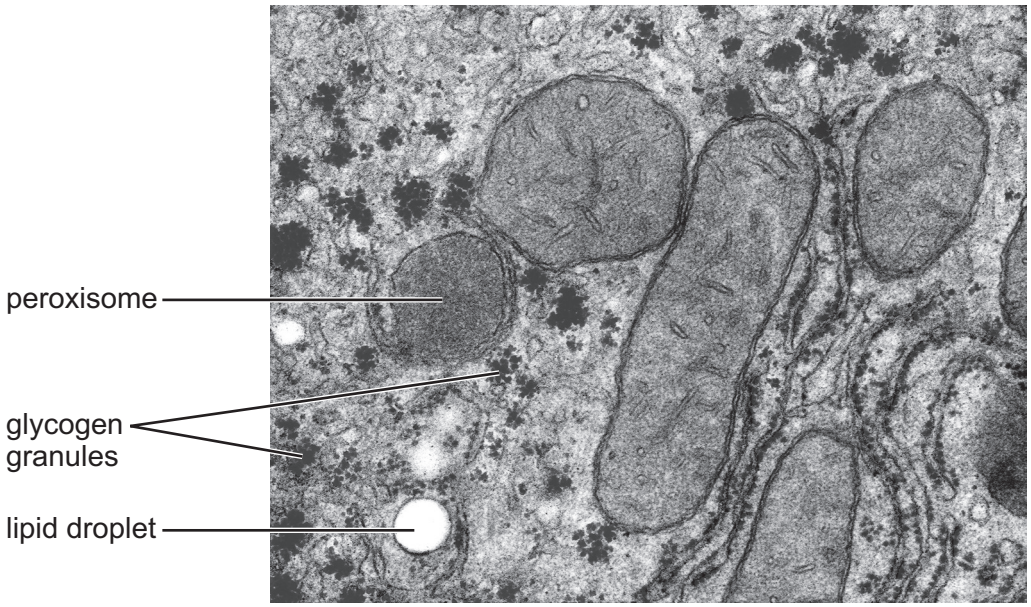


Fig. 3.2

(i) Describe the evidence **visible** in Fig. 3.2, apart from the presence of a peroxisome, that indicates some of the functions of a hepatocyte.

Add labels to Fig. 3.2 to identify the location of any cell structures, if not already labelled, that are part of your evidence.

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..... [3]

(ii) The mitochondria in Fig. 3.2 are larger than the peroxisome.

State **one other** difference, **visible** in Fig. 3.2, between a peroxisome and a mitochondrion.

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..... [1]

(iii) Some of the enzymes used within mitochondria can be synthesised by the organelle. Peroxisomes cannot synthesise any of the enzymes that they contain.

Suggest why a mitochondrion can synthesise enzymes, but a peroxisome cannot synthesise enzymes.

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..... [2]

(iv) One of the enzymes present in peroxisomes is catalase. This enzyme catalyses the breakdown of hydrogen peroxide to harmless products.

Suggest why it is useful to the cell for this reaction to take place within peroxisomes.

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..... [2]

[Total: 14]

4 The alveoli of the lungs are the main gas exchange surface in humans.

(a) Explain how blood flow through the alveolar capillaries helps to maintain steep diffusion gradients for gas exchange.

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..... [2]

(b) Ventilation of the lungs is the process of inhalation and exhalation. Ventilation helps to maintain steep diffusion gradients.

Explain the role of elastic fibres in the alveolar wall during ventilation.

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..... [2]

(c) Some cells in the alveolar wall are specialised to secrete surfactant to prevent collapse of the alveoli at the end of exhalation. In these cells, surfactant is stored in membrane-bound organelles known as lamellar bodies. Surfactant is a mixture of lipids, mainly phospholipids, and some proteins.

A protein known as ATP-binding cassette transporter A3 (ABCA3) is needed to move surfactant phospholipids into lamellar bodies from the surrounding cytosol (fluid part of cytoplasm).

Suggest **and** explain the features of protein ABCA3 that make it suited to its function.

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..... [3]

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(d) The gene *ABCA3* codes for protein ABCA3. The gene is 80 kb (80 000 base pairs) long and is composed of introns and exons. Protein ABCA3 is composed of 1704 amino acids.

(i) Fig. 4.1 shows the flow of genetic information in the production of ABCA3.

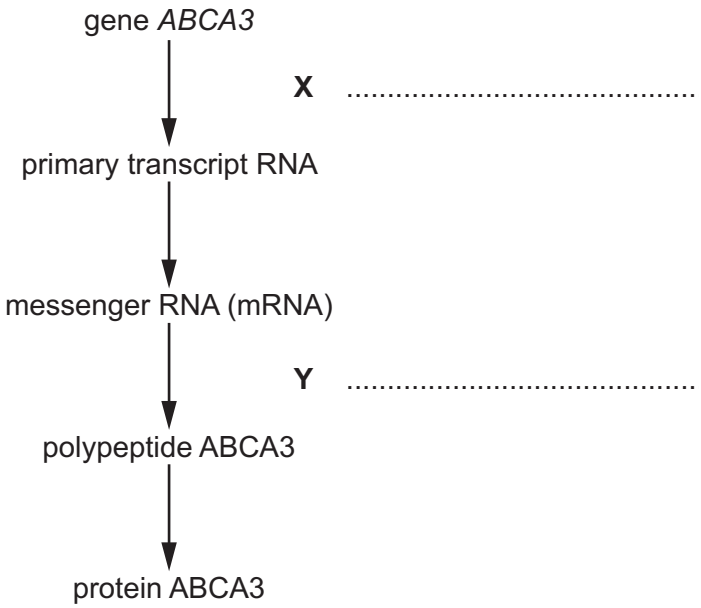


Fig. 4.1

Complete Fig. 4.1 to name the processes occurring at **X** and **Y**. [2]

(ii) A triplet of bases codes for one amino acid. This fact only partly explains how the activity of gene *ABCA3*, which is 80 kb long, can result in the protein ABCA3, which is only 1704 amino acids long.

Suggest **other** reasons to explain the difference in the number of base pairs in gene *ABCA3* compared with the number of amino acids in protein ABCA3.

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..... [3]

[Total: 12]

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5 Tuberculosis (TB) is an infectious disease caused by a bacterium. In the majority of people, only the lungs are affected.

In most cases, the transmission of TB from an infected person to an uninfected person involves *Mycobacterium tuberculosis*. A different species of bacterium is involved in the transmission of TB from cattle, such as dairy cows, to humans.

(a) Name the species of bacterium causing the transmission of TB from dairy cows to humans.

..... [1]

(b) In some areas, cattle cannot be regularly tested or treated for TB. In these areas, milk and dairy products from infected dairy cattle may enter the human food chain.

Outline a control measure that can be taken to protect people that consume milk and dairy products from these infected cattle.

.....

..... [1]

(c) Cattle are not usually affected by *M. tuberculosis*, but the pathogen can cause disease in other animals.

A few cases of transmission of TB from people to animals have been reported.

Explain the most likely mode of transmission of TB from an infected person to an animal.

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..... [2]

(d) In most people, the response of the immune system to the infection of lung tissue by *M. tuberculosis* can prevent the spread of the bacterium to other organs of the body. The bacterium is contained in the lungs in a dormant state. This is known as latent TB.

Outline the treatment that is used to kill *M. tuberculosis* in latent TB infections.

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..... [2]

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(e) *M. tuberculosis* can spread in the blood and lymph to other organs in the body.

In very rare cases, a disease known as mycotic aneurysm can be caused by infection of the arterial wall, particularly in elastic arteries. The damage caused by the pathogen can lead to a rupture (bursting) of the artery.

With reference to the structure of the wall of **elastic** arteries, suggest how damage caused by *M. tuberculosis* infection can lead to the rupture of the artery.

You may draw a diagram if you wish.

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Space for diagram

[3]

[Total: 9]

6 Water that is absorbed from the soil solution by the roots of a plant enters xylem vessels and is transported to the leaves and buds.

Fig. 6.1 shows four important requirements for the efficient transport of water from the roots to the leaves of a plant.

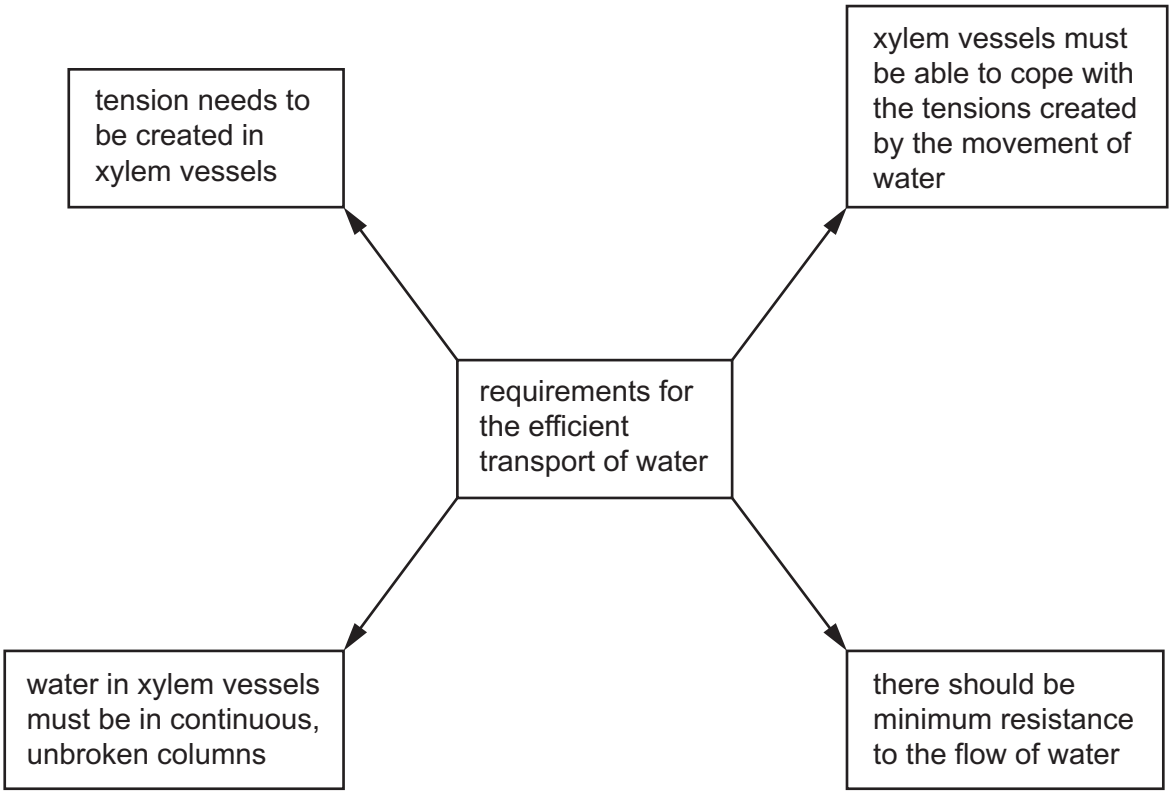


Fig. 6.1

(a) Name the specialised cells that are arranged end to end to form xylem vessels.

..... [1]

(b) Explain how tension is created in the xylem vessels.

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..... [2]

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(c) Fig. 6.1 highlights how the structure of xylem vessels must be related to their function. This means that during the development of xylem vessels changes need to occur to the cells forming the vessels.

(i) The walls of the cells forming the xylem vessel walls become lignified during development.

Explain how this feature is important for the efficient transport of water.

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..... [2]

(ii) During the development of xylem vessels, the end walls of the cells forming the vessels break down. This contributes to minimising resistance to the flow of water.

Describe **one** other main change that needs to occur to these cells so that their structure becomes suited to their function.

.....

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..... [1]

[Total: 6]

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BIOLOGY **9700/23**

Paper 2 AS Level Structured Questions **October/November 2023**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages. Any blank pages are indicated.

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1 The malarial pathogen, *Plasmodium falciparum*, enters red blood cells after a person becomes infected. After some time, each cell of *P. falciparum* divides to form daughter cells.

Fig. 1.1 shows a cell of *P. falciparum* that is forming many daughter cells.

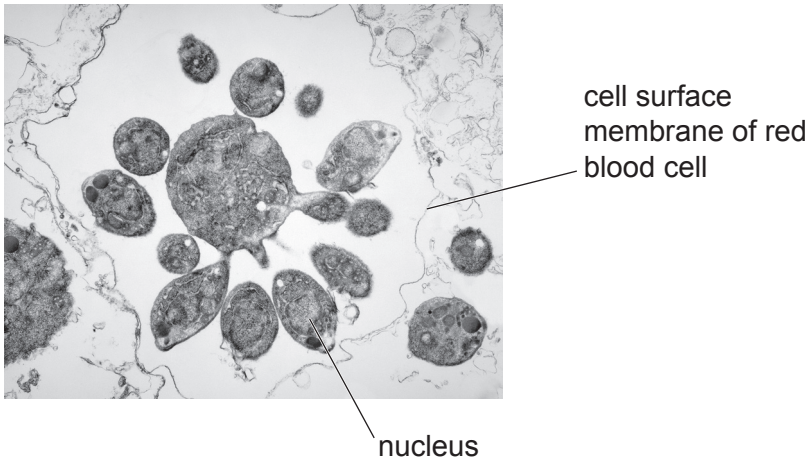


Fig. 1.1

(a) With reference to Fig. 1.1, suggest how the presence of *P. falciparum* affects a red blood cell.

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..... [3]

(b) When *P. falciparum* divides there is unequal division of the cytoplasm to form small, genetically identical daughter cells.

Outline the events that occur in the cell of *P. falciparum* to form the daughter cells shown in Fig. 1.1.

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..... [3]

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In 2013, the World Health Organization (WHO) set a target for researchers to create a vaccine for malaria. WHO required the vaccine to show 75% efficacy and be ready for use by 2030.

Efficacy is a measure of the effectiveness of a vaccine in reducing the number of new cases of malaria.

A trial of the R21/Matrix-M^{TM} vaccine in Burkina Faso in 2020 achieved a 77% efficacy over a 12-month period. A control group received a vaccine for rabies.

Vaccines stimulate an immune response with the production of antibodies.

(c) Explain how antibodies will reduce the spread of the malarial pathogen through the bloodstream.

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..... [3]

(d) Some vaccination programmes have been more successful than others.

Discuss the factors that contribute to the success of a vaccination programme.

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..... [5]

[Total: 14]

2 Glucose is used in the synthesis of amylose. Glucose is first converted to glucose 1-phosphate (G 1-P).

Starch phosphorylase is an intracellular enzyme that can catalyse the synthesis of amylose from G 1-P, which is the substrate for the reaction:

(glucose 1-phosphate)n ⟶ amylose + (phosphate ions)n

n = a large number

Students used a colorimeter to investigate the progress of the reaction.

The students made a reaction mixture containing 0.01 mol dm^{-3} G 1-P in a buffer solution at pH 6.0. A very small quantity of amylose was added to initiate the reaction.

A solution of starch phosphorylase was added to the reaction mixture and samples were taken at 1-minute intervals. Each sample was added to a dilute iodine solution, stirred and then poured into a cuvette. The absorbance of each solution was recorded.

The results of the investigation are shown in Fig. 2.1.

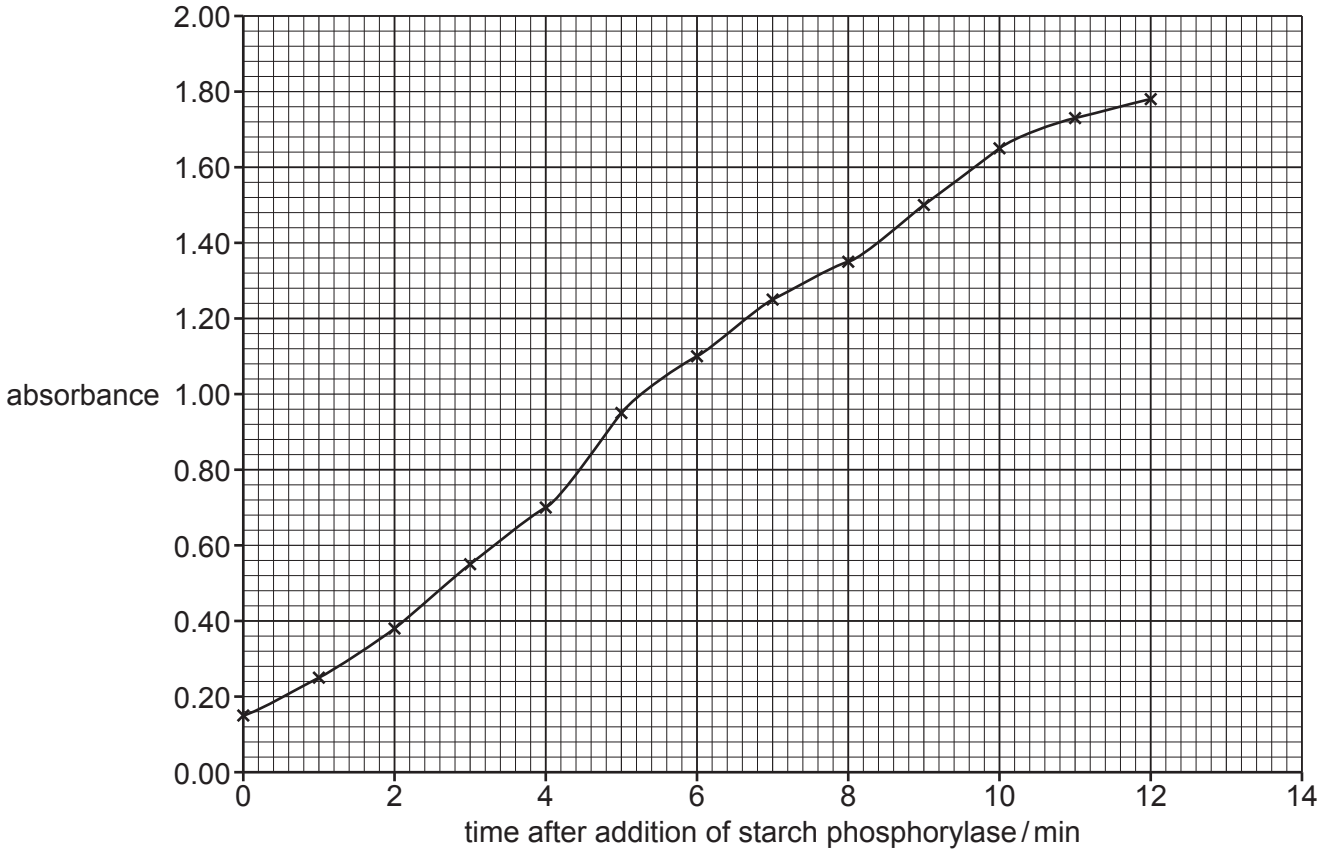


Fig. 2.1

(a) (i) Explain why the absorbance increases, as shown in Fig. 2.1.

.....

.....

..... [1]

(ii) The students took their final sample at 12 minutes.

Predict the results for absorbance if the students had continued to take samples for a further 10 minutes. Explain your answer.

prediction .....

.....

.....

explanation .....

.....

.....

[2]

(iii) State an advantage of using a colorimeter in determining the progress of the reaction.

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..... [1]

(b) The reaction catalysed by starch phosphorylase occurs at the ends of amylose molecules.

Describe the sequence of events that occurs when starch phosphorylase catalyses the addition of a molecule of glucose to the end of an amylose molecule.

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..... [4]

[Total: 8]

3 Haemoglobin is a complex protein molecule made of four separate subunits, as shown in Fig. 3.1.

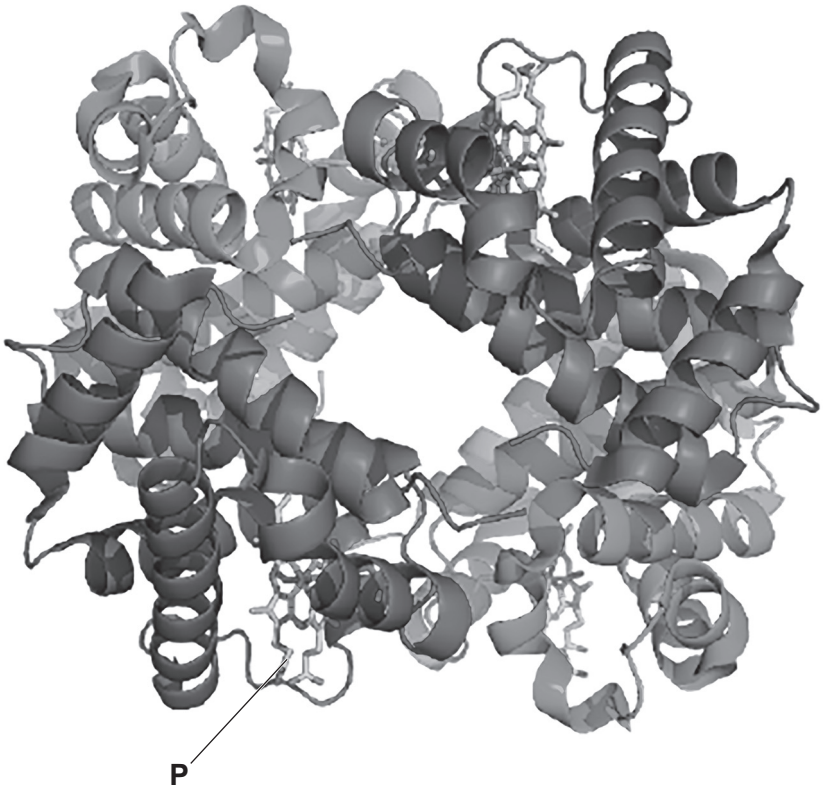


Fig. 3.1

(a) (i) The shading represents the two different polypeptides that form a molecule of haemoglobin.

State the names of the **two** different polypeptides.

.....

..... [1]

(ii) Identify the structure labelled **P** in Fig. 3.1.

..... [1]

(iii) Fig. 3.1 shows some of the levels of protein structure.

State the level of protein structure that is **not** shown in Fig. 3.1.

.....

..... [1]

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(b) Haemoglobin is involved in the transport of carbon dioxide.

Molecules of carbon dioxide enter red blood cells as the cells travel in capillaries through muscle tissue. Some of these molecules are converted to carbonic acid.

Explain how haemoglobin is involved in the transport of carbon dioxide molecules that are **not** converted to carbonic acid.

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..... [3]

(c) When haemoglobin associates (binds) with oxygen it forms oxyhaemoglobin.

State the precise site in the mammalian body where haemoglobin molecules bind with oxygen.

.....

..... [1]

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(d) The compound 2,3-diphosphoglycerate (2,3-DPG) is produced in red blood cells. 2,3-DPG binds to haemoglobin and stabilises it.

Fig. 3.2 shows oxygen dissociation curves when red blood cells have high and low concentrations of 2,3-DPG.

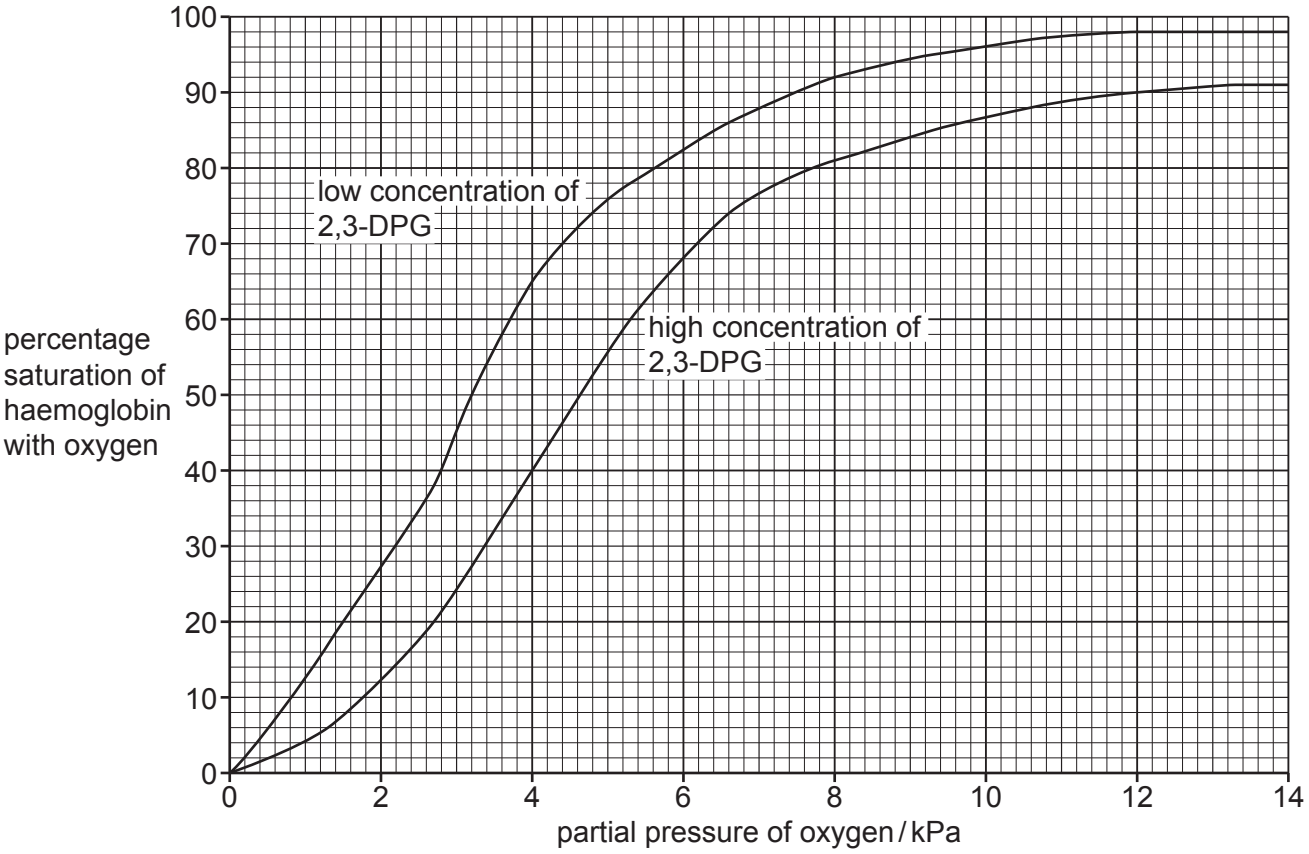


Fig. 3.2

P_{50} is the partial pressure of oxygen when haemoglobin is 50% saturated. The P_{50} is used to compare the affinity of haemoglobin for oxygen under different conditions.

(i) Use the information in Fig. 3.2 to describe the effect of an increase in the concentration of 2,3-DPG on the oxygen dissociation curve.

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..... [2]

(ii) Blood is stored in blood banks for use in hospitals during operations.

The concentration of 2,3-DPG in red blood cells decreases when blood is stored in a blood bank.

State **and** explain the effect that the use of blood taken from a blood bank has on the supply of oxygen to the tissues of a person during an operation.

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..... [2]

[Total: 11]

4 Fig. 4.1 is a diagram showing the transcription of part of the *COL1A2* gene that codes for a collagen polypeptide. The part of the *COL1A2* gene shown is a section of exon. Structure **A** represents an enzyme involved in transcription.

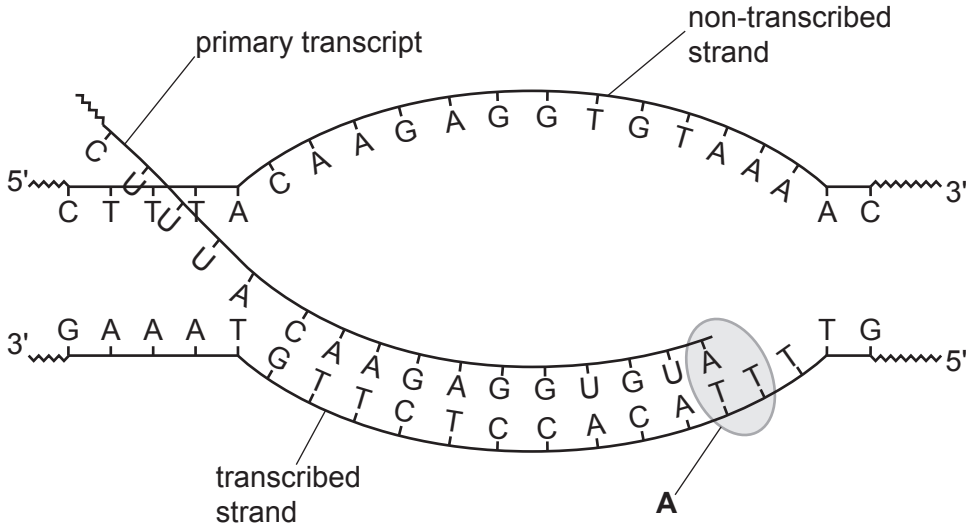


Fig. 4.1

(a) (i) Name the enzyme labelled **A** in Fig. 4.1.

..... [1]

(ii) Name the bond that forms between the nucleotides in the primary transcript.

..... [1]

(b) (i) State the number of amino acids that are coded for by the sequence of nucleotides on the primary transcript shown in Fig. 4.1.

..... [1]

(ii) Use the information in Fig. 4.1 to explain why one of the strands of DNA is **not** transcribed.

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..... [2]

(c) New mitochondria are formed when a mitochondrion divides into two.

Fig. 4.2 is a transmission electron micrograph of a mitochondrion that is dividing.



magnification ×50 000

Fig. 4.2

(i) State **two** features of mitochondria that are **visible** in Fig. 4.2.

1 .....

2 .....

[2]

(ii) The line on Fig. 4.2 shows the diameter of one of the mitochondria.

Calculate the actual diameter of the mitochondrion.

Give your answer to one significant figure.

answer = ... μm [1]

(d) Mitochondrial DNA codes for some polypeptides of proteins used within the mitochondrion. Some of the proteins allow movement of ions into and out of the mitochondria.

Outline the ways in which ions can move into mitochondria.

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..... [3]

[Total: 11]

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5 In flowering plants, transport of assimilates occurs in phloem tissue between sources and sinks.

(a) (i) Explain why a root can be a source **and** a sink.

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.....

..... [2]

(ii) State **two** examples of assimilates that are transported in the phloem.

..... [1]

(b) Describe **and** explain the mechanism that is responsible for the movement of phloem sap in sieve tubes.

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..... [4]

(c) Tobacco mosaic virus (TMV) infects many crop plants. The virus passes between cells in the leaves and can travel throughout plants in the phloem.

The enzyme pectin methylesterase (PME) is involved with the production of cell walls. The enzyme is also known to influence the movement of TMV through plants. Scientists investigated the effect of PME on the transport of TMV through plants.

The scientists used three varieties of tobacco plants. Two varieties, **V1** and **V2**, have small quantities of PME. A third variety, **C**, has the normal quantity of PME and was used as the control in this investigation.

The plants in each group were infected with TMV at the same time. The accumulation of the virus particles transported to the leaves at the top of the plants was determined over 36 days.

The results are shown in Fig. 5.1. The arrow indicates when all the plants were infected with TMV.

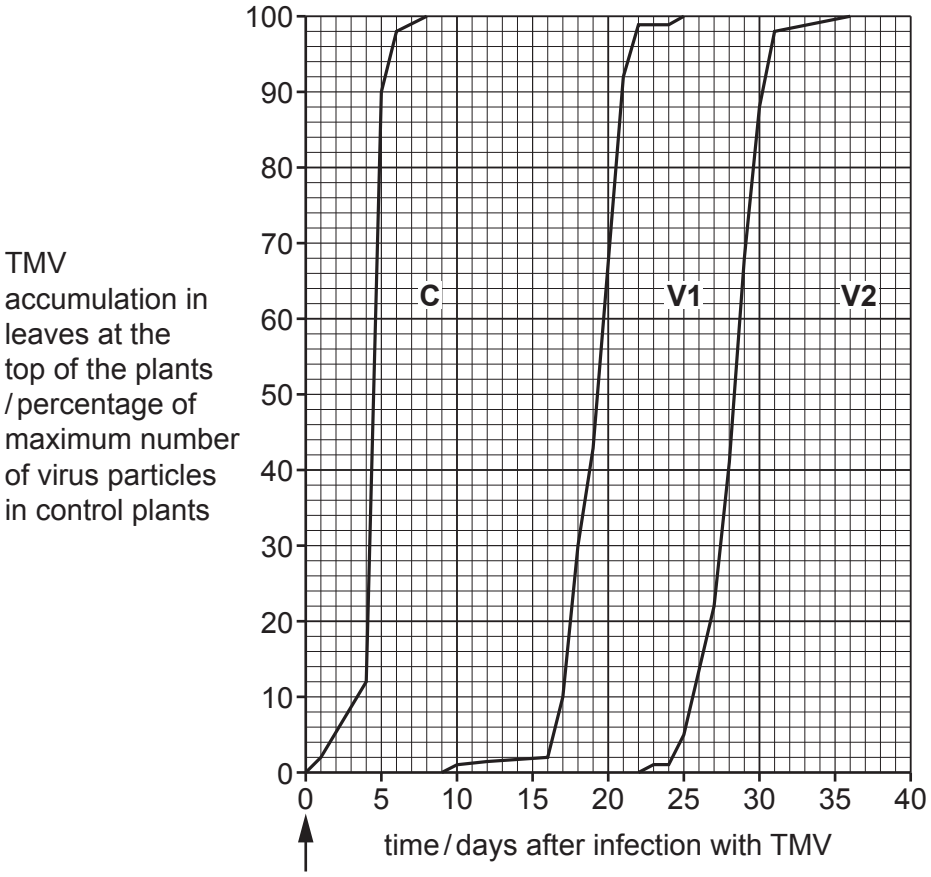


Fig. 5.1

Compare the results for varieties **V1** and **V2** with the control group of plants, **C**.

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..... [3]

[Total: 10]

6 The mammalian heart consists of four chambers.

(a) Explain why the ventricles have thicker walls than the atria.

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.....

..... [2]

(b) Complete Table 6.1 to identify the structure in the heart responsible for each function listed.

Table 6.1

function	structure in the heart
initiates the heartbeat	
delays the wave of depolarisation between the atria and the ventricles	
transmits the wave of depolarisation through muscles of the ventricle	
closes when the left ventricle contracts	

[4]

[Total: 6]

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