Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2246188760

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **May/June 2025**

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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[Turn over

1 **(a)** Amylose and the triglyceride stearin are macromolecules.

Explain why amylose and stearin are macromolecules, but only amylose is a polymer.

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..... [2]

(b) Students used the enzyme maltase extracted from the fungus *Aspergillus oryzae* to investigate the properties of enzymes.

Fig. 1.1 is a diagram of a maltose molecule.

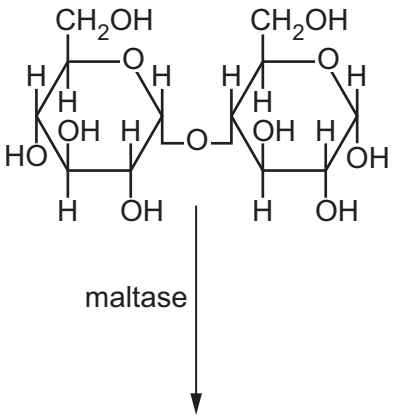


Fig. 1.1

(i) Complete Fig. 1.1 to show the reaction catalysed by maltase.

[3]

(ii) State the type of covalent bond that is broken in the reaction.

..... [1]

(iii) State the type of reaction catalysed by maltase.

..... [1]

[Total: 7]

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Question 2 starts on page 4.

2 In mammals, the small intestine is the main site of absorption of the products of digestion.

Fig. 2.1 is a transmission electron micrograph of a longitudinal section (L.S.) of part of an epithelial cell from the small intestine of a mammal.

Fig. 2.2 is a transmission electron micrograph of a horizontal section made at the position indicated by the two arrows in Fig. 2.1.

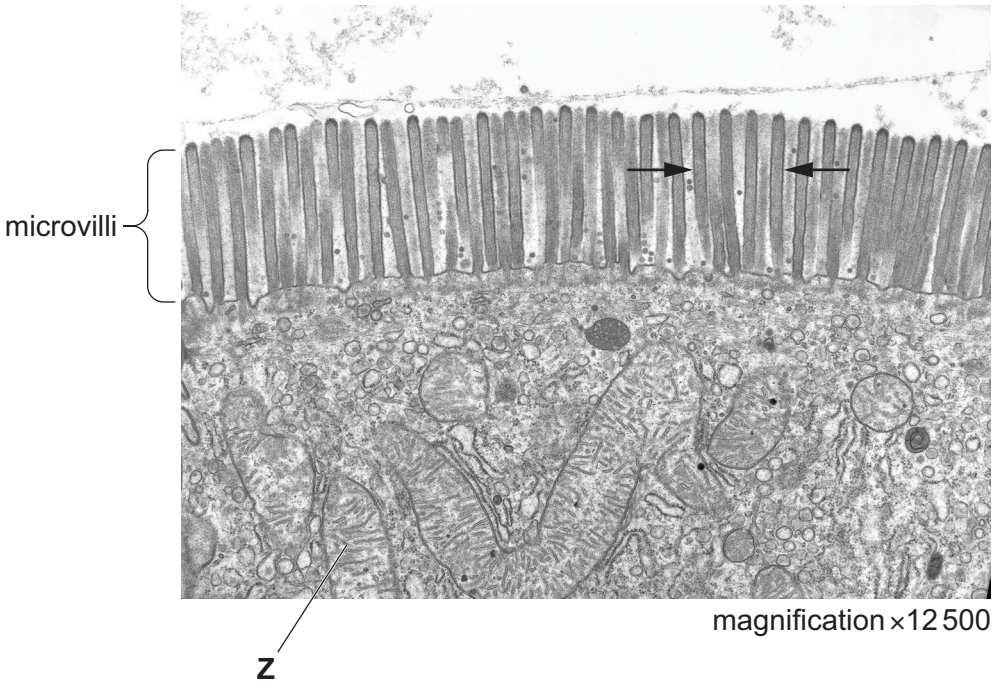


Fig. 2.1

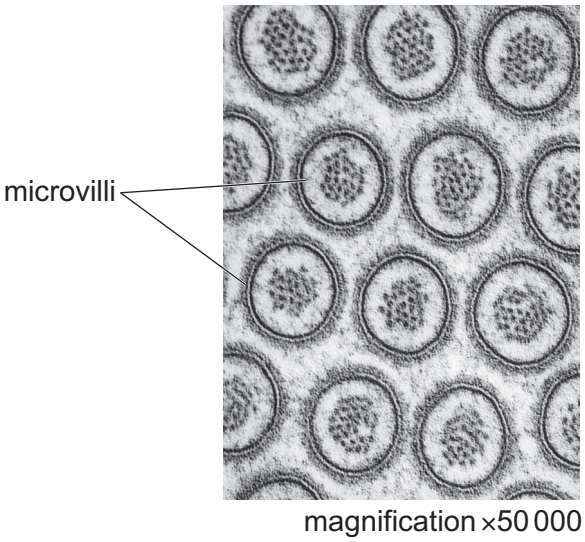


Fig. 2.2

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(a) Microvilli and cilia are cell structures.

Describe how the structure of cilia differs from the structure of the microvilli visible in Fig. 2.1 and Fig. 2.2.

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..... [2]

(b) A scientist measured the length and the diameter of some of the microvilli shown in Fig. 2.1 to estimate the total surface area of microvilli on the surface of the epithelial cell.

The scientist assumed that each microvillus was cylindrical in shape.

Suggest **one** other measurement needed to estimate the total surface area of the microvilli of the epithelial cell.

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..... [1]

(c) Identify the organelle labelled **Z** in Fig. 2.1 **and** explain why there is a large number of these organelles in the epithelial cells of the small intestine.

organelle .....

explanation .....

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.....

..... [2]

(d) Bacteria are found attached to epithelial cells in the intestines of mammals.

Describe how the organisation and distribution of DNA in epithelial cells differs from the organisation and distribution of DNA in bacterial cells.

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[Total: 7]



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3 **(a)** Scientists investigated the progress of reactions catalysed by two enzymes: dopa oxidase and neutrase. The reactions catalysed by these enzymes result in changes to the appearance of the reaction mixtures.

The reactions are shown in Fig. 3.1.

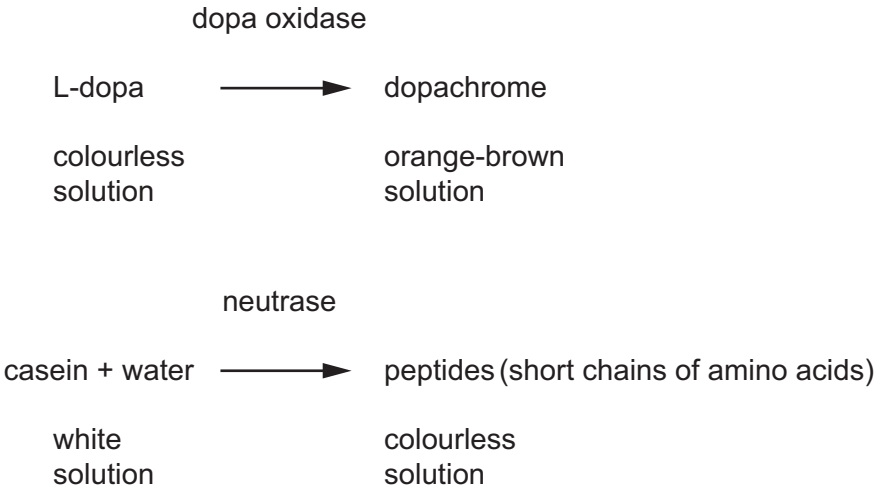


Fig. 3.1

The changes in appearance of the reaction mixtures make it possible to follow the reactions using a colorimeter.

Fig. 3.2 shows the progress of the reaction catalysed by dopa oxidase as recorded from a colorimeter.

Fig. 3.3 shows the progress of the reaction catalysed by neutrase as recorded from a colorimeter.

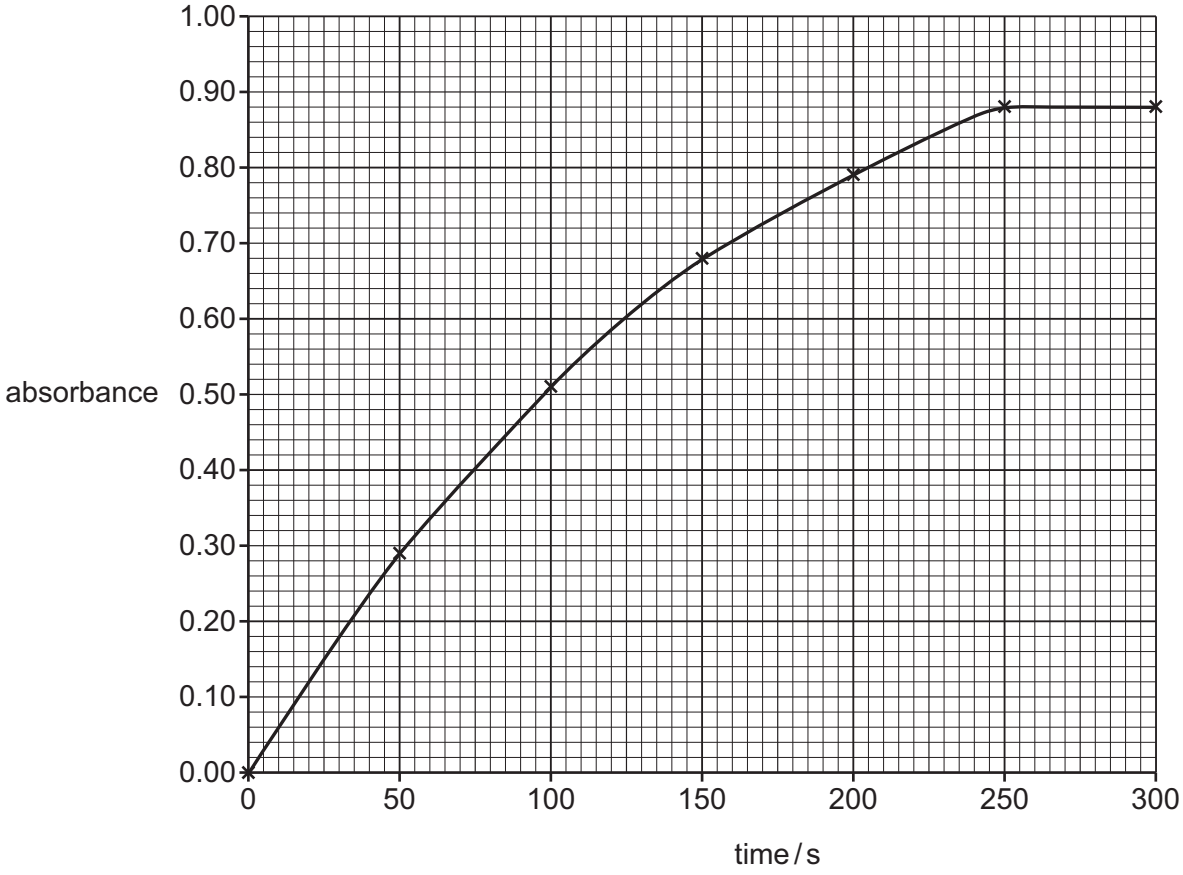


Fig. 3.2

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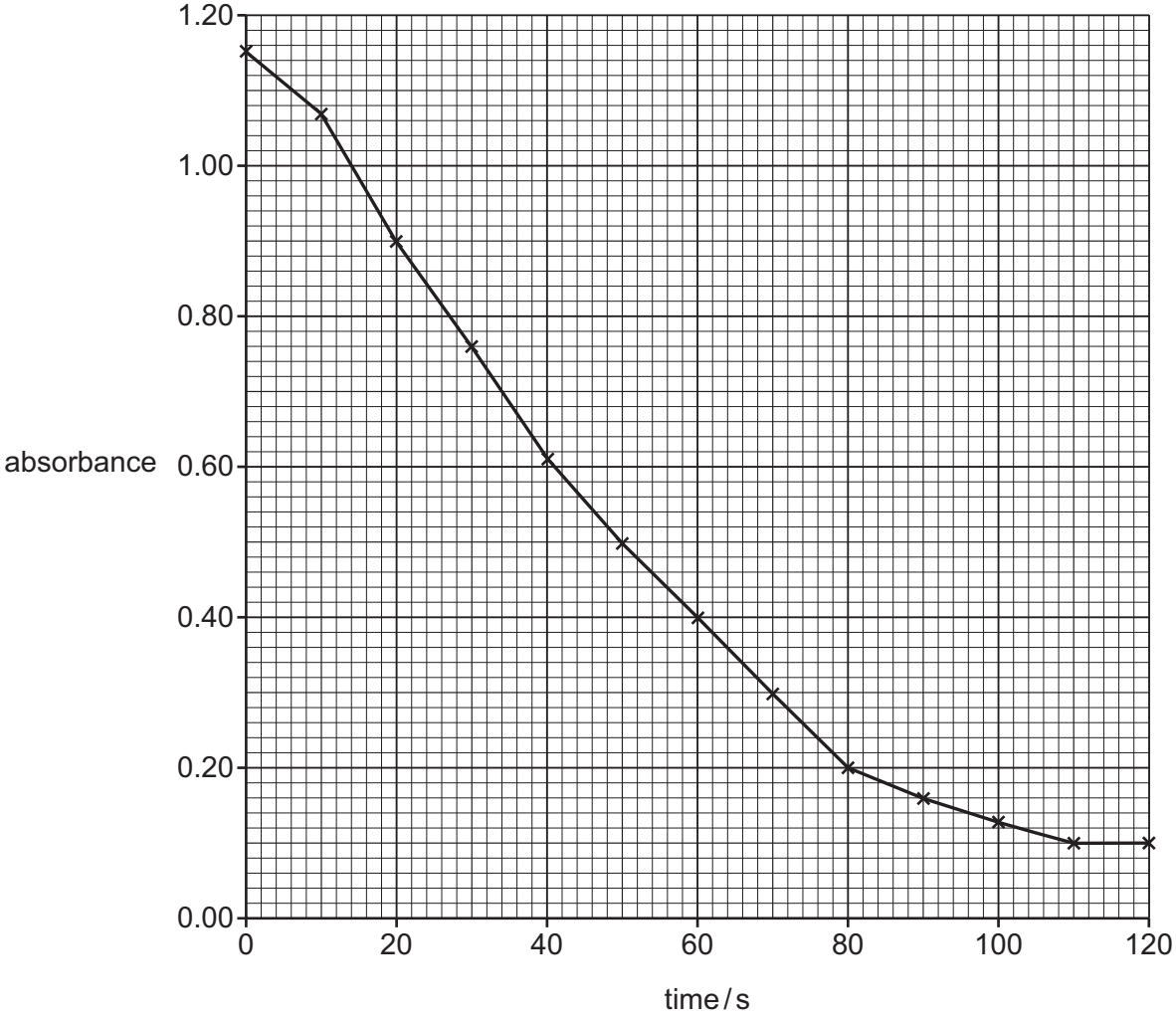


Fig. 3.3

(i) With reference to Fig. 3.1, Fig. 3.2 and Fig. 3.3, describe **and** explain the similarities between the progress of the two reactions.

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(ii) Suggest **two** advantages of using a colorimeter to investigate the progress of reactions such as those shown in Fig. 3.1.

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..... [2]

(b) Scientists searching for a suitable enzyme to use in an industrial process isolated the bacterium *Vibrio parahaemolyticus* from the mouth of the Mediterranean eel, *Muraena helena*.

The scientists discovered an enzyme in the bacterium that was suitable for the industrial process. The scientists named the enzyme VpSP37.

The scientists investigated how the rate of reaction catalysed by VpSP37 is affected by the concentration of its substrate. The results of the investigation are shown in Fig. 3.4.

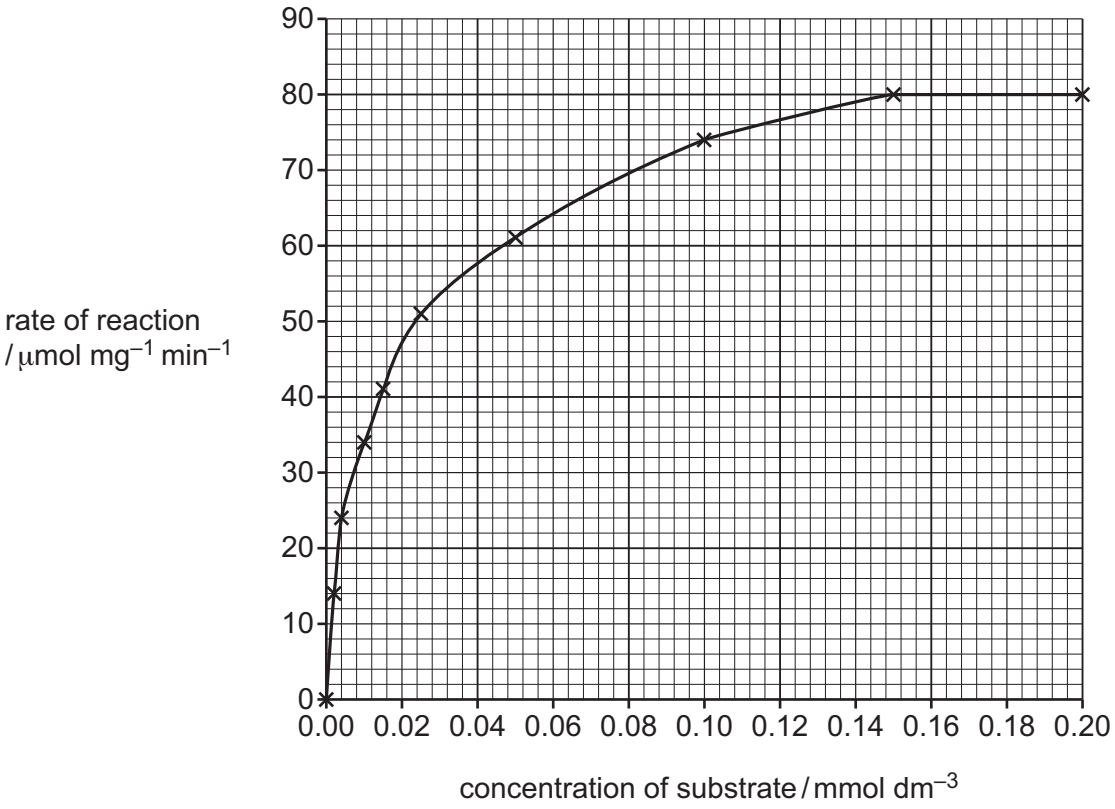


Fig. 3.4

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(i) Calculate the Michaelis–Menten constant, K_m, for the enzyme VpSP37 using the information in Fig. 3.4.

Show your working.

K_m = ... [2]

(ii) The scientists discovered other enzymes that were suitable for the industrial process. These enzymes had higher K_m values than VpSP37.

Explain the advantage of using the enzyme VpSP37 in the industrial process rather than one of these other enzymes with higher K_m values.

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4 **(a)** Cells of the immune system have cell surface receptors that detect molecules made by pathogens. One of these cell surface receptors is known as TLR8.

The gene *TLR8* is found on the X chromosome in humans.

Fig. 4.1 shows the production of messenger RNA (mRNA) formed from the gene *TLR8* in the nucleus of a macrophage.

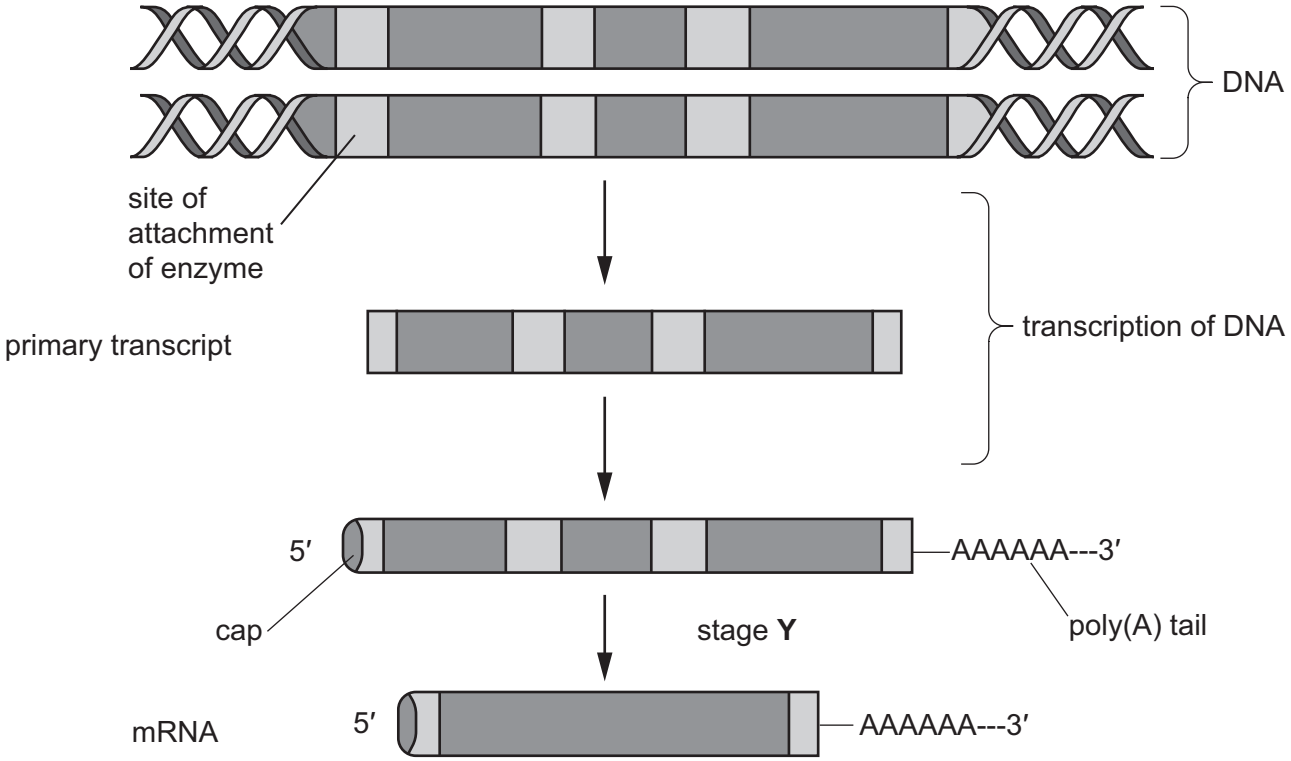


Fig. 4.1

(i) Name the enzyme that catalyses the transcription of DNA.

..... [1]

(ii) Fig. 4.1 shows that the primary transcript is modified by the addition of nucleotides to both ends of the molecule.

The cap shown in Fig. 4.1 is a guanine nucleotide that is added to the 5′ end of RNA. The poly(A) tail added to the 3′ end consists of many adenine nucleotides. The cap and the tail have a function in stage **Y** and are also important for the stability and role of mRNA.

Suggest the functions of the cap and the poly(A) tail in the stability and role of mRNA.

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(iii) Describe the process that occurs at stage **Y** in Fig. 4.1.

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..... [3]

(b) The nucleotide sequence TTAGGG is repeated in the direction 5′ to 3′ in the telomeres of human chromosomes.

(i) State where in a chromosome the telomeres are found.

..... [1]

(ii) Outline the role of telomeres.

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(c) Melanoma is a type of tumour that develops from pigment-producing skin cells known as melanocytes.

Outline how a tumour may form from a melanocyte.

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..... [4]

(d) A melanoma tumour is cancerous and may spread to other parts of the body.

T-vec is a new drug that has been developed to treat melanoma that has spread to other parts of the body, including lymph nodes.

T-vec contains a virus that infects some of the melanoma cells, causing the cells to burst and release their contents. Some of the contents of the melanoma cells act as cytokines and others act as antigens.

Explain the effects of the cytokines and antigens released from melanoma cells in stimulating the immune system to destroy the cancerous cells.

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Question 5 starts on page 16.

5 Phosphate ions are absorbed from the soil solution by roots and are needed for cellular processes throughout plants.

Scientists investigated the movement of phosphate ions in flowering plants. The scientists discovered that phosphate ions in the leaves are transported from the roots in the xylem. Only a small proportion of the phosphate ions that are absorbed are transported to the growing points of the roots and shoots.

(a) Suggest why only a small proportion of the absorbed phosphate ions are transported to the growing points.

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..... [2]

(b) *Gossypium hirsutum* is the most common species of plant grown for the production of cotton across the world.

Scientists carried out an investigation to trace the pathway taken by phosphate ions from the leaves of cotton plants into the stems. The scientists used a radioactive isotope of phosphorus (^{32}P) to trace the pathway of phosphate ions.

Some cotton plants were divided into two groups: **A** and **B**.

In group **A**, the scientists:

- inserted impermeable waxed paper between the xylem and phloem in the stem below a leaf of each plant
- injected a solution containing phosphate ions labelled with ^{32}P (labelled phosphate ions) into a vein of each leaf, as shown in Fig. 5.1.

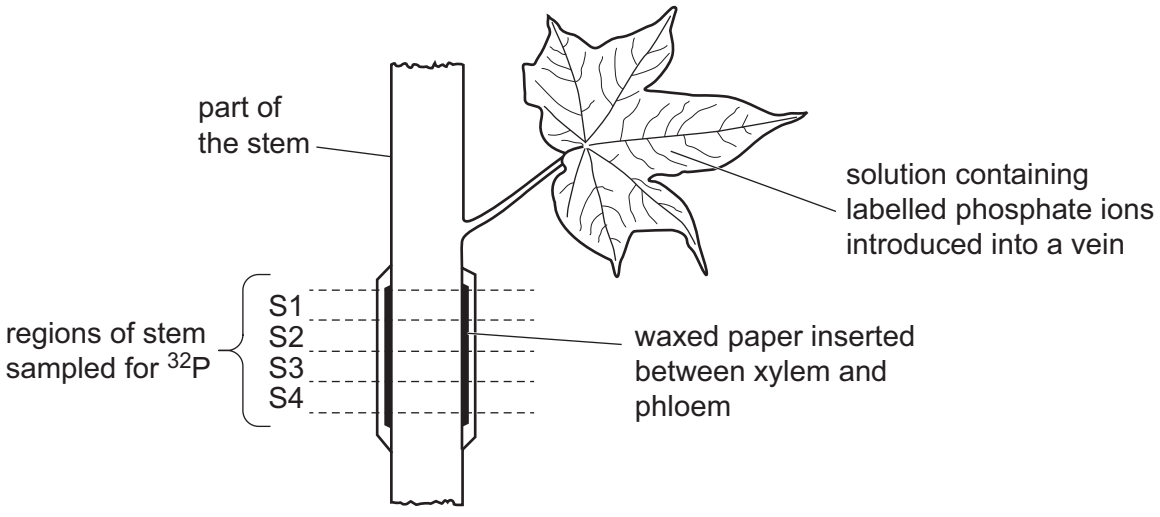


Fig. 5.1

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The procedure was repeated on the plants in group **B** but without inserting the waxed paper.

After one hour, the scientists determined the percentage of labelled phosphate ions in the four sections of the stem, **S1** to **S4**, shown in Fig. 5.1. The results are shown in Table 5.1.

Table 5.1

region of stem sampled	percentage of injected labelled phosphate ions in stem tissues			
	group A – stems with waxed paper		group B – stems with no waxed paper	
	phloem	xylem	phloem	xylem
S1	12	1	15	5
S2	7	<1	10	6
S3	13	0	5	2
S4	5	<1	3	1

Use Fig. 5.1 and the data in Table 5.1 to discuss the pathway taken by the solution containing phosphate ions labelled with ^{32}P in cotton plants.

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6 **(a)** Fig. 6.1 is a ribbon model of a molecule of haemoglobin.

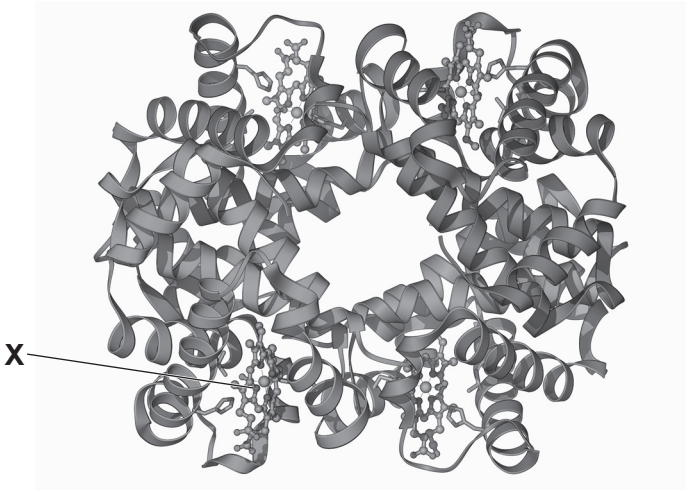


Fig. 6.1

(i) State the part of the haemoglobin molecule labelled **X**.

..... [1]

(ii) State the function of the structure labelled **X**.

.....

..... [1]

(iii) Haemoglobin is described as having quaternary structure.

State what is meant by quaternary structure.

.....

..... [1]

(b) The effect of the partial pressure of oxygen (pO_2) and the effect of the partial pressure of carbon dioxide (pCO_2) on the percentage saturation of haemoglobin was investigated.

A sample of mammalian blood was exposed to a gas mixture that contained increasing pO_2. In the experiment, the pCO_2 was maintained at 2.7 kPa. The percentage saturation of haemoglobin in the blood sample was determined as the pO_2 increased.

The experiment was repeated with further samples of blood with a pCO_2 maintained at 5.3 kPa and at 10.7 kPa.

The results are shown in Fig. 6.2.

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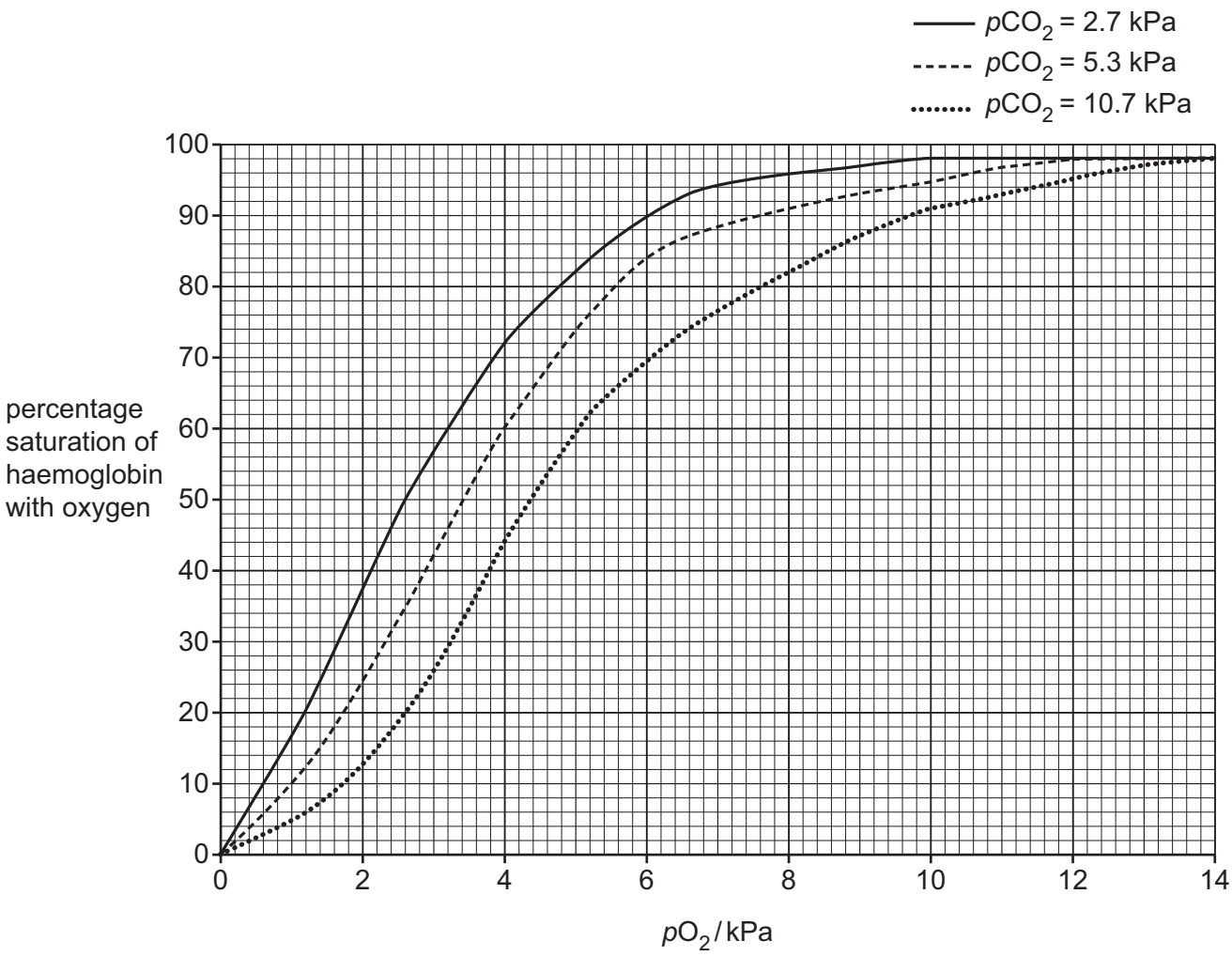


Fig. 6.2

(i) The pCO_2 of alveolar air is 5.3 kPa.

With reference to Fig. 6.2, state the likely partial pressure of oxygen in the alveoli of the mammal.

..... [1]

(ii) Suggest the range of partial pressures of oxygen in respiring tissues **and** use Fig. 6.2 to give evidence for your answer.

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..... [2]

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(iii) Use the information in Fig. 6.2 to describe the effect of increasing pCO_2 on the percentage saturation of haemoglobin with oxygen.

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..... [3]

(iv) State the name given to the effect you have described in part **(iii)**.

..... [1]

(v) Explain the advantage to the mammal of the effect you described in part **(iii)**.

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..... [2]

[Total: 12]

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Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

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CANDIDATE NUMBER

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BIOLOGY **9700/22**

Paper 2 AS Level Structured Questions **May/June 2025**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

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

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1 Root hair cells are specialised plant cells located in the outer layer of young roots of plants. Root hair cells have an essential role in the uptake of water and dissolved mineral ions from the soil solution.

The transport of water across the root to reach the central xylem tissue can occur by the symplast pathway or apoplast pathway.

(a) Fig. 1.1 is a diagram of a photomicrograph of a root hair cell.

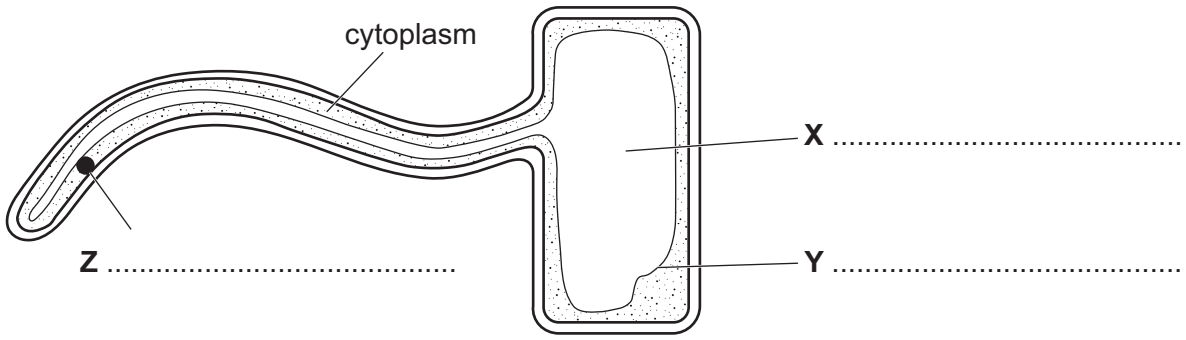


Fig. 1.1

On Fig. 1.1, name cell structures **X**, **Y** and **Z**.

[3]

(b) In the symplast pathway, water passes through the cells of the different tissues in the root before entering the xylem vessels of xylem tissue.

Name the tissues of the root, in the correct sequence, through which water passes in the symplast pathway.

.....

.....

..... [2]

(c) In the apoplast pathway, water passes along the cell walls of adjacent plant cells and through the intercellular spaces. This is more efficient than the symplast pathway.

Explain the structural features of plant cell walls that make the apoplast pathway an efficient pathway for the transport of water.

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..... [3]

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(d) Root hair cells also synthesise and secrete substances into the soil.

Electron microscopy of the structure of root hairs has identified endoplasmic reticulum (ER), a number of small Golgi bodies, and numerous vesicles.

- Root hair cells of the barley plant secrete enzymes known as acid phosphatases, which catalyse the release of inorganic phosphate ions from organic phosphates in the soil.
- Root hair cells of the sorghum plant secrete a hydrophobic, lipid compound known as sorgoleone, which slows down the growth of neighbouring plants.

(i) Explain why the proportion of rough ER to smooth ER may be different in the root hair cells of barley plants compared with the root hair cells of sorghum plants.

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..... [2]

(ii) Student **X** stated that acid phosphatases and sorgoleone could be transported out of root hair cells using the **same** process.

Student **Y** stated that acid phosphatases and sorgoleone are transported out of root hair cells using **different** processes.

Suggest the reasons given by student **X** and by student **Y** to support their statements.

student **X** .....

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student **Y** .....

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[4]

[Total: 14]

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2 The transport of respiratory gases involves blood plasma and red blood cells. Red blood cells contain the globular protein, haemoglobin.

(a) Describe features of a haemoglobin molecule that are typical of a globular protein, **other than** having an approximately spherical shape.

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..... [2]

(b) A number of substances are involved in the transport of respiratory gases.

Complete Table 2.1 by stating the name of the substance that matches the description of its role in the transport of respiratory gases.

The first row has been completed for you.

Table 2.1

substance	role in the transport of respiratory gases
carbon dioxide	In the capillaries of respiring tissues, this combines with water to form carbonic acid.
	In the capillaries of respiring tissues, this enters red blood cells through a membrane transport protein.
	In red blood cells, this is formed when carbon dioxide binds to haemoglobin.
	In alveolar capillaries, this combines with a hydrogen ion in red blood cells to form carbonic acid.
	In alveolar capillaries, this is formed in red blood cells as a result of oxygen binding to a haem group.
	In red blood cells, this combines with haemoglobin to form haemoglobinic acid.

[5]

[Total: 7]

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3 Carrots are root vegetables of the carrot plant. The carrot plant is an important food crop that is grown throughout the world. Carrots have a sweet taste because sugars form a proportion of the total carbohydrate present.

Plant breeding has produced many different varieties of carrot, with different levels of sweetness.

(a) One of the sugars found in carrots is galactose.

Galactose has the same molecular formula, $C_6H_{12}O_6$, as α-glucose.

Fig. 3.1 shows the molecular structure of galactose found in carrots. This is similar, but not identical, to the molecular structure of α-glucose.

In Fig. 3.1, the six carbon atoms are numbered 1 to 6.

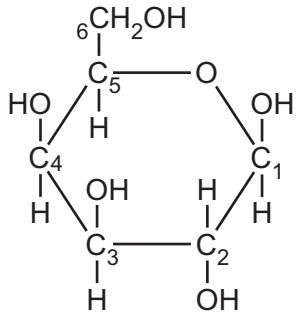


Fig. 3.1

State the differences between the molecular structure of galactose, shown in Fig. 3.1, and the molecular structure of α-glucose.

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..... [1]

(b) An investigation was carried out to determine the sugar content of mature carrots produced by different local varieties of carrot plants that are grown in Tunisia, North Africa.

Carrot plants were grown from seed under standardised conditions. When mature, the carrots were harvested.

The different sugars present in the carrots were identified. Measurements of sugar content for each of the sugars were made.

Table 3.1 shows the results for five different local varieties of carrot plant, **A** to **E**.

Table 3.1

local variety	sugar content of carrots / mg g^{-1} of dry weight			
	fructose	galactose	glucose	sucrose
A	183.04	1.43	173.28	73.73
B	194.43	1.13	188.18	46.20
C	200.15	5.99	125.19	85.93
D	157.35	4.88	137.28	89.57
E	170.38	4.54	133.57	60.27

After studying the results shown in Table 3.1, a student concluded that the carrots from the local varieties contain the same four sugars.

The student made three other conclusions from the data in Table 3.1.

conclusion 1 There are non-reducing and reducing sugars in the carrots.

conclusion 2 There are monosaccharide and disaccharide sugars in the carrots.

conclusion 3 The carrots have the same pattern of results.

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Explain the evidence in Table 3.1 that supports these three other conclusions.

conclusion 1 .....

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conclusion 2 .....

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conclusion 3 .....

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..... [3]

(c) Carbohydrates that are **not** sugars are also present in carrots.

Name **one** carbohydrate that is present in carrots and that is **not** a sugar.

..... [1]

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(d) Each carrot plant produces a carrot in the first year of growth.

If the carrot is **not** removed from the plant after it matures, the plant passes through a dormant period and shoots develop from the carrot in the second year of growth. This allows flowers to be produced and seed formation to occur before the plant dies.

Explain, with reference to the life cycle of the carrot plant, when the carrot acts as a **source and** when the carrot acts as a **sink**.

source .....

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sink .....

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[3]

(e) Carrot virus Y is a pathogen of carrot plants. The virus, which belongs to a group known as *Potyvirus*, replicates its viral nucleic acid and proteins within host carrot cells.

The general structure of potyviruses is shown in Fig. 3.2.

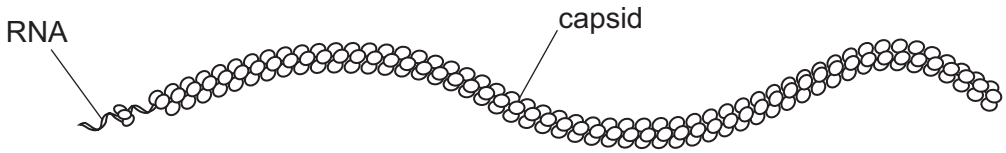


Fig. 3.2

The synthesis of viral proteins in host carrot cells only involves the process of translation. The process of transcription does **not** occur.

Suggest why translation occurs in host carrot cells during the synthesis of **viral** proteins, but transcription does **not** occur.

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[Total: 10]

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4 Tuberculosis (TB) is an infectious disease that is caused by a bacterial pathogen.

The pathogen has mechanisms to avoid digestion by phagocytes. Macrophages may engulf the bacteria, but in some cases the bacteria remain alive within the cells instead of being killed.

(a) Although there are two main species of bacterium causing TB, it is rare for the species that causes bovine TB in cattle to infect humans.

Name the species of bacterium that is the **main** cause of TB in humans.

..... [1]

(b) Explain how the pathogen named in **(a)** is transmitted from a person with the disease to a person who is uninfected.

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..... [2]

(c) State the type of therapeutic drug used to treat TB.

..... [1]

(d) Fig. 4.1 is a photomicrograph of a section of lung tissue taken from a person who has **not** been infected with the bacterial pathogen and who does **not** have TB.

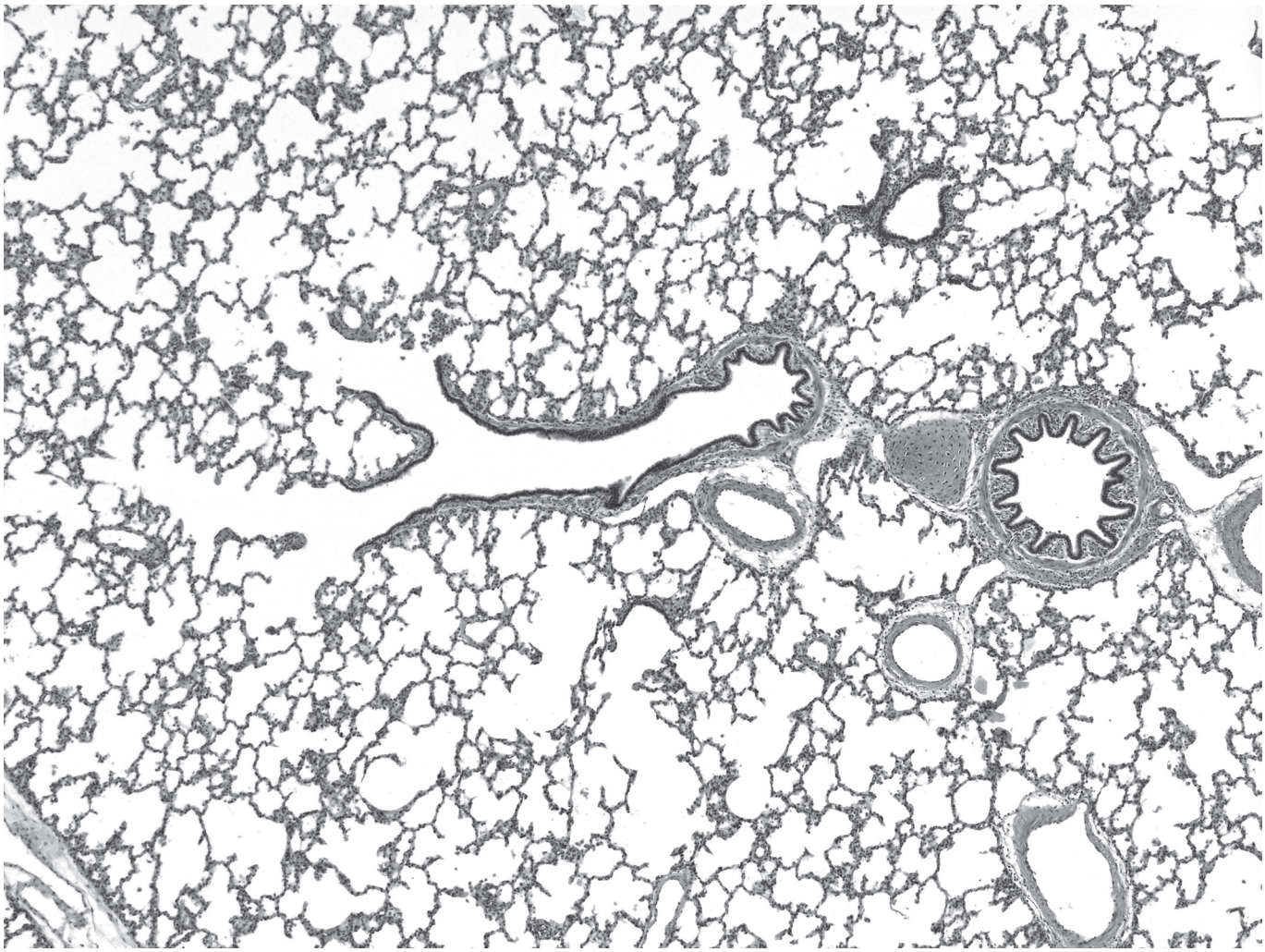


Fig. 4.1

Blood vessels and some structures of the gas exchange system are visible in Fig. 4.1.

On Fig. 4.1, use a label line and label:

- a bronchus
- a bronchiole
- a blood vessel.

[3]

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(e) In some people with TB, areas known as granulomas may form in lung tissue as part of an immune response to the pathogen.

Fig. 4.2 is a photomicrograph of a granuloma in lung tissue.

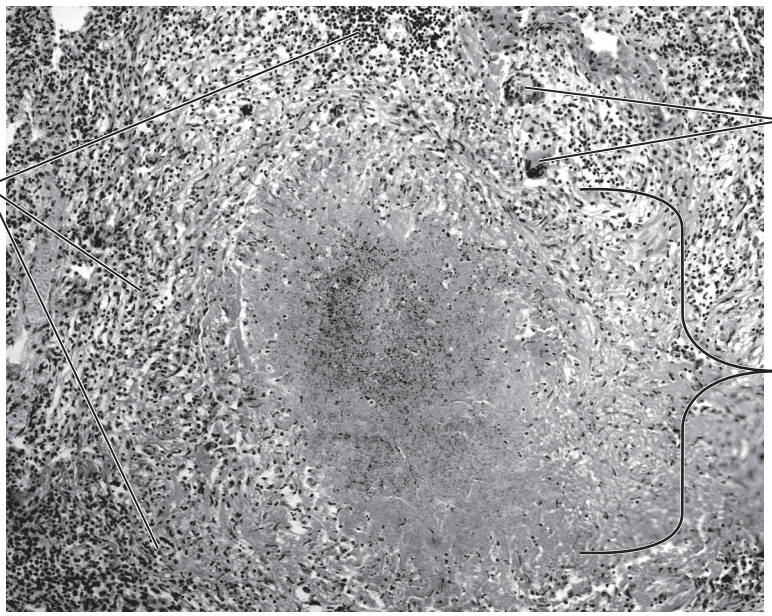


Fig. 4.2

With reference to Fig. 4.1 and Fig. 4.2, describe **and** explain how the changes that occur as a result of granuloma formation:

- can affect gas exchange and harm the health of an infected person
- may help to prevent TB developing in other parts of the body.

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[Total: 12]

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5 There is a global shortage of blood for transfusions. Researchers can culture bone marrow stem cells in the laboratory to manufacture red blood cells for potential use as an artificial blood product.

The researchers collect bone marrow stem cells that are present in small quantities in blood, rather than extracting them from bone marrow.

- Antibodies, specific to bone marrow stem cells, are attached to tiny magnetic beads.
- The beads are added to a sample of blood.
- An electric field is applied to immobilise the beads so that the bone marrow stem cells can be collected.

(a) The antibodies are attached to the beads so that the sites used for binding to specific molecules on the bone marrow stem cells are left exposed.

Name the term given to the specific molecules on the bone marrow stem cells that attach to the antibody binding sites.

..... [1]

(b) Suggest **and** explain the advantages of using bone marrow stem cells from the blood sample to manufacture artificial red blood cells.

.....

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..... [3]

(c) One desirable feature of artificial blood products, such as artificial red blood cells, is that they should be economical to produce.

Suggest **other** desirable features of artificial blood products.

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[Total: 7]

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6 Horseradish peroxidase (HRP) is an enzyme that can be extracted from the roots of the horseradish plant, *Armoracia rusticana*. HRP is used extensively in industry and technology.

In the reaction catalysed by HRP, hydrogen peroxide (H_2O_2) is used to oxidise an organic substrate. This is summarised in Fig. 6.1.

$$\text{organic substrate + hydrogen peroxide} \xrightarrow{\text{HRP}} \text{oxidised substrate + water}$$

Fig. 6.1

(a) Inhibitors can have an effect on V_{max}, the maximum rate of reaction, and K_m, the Michaelis–Menten constant, of HRP.

Fig. 6.2 shows the effect of substrate concentration on the rate of reaction of HRP.

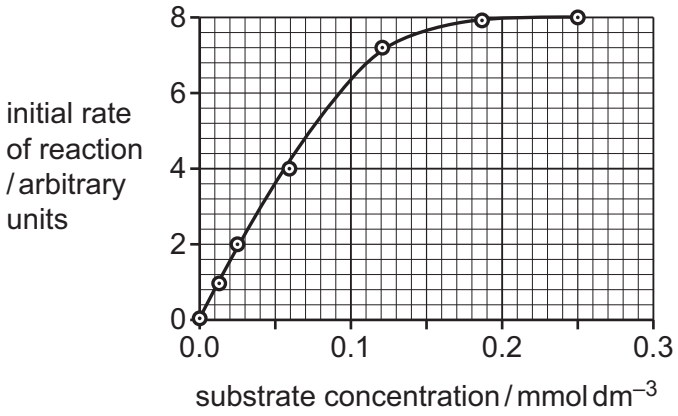


Fig. 6.2

Complete Fig. 6.2 by drawing a curve to show how the presence of a non-competitive inhibitor will affect the rate of reaction of HRP.

Use the curve **you have drawn** to obtain an estimate of K_m.

K_m = ... [2]

(b) Scientists can design synthetic DNA nucleotide sequences to produce a synthetic HRP gene. These sequences will include a start codon and a stop codon so that translation of messenger RNA (mRNA) can occur.

Explain what is meant by a start codon **and** a stop codon.

.....

.....

.....

..... [2]

(c) HRP is used in an immunological test known as a sandwich ELISA. One use of the test is to diagnose disease.

Fig. 6.3 outlines the main steps in a sandwich ELISA in which a toxin released by a pathogen is detected in a sample of body fluid taken from a person who is ill.

The test involves two types of monoclonal antibody that can bind to the toxin, a capture antibody and a detection antibody.

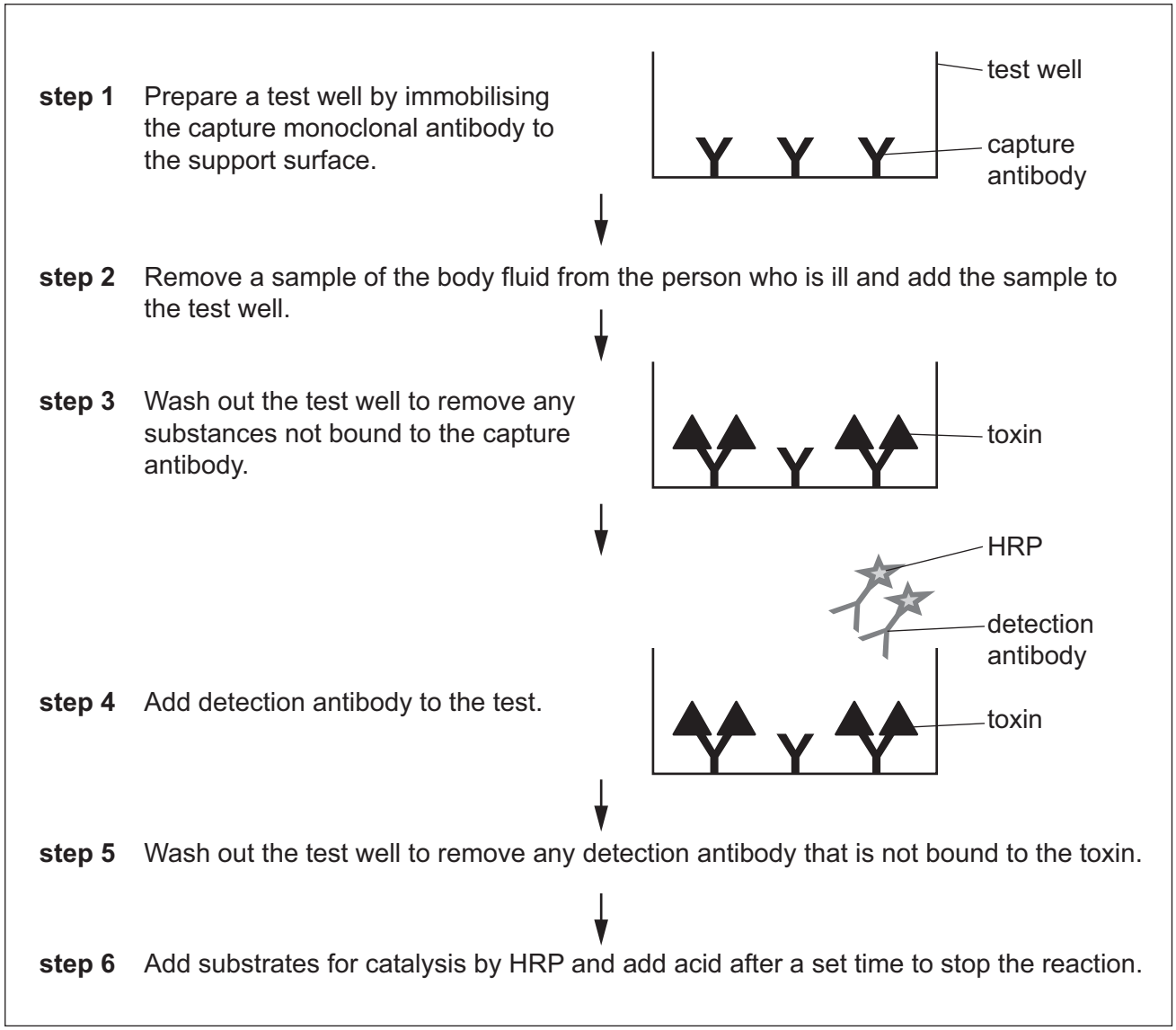


Fig. 6.3

(i) Complete Fig. 6.4 to show the situation in the test well after **step 5**.



Fig. 6.4

[1]

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(ii) With reference to Fig. 6.3, describe **one** difference between the capture antibody and the detection antibody.

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..... [1]

(iii) Fig. 6.5 outlines the reaction catalysed by HRP in **step 6**. The organic substrate, TMB, is in excess and changes colour when it is oxidised. This indicates a positive test result.

$$\underset{\text{colourless}}{\text{TMB}} + H_2O_2 \xrightarrow{\text{HRP}} \underset{\text{blue-green}}{\text{oxidised TMB}} + \text{water}$$

Fig. 6.5

A student suggested that:

- a low concentration of toxin may by diagnosed as a negative result instead of a positive result
- using a colorimeter after **step 6** in the sandwich ELISA test would provide a quantitative result and help to avoid this error.

With reference to Fig. 6.5, explain why using a colorimeter would provide a quantitative measurement for detection of a low concentration of the toxin and help to confirm a positive result.

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CANDIDATE NAME

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4431564509

BIOLOGY **9700/23**

Paper 2 AS Level Structured Questions **May/June 2025**

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 [ ].

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[Turn over

1 *Ranunculus* is a group (genus) of dicotyledonous plants that includes more than 1600 species.

(a) Fig. 1.1 is a photomicrograph of a transverse section through part of a root of a *Ranunculus* species.

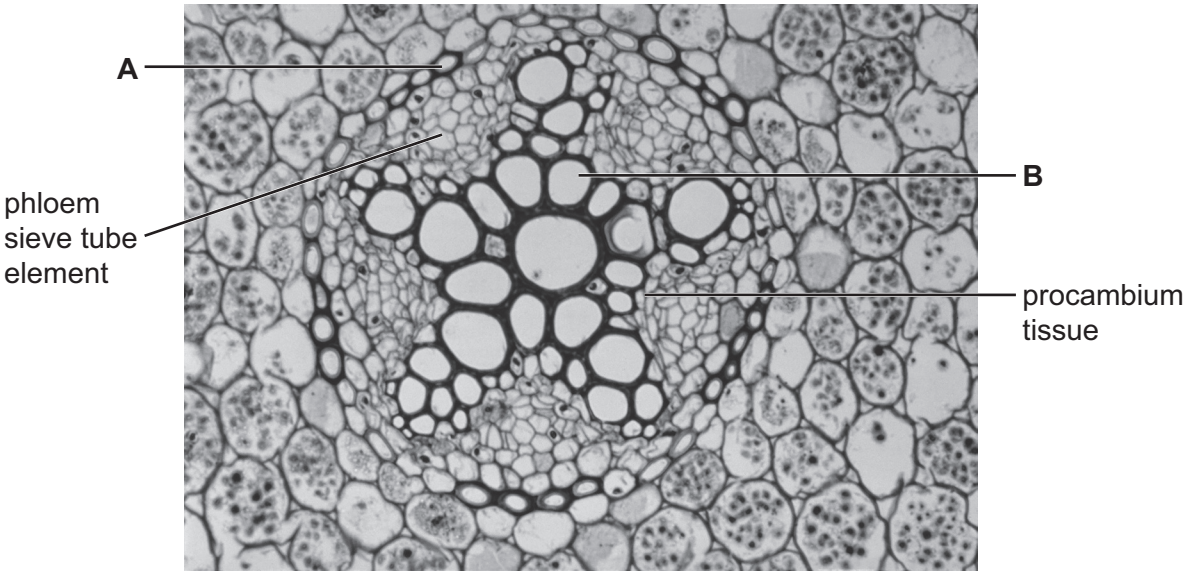


Fig. 1.1

(i) Name the cells labelled **A** and **B** in Fig. 1.1.

A .....

B .....

[2]

(ii) The procambium tissue shown in Fig. 1.1 consists of stem cells.

Suggest a role of the procambium tissue in the roots of this plant.

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..... [1]

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(b) Some species in the *Ranunculus* genus are xerophytes.

State **and** explain **two** adaptations of the leaves of xerophytic plants that reduce water loss.

adaptation .....

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explanation .....

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adaptation .....

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explanation .....

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[4]

[Total: 7]

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2 Bees are insects that produce venom as a means of self-defence.

Melittin is a polypeptide present in the venom of bees.

(a) Lysine is one of the amino acids present in melittin.

Fig. 2.1 shows an incomplete diagram of the structure of lysine.

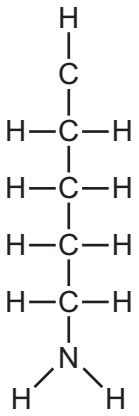


Fig. 2.1

(i) State the number of carbon atoms in the R group of lysine.

..... [1]

(ii) Complete the diagram of the structure of lysine in Fig. 2.1. [2]

(b) Descriptions of the structure of melittin are shown in Table 2.1.

Complete Table 2.1 by writing the level of protein structure that applies to each description.

Table 2.1

description	level of protein structure
in some conditions, four melittin polypeptides can bind to each other	
a melittin polypeptide consists of a sequence of 26 amino acids	
alpha helices are formed at each end of a melittin polypeptide	

[3]

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(c) When a bee stings a person, venom enters the body.

Melittin in the venom interacts with cell surface membranes of body cells, as shown in Fig. 2.2.

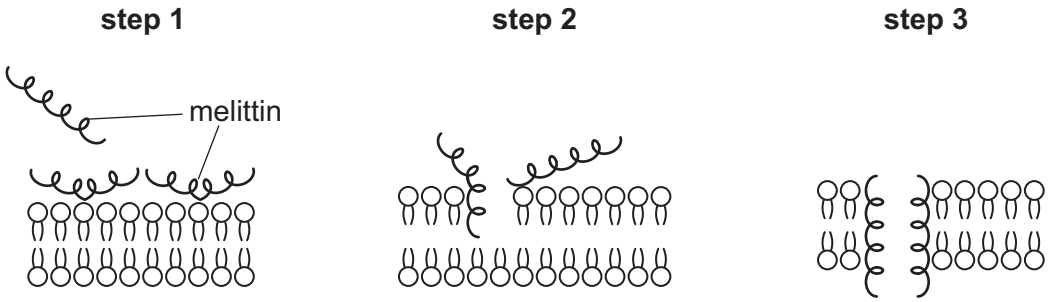


Fig. 2.2

Outline how melittin affects the structure of a cell surface membrane, as shown in Fig. 2.2.

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..... [2]

(d) Cells that have been affected by melittin break down into cell fragments.

These cell fragments are taken in by phagocytes for further breakdown.

Describe the process by which phagocytes take in and break down these cell fragments.

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3 *Staphylococcus epidermidis* is a species of bacterium that lives on human skin.

Staphylococcus aureus is a pathogenic bacterium that can infect humans.

(a) *S. epidermidis* and *S. aureus* are prokaryotes.

Table 3.1 shows some cell features that could apply to typical prokaryotic cells or to typical eukaryotic cells or to both types of cell.

Complete Table 3.1 by using a tick (✓) if the feature applies to the type of cell or a cross (✗) if the feature does not apply to the type of cell.

Put a tick (✓) or a cross (✗) in every box.

Table 3.1

feature	prokaryotic cell	eukaryotic cell
circular DNA		
80S ribosomes		
a cell diameter of 20 μm		

[3]

(b) One way that *S. aureus* can infect humans is through wounds (breaks) in the skin.

Populations of *S. aureus* develop on human skin as part of a biofilm. The biofilm contains cells of *S. aureus* within a mixture of polymers that have been secreted by the cells.

S. epidermidis produces a protease enzyme that prevents the growth of *S. aureus* populations on human skin. Proteases catalyse the breakdown of proteins.

Fig. 3.1 is a diagram showing populations of *S. epidermidis* and *S. aureus* on human skin cells.

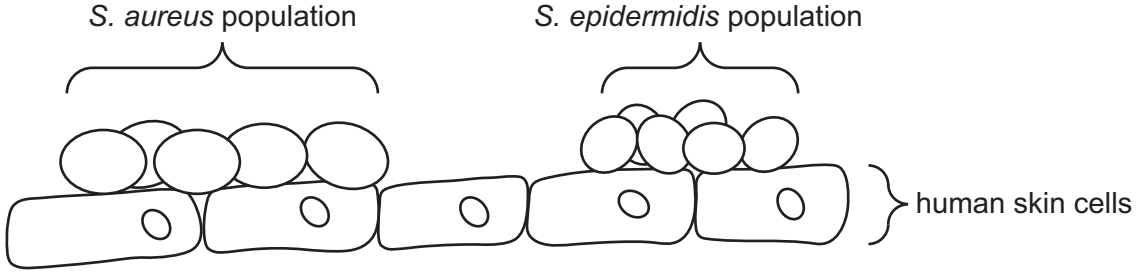


Fig. 3.1

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Suggest **and** explain how the protease produced by *S. epidermidis* cells prevents the growth of an *S. aureus* population on human skin.

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..... [3]

(c) *S. aureus* can infect many tissues in the human body, including tissues in the gas exchange system.

(i) Describe the role of goblet cells in the protection of tissues in the trachea from infection by *S. aureus*.

.....

.....

.....

..... [2]

(ii) *S. aureus* cells can infect tissues by passing in between cells that line the lumen of the trachea.

State the name of a cell type, **other than** goblet cells, that lines the lumen of the trachea.

..... [1]

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(d) Vancomycin and penicillin are antibiotics that are used to treat infectious diseases caused by *S. aureus*.

Fig. 3.2 shows the mechanism of action of vancomycin.

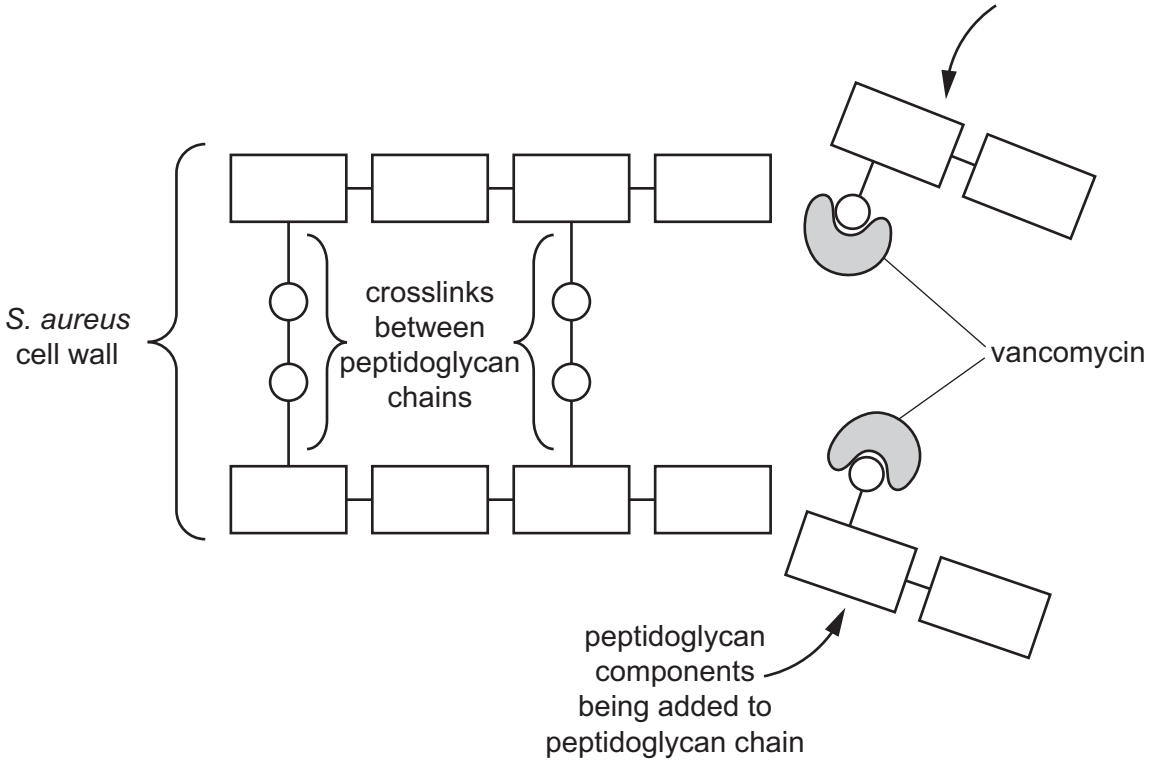


Fig. 3.2

(i) Vancomycin and penicillin act on the cell wall of bacterial cells.

With reference to Fig. 3.2, describe the similarities **and** differences between the mechanism of action of vancomycin and the mechanism of action of penicillin.

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..... [3]

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(ii) Some strains of *S. aureus* are resistant to vancomycin and penicillin.

Describe the steps that can be taken to reduce the impact of antibiotic resistance.

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4 Lysosomes are membrane-bound organelles found in mammalian cells.

(a) Scientists measured the concentration of cholesterol in the membranes of lysosomes in a mammalian cell.

The concentration of cholesterol in the lysosome membranes was found to be lower than the concentration in other membranes inside mammalian cells.

(i) State how a lower concentration of cholesterol would make the properties of lysosome membranes different from other membranes in mammalian cells.

.....

.....

..... [1]

(ii) Suggest why the lower concentration of cholesterol in lysosome membranes would help lysosomes carry out their function.

.....

.....

..... [1]

(b) The enzyme α-galactosidase is present in lysosomes.

Students investigated the effect of substrate concentration on the rate of reaction catalysed by α-galactosidase at pH 4.5 and at pH 5.9.

The results are shown in Fig. 4.1.

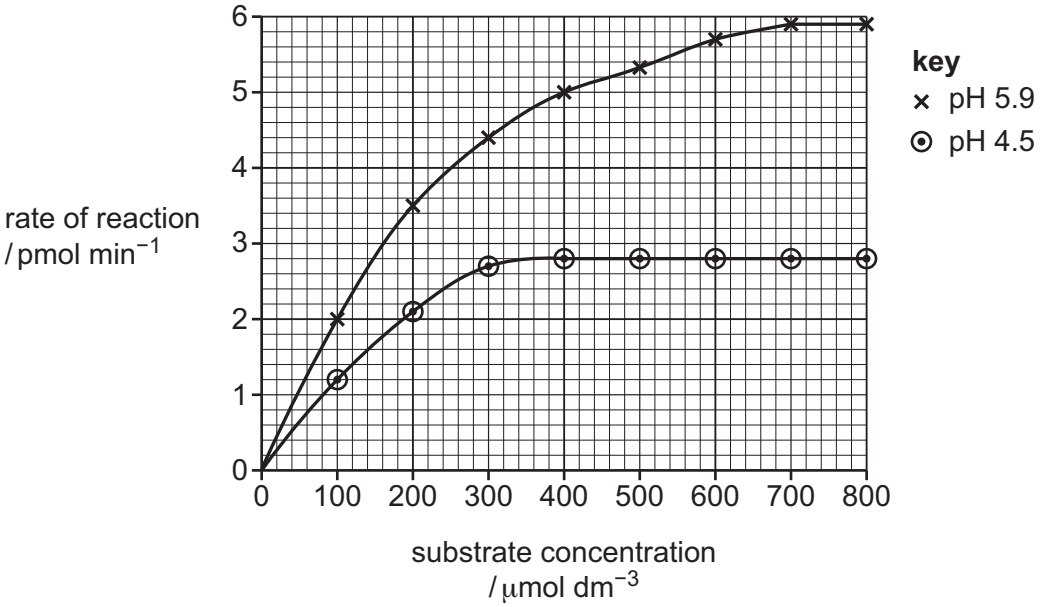


Fig. 4.1

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(i) Determine the Michaelis–Menten constant, K_m, for α-galactosidase at pH 4.5 using the data in Fig. 4.1.

State the unit for the K_m value in your answer.

K_m = ... unit ..... [2]

(ii) With reference to Fig. 4.1, describe the differences in the results at pH 4.5 and pH 5.9 **and** suggest explanations for the differences.

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[Total: 8]

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5 Telomeres are lengths of DNA that consist of repetitive nucleotide sequences. Telomeres are present in eukaryotic chromosomes.

(a) Outline the role of telomeres in eukaryotic chromosomes.

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..... [3]

(b) Fig. 5.1 shows part of the telomere nucleotide sequence in one of the DNA strands.

A A T C C C A A T C C C A A T C C C

Fig. 5.1

Scientists have found that the DNA in telomeres can be transcribed to produce RNA known as TERRA.

(i) TERRA is transcribed from the DNA nucleotide sequence shown in Fig. 5.1.

Complete Fig. 5.2 to show the six bases in the RNA sequence of TERRA.

DNA sequence:	**A**	**A**	**T**	**C**	**C**	**C**
RNA sequence:	……	……	……	……	……	……

Fig. 5.2

[1]

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(ii) Fig. 5.3 is a diagram showing DNA triplet codes on the non-transcribed strand of a gene and the amino acids coded by the triplets.

The bases in the centre of the diagram represent the first base in a triplet.

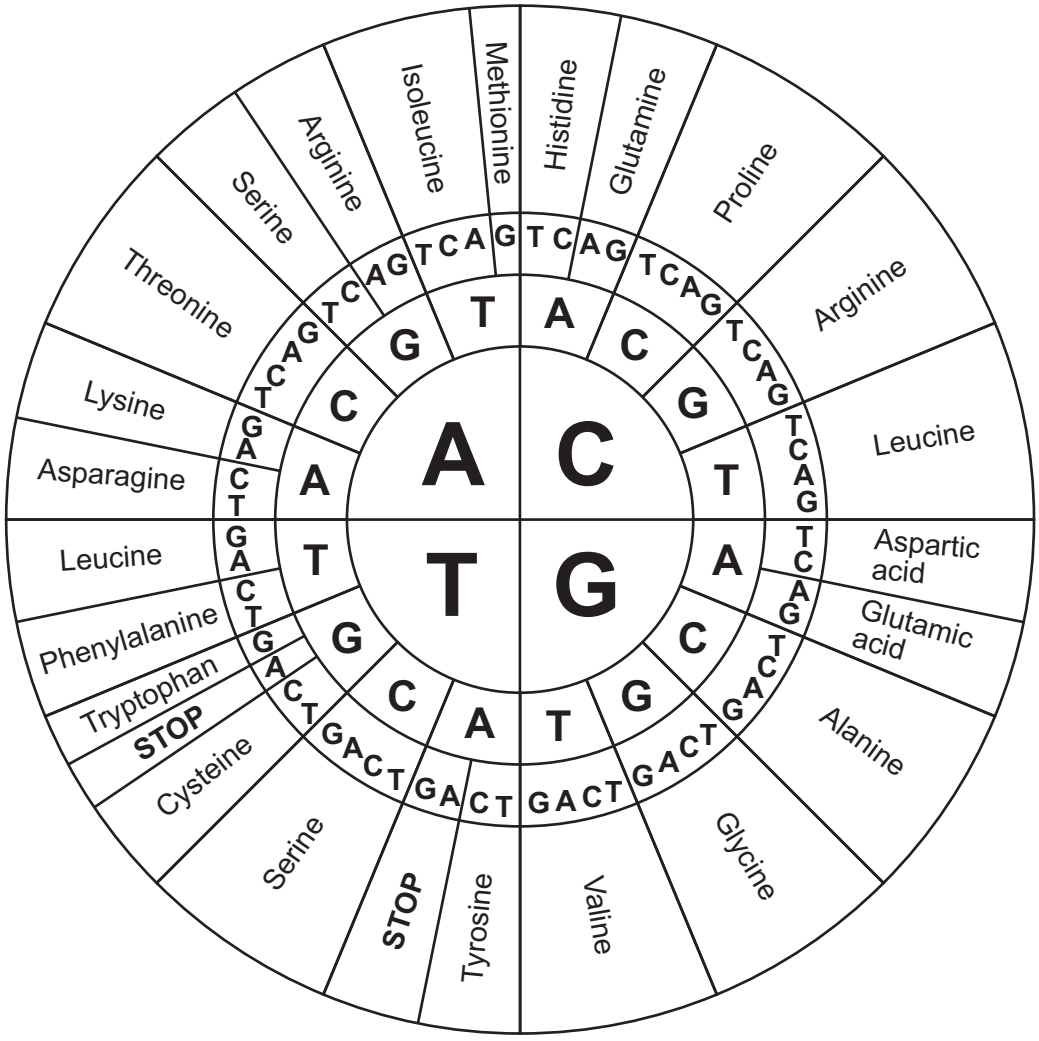


Fig. 5.3

Dipeptides are sometimes translated from TERRA RNA.

Use Fig. 5.3 to state the **two** amino acids in the dipeptide translated from TERRA RNA.

1 .....

2 .....

[2]

(iii) Scientists have discovered that TERRA interacts with genes in stem cells.

Increased concentrations of TERRA in stem cells result in a large increase in the number of genes that are transcribed.

Suggest the result of the large increase in the number of genes that are transcribed in stem cells.

.....

..... [1]

[Total: 7]

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6 Monoclonal antibodies can be used in the treatment of disease.

(a) Describe how monoclonal antibodies are produced using the hybridoma method.

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..... [5]

(b) Abciximab is a drug developed from a monoclonal antibody. Abciximab is used to prevent blood clotting in the coronary arteries in people with coronary heart disease.

Abciximab prevents blood clotting by stopping structures called platelets from binding together.

Fig. 6.1 shows platelets and abciximab in a coronary artery.

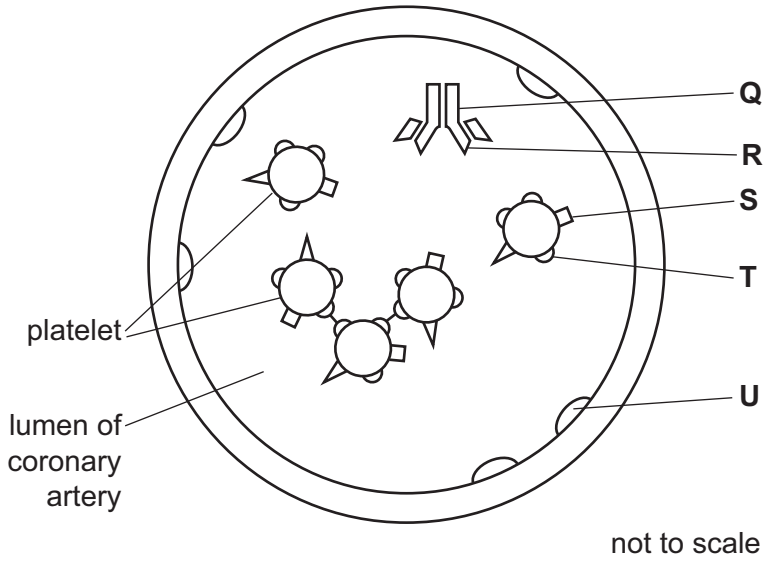


Fig. 6.1

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State the letter in Fig. 6.1 that represents:

- the target antigen for abciximab ……..
- the constant region of abciximab ……..
- one of the antigen binding sites of abciximab …….. .

[3]

(c) Coronary arteries supply oxygenated blood to the cells of the heart.

The passage outlines the cardiac cycle of the heart and the structures in the heart that control the cycle.

Complete the passage by using the most appropriate scientific terms.

The sinoatrial node is located in the wall of the ……..., one of four chambers of the mammalian heart. Electrical impulses from the sinoatrial node reach the atrioventricular node, which transmits impulses towards the apex of the heart along a series of specialised muscle fibres called ……. Pressure increases in the ventricles when they contract in the stage of the cardiac cycle known as ……..

[3]

[Total: 11]

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CANDIDATE NAME

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1071419553

BIOLOGY **9700/24**

Paper 2 AS Level Structured Questions **May/June 2025**

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 [ ].

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1 In the roots of plants, specialised tissues are formed from a region in the root tip known as the root apical meristem.

Fig. 1.1 shows the different regions of a root tip.

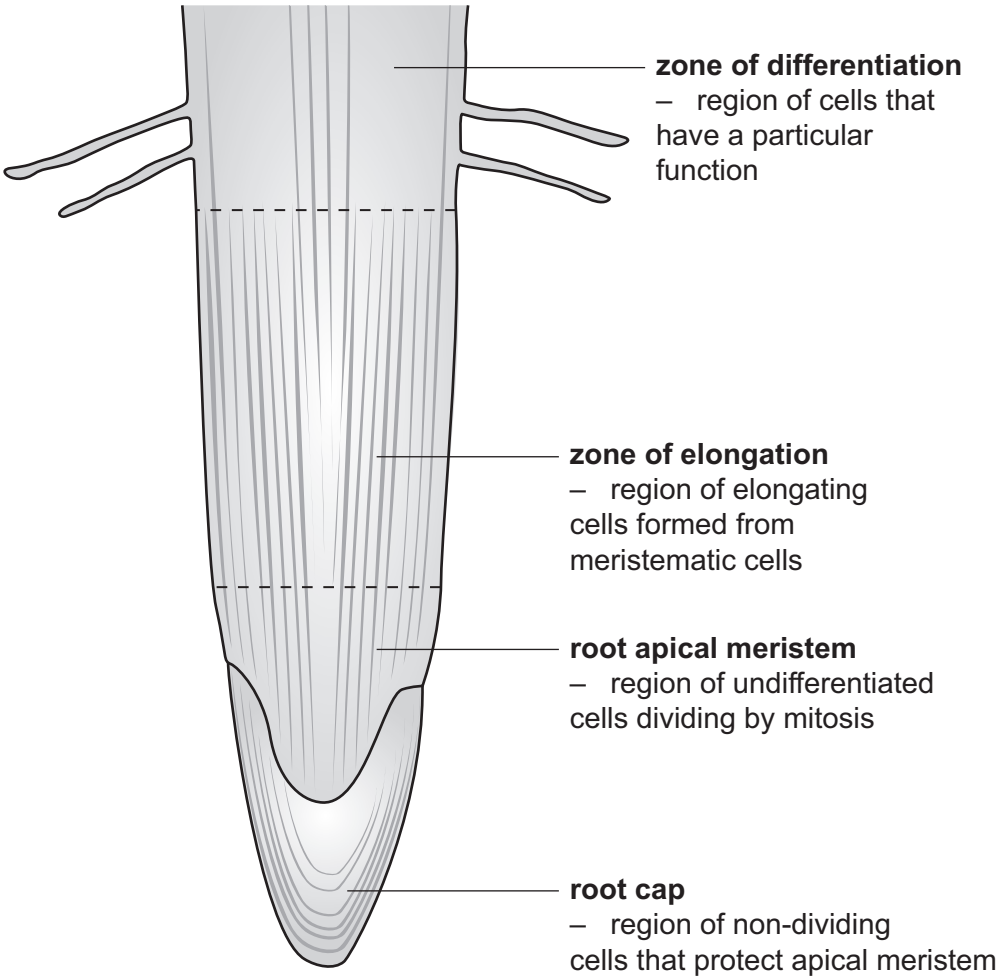


Fig. 1.1

(a) Cells in all stages of mitosis will be visible in the root apical meristem by using the high power of a light microscope.

(i) Name the stage of mitosis during which the chromosomes are arranged at the spindle equator of the cell.

..... [1]

(ii) Early in mitosis, the nuclear envelope breaks up into vesicles and so will not be seen in some cells in the root apical meristem.

Name the stage of mitosis during which the vesicles fuse to form new nuclear envelopes.

..... [1]

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(b) In the zone of elongation, shown in Fig. 1.1, the newly formed cells expand and elongate.

Two main events that occur in these cells are:

- the entry of water into the cells
- the formation of the large vacuole.

(i) Outline the process by which water enters the cells.

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..... [3]

(ii) Outline the structure of a fully mature plant vacuole.

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.....

..... [2]

(c) In the zone of differentiation, shown in Fig. 1.1, two types of vascular (transport) tissue form: xylem and phloem.

Draw a diagram showing the distribution of the vascular tissue as seen in a transverse section of a root in the zone of differentiation.

[2]

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(d) Starch can be stored in the roots of plants. This can be converted to sucrose, which is loaded into phloem sieve tubes for transport within the phloem sap to growing areas in the stem.

After loading of sucrose into phloem sieve tubes, the transport of phloem sap occurs by mass flow.

Explain how the phloem sap is moved within the sieve tubes by mass flow from the root storage areas to the growing areas of the stem.

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[Total: 13]

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2 The human pancreas synthesises and secretes a number of different digestive enzymes. These enzymes have their effect in the small intestine.

Pancreatic lipase acts by breaking the bond between glycerol and fatty acids in triglycerides.

(a) State the term used to describe any enzyme that is secreted to the outside of the cell where it has its effect.

..... [1]

(b) One of the triglycerides found in olive oil is shown in Fig. 2.1.

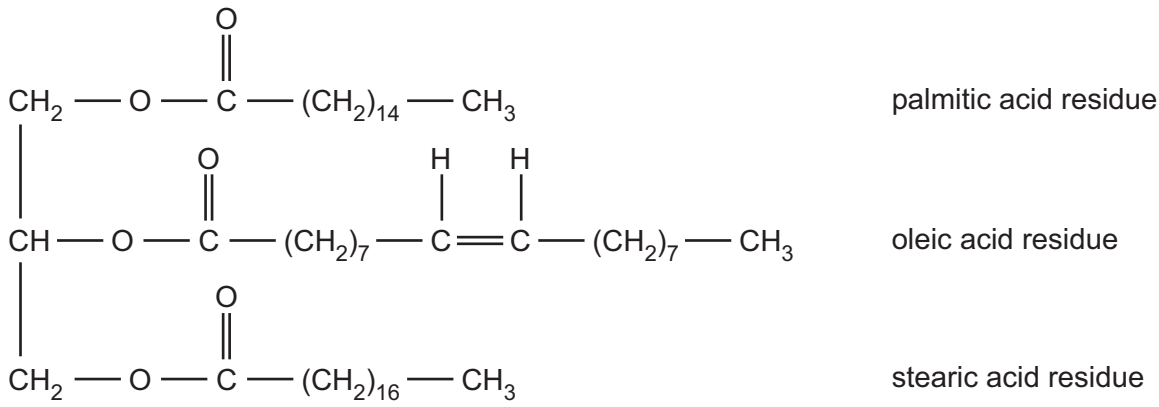


Fig. 2.1

(i) Draw an arrow on Fig. 2.1 to show where the bond between the glycerol residue and the stearic acid residue is broken by lipase digestion. [1]

(ii) State the type of reaction that occurs to produce stearic acid from this triglyceride **and** name the type of bond that is broken.

type of reaction .....

type of bond .....
[2]

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Investigations were carried out into the activity of a lipase extracted from a strain of bacterium that lives in hot springs.

(c) The activity of the bacterial lipase was measured at 37 °C using different concentrations of olive oil as the substrate.

The results were used to derive a Michaelis–Menten constant (K_m) of 91.76 mmol dm^{-3}.

Explain what is meant by a K_m of 91.76 mmol dm^{-3}.

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..... [2]

(d) Fig. 2.2 shows the results of an investigation into the effect of temperature on the activity of the bacterial lipase.

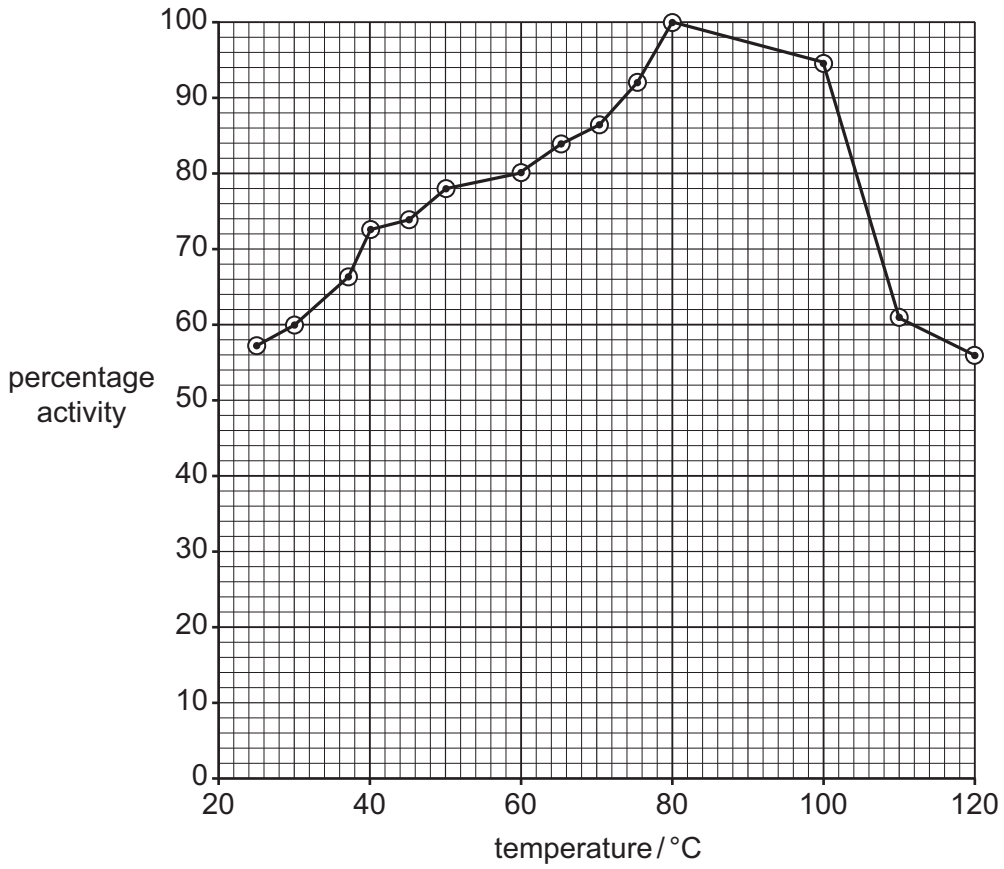


Fig. 2.2

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(i) Describe **and** explain the results shown in Fig. 2.2.

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(ii) An investigation using human pancreatic lipase at the same range of temperature will produce different results from those shown in Fig. 2.2.

Predict how the trend will be different from that shown in Fig. 2.2.

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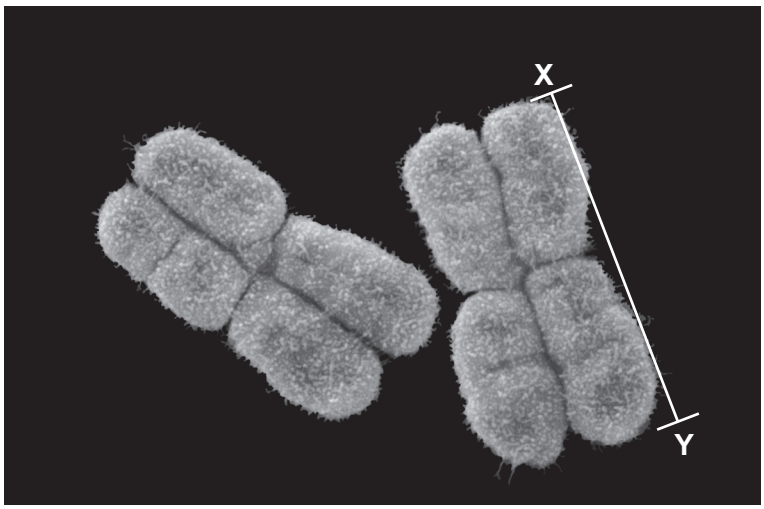
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3 Fig. 3.1 is a scanning electron micrograph of a pair of human chromosomes in a stage of the mitotic cell cycle.



magnification ×8625

Fig. 3.1

(a) Calculate the actual length, to the nearest 0.1 μm, of the chromosome in Fig. 3.1 indicated by the line **X**–**Y**.

Write the formula you used to make your calculation.

formula

actual length = ... μm [2]

(b) Outline **one** feature of Fig. 3.1 that confirms the microscope used to obtain the image is a scanning electron microscope and **not** a transmission electron microscope.

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..... [1]

(c) With reference to Fig. 3.1, explain how it is possible to deduce that DNA replication has already occurred.

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[Total: 4]

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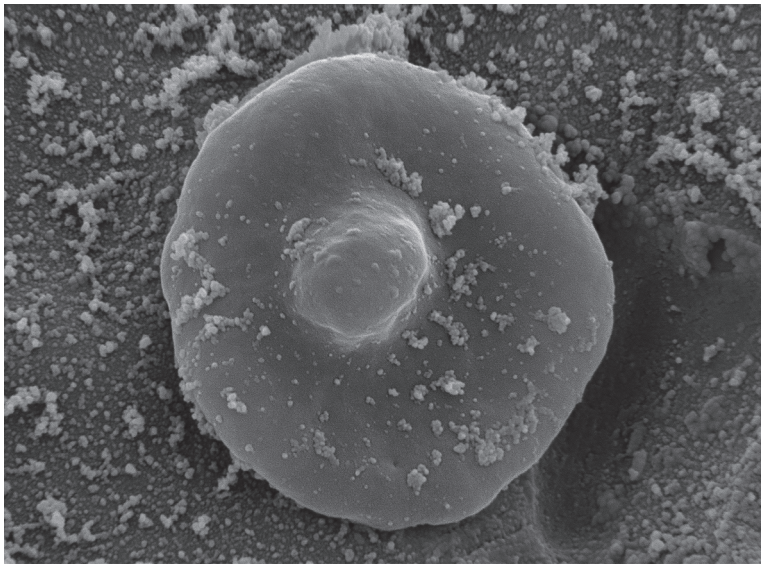
4 A number of species in the genus *Plasmodium* are known to cause malaria in humans.

Plasmodium has a complex life cycle with a number of different structural forms. The merozoite is one form of the pathogen that is present in human hosts.

(a) State the type of organism that causes malaria.

..... [1]

Fig. 4.1 is a scanning electron micrograph of a red blood cell infected with merozoites. Debris (waste particles) from the preparation of the electron micrograph is also shown.



magnification ×23 000

Fig. 4.1

(b) State the difference between the appearance of the red blood cell shown in Fig. 4.1 and a healthy red blood cell.

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..... [1]

(c) When *Plasmodium* is present within mature red blood cells there is a decrease in concentration of haemoglobin in these infected cells.

Suggest why the concentration of haemoglobin within the infected red blood cells decreases.

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..... [1]

A protein known as merozoite surface protein 1 (MSP1) is found as part of the cell surface membrane of merozoites. All species of *Plasmodium* that cause malaria have MSP1. The protein is used to help *Plasmodium* enter human red blood cells.

(d) MSP1 is composed of a single polypeptide, which is coded for by gene *MSP1*.

Some of the steps occurring in the synthesis of MSP1 by *Plasmodium* are described in Table 4.1. They are **not** listed in the correct sequence.

Table 4.1

step	description
A	tRNA, following amino acid activation, attaches to ribosome
B	mRNA passes through nuclear pores
C	a stop codon is reached and the polypeptide is released
D	DNA double helix unwinds
E	codon–anticodon binding occurs
F	RNA polymerase forms phosphodiester bonds
G	peptide bond formation occurs
H	mRNA attaches to ribosome

Use the steps described in Table 4.1 to complete Table 4.2 to show the correct sequence of events as they would occur in the synthesis of MSP1.

Two of the steps have been added to Table 4.2 for you.

Table 4.2

correct sequence	step
1	
2	
3	
4	**H**
5	
6	
7	
8	**C**

[4]

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(e) The MSP1 protein has three levels of protein structure: primary, secondary and tertiary.

Outline the changes that occur after translation to a polypeptide, such as the MSP1 polypeptide, that result in a protein showing secondary and tertiary structure.

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(f) Subunit vaccines are vaccines that contain non-self antigens, but do **not** contain whole organisms. The aim is to stimulate a primary immune response after the vaccine is given so that the person gains artificial active immunity.

One trial that has been carried out on human volunteers has used MSP1 from *Plasmodium falciparum* in a subunit vaccine against malaria.

Explain why a vaccine containing MSP1 provides artificial active immunity to malaria.

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(g) The female *Anopheles* mosquito is the vector of *Plasmodium*.

Discuss the ways in which the vector is controlled to help prevent the transmission of malaria.

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5 The human gas exchange system is responsible for the efficient uptake of oxygen into the blood and for the excretion of carbon dioxide.

The different tissues of the human gas exchange system are each adapted to their specific function.

(a) Ciliated epithelium is a lining tissue found in the human gas exchange system. The tissue is composed of ciliated epithelial cells and goblet cells.

Squamous epithelium is a lining tissue found in the walls of the alveoli.

(i) Squamous epithelial cells do **not** have cilia, unlike ciliated epithelial cells.

Suggest why ciliated epithelial cells are **not suitable** as the lining tissue in the walls of alveoli.

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..... [2]

(ii) Goblet cells and mucous glands function to maintain the health of the gas exchange system. They produce mucus that traps pathogens and other particles, such as dust.

Explain why ciliated epithelial cells are also important in maintaining the health of the gas exchange system.

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..... [2]

(b) The statements in Fig. 5.1 refer to the saturation of haemoglobin with oxygen in blood leaving the alveolar capillaries.

For a healthy person who inhales air in areas with **no air pollution**, the saturation of haemoglobin with oxygen can be as high as 99%. For the same healthy person who inhales air in areas with **high air pollution**, the saturation of haemoglobin with oxygen is often lower than 99%.

Fig. 5.1

Suggest explanations for the differences stated in Fig. 5.1.

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6 The sinoatrial node (SAN), the atrioventricular node (AVN) and the Purkyne fibres have a role in the initiation and control of heart action.

(a) The sinoatrial nodal artery (SN artery) is a branch of one of the main arteries serving the cardiac muscle. Partial blockage of the SN artery as a result of cardiovascular disease can cause the SAN to malfunction.

(i) Name the main artery serving the cardiac muscle from which the SN artery branches.

..... [1]

(ii) With reference to the role of the SAN, suggest how a slow rate of ventricular contraction could indicate that the SAN is **not** functioning correctly.

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(b) In people with Wolff–Parkinson–White syndrome, there is a bundle of fibres known as the bundle of Kent. These fibres can conduct impulses from the atria to the ventricles. This means that impulses do **not** always take the normal route through the AVN to the ventricles.

With reference to the role of the AVN, suggest **and** explain the change that occurs in the heart rate when impulses pass down the bundle of Kent to the ventricles instead of passing through the AVN.

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