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.

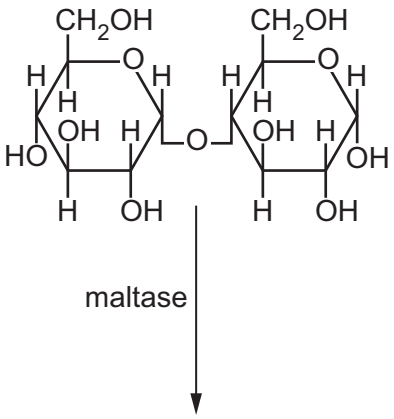



**Fig. 1.1**

**(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.

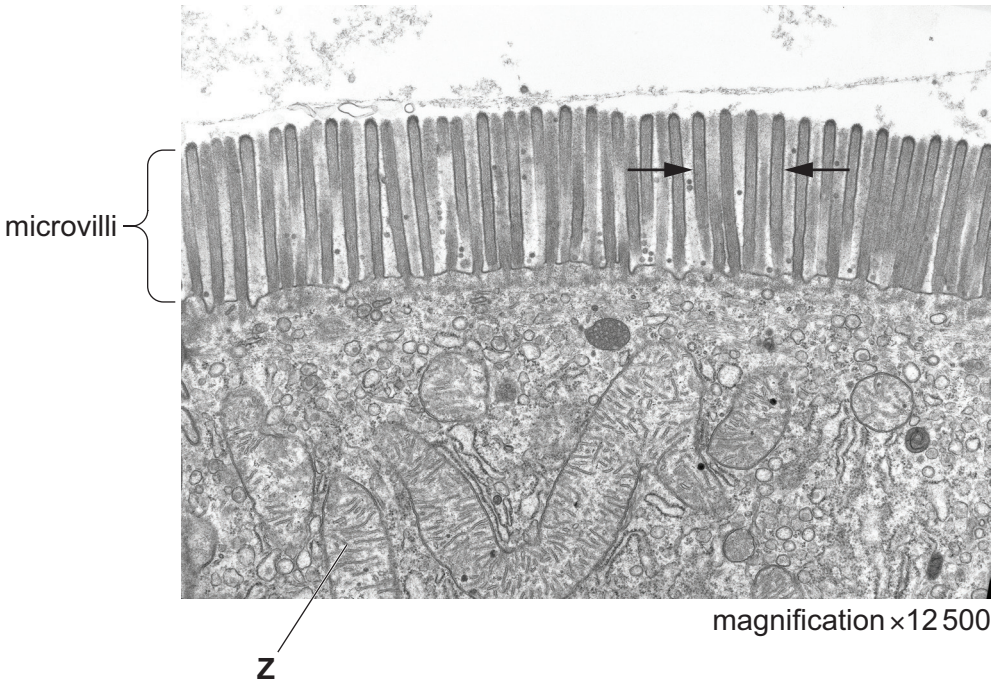



**Fig. 2.1**

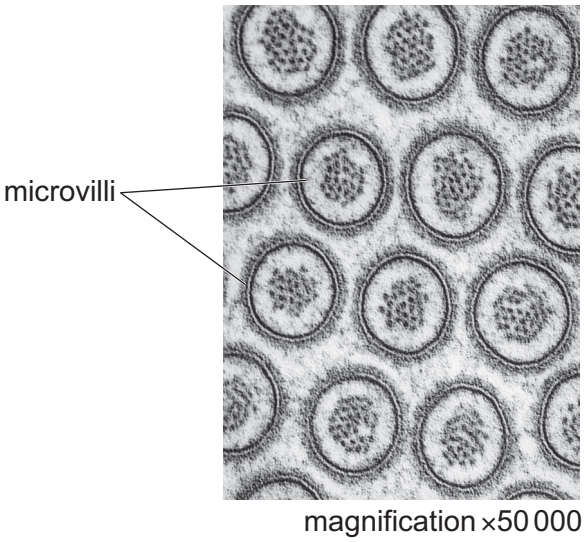



**Fig. 2.2**

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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.

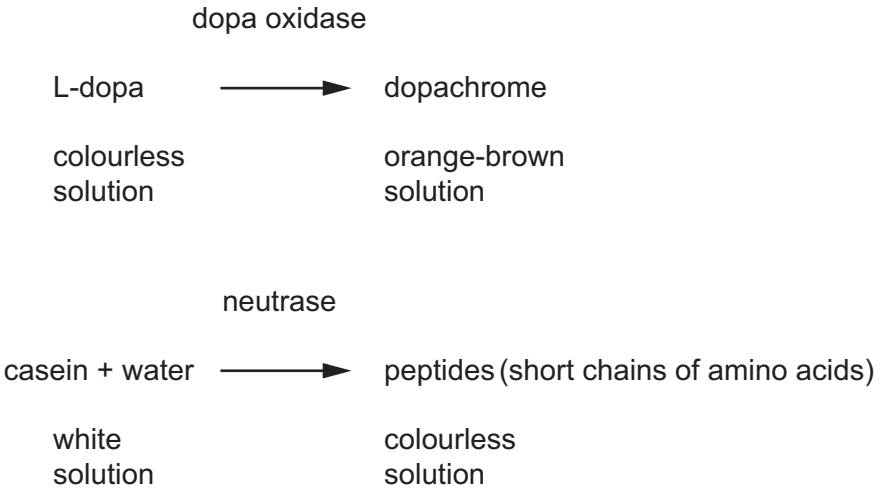



**Fig. 3.1**

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.

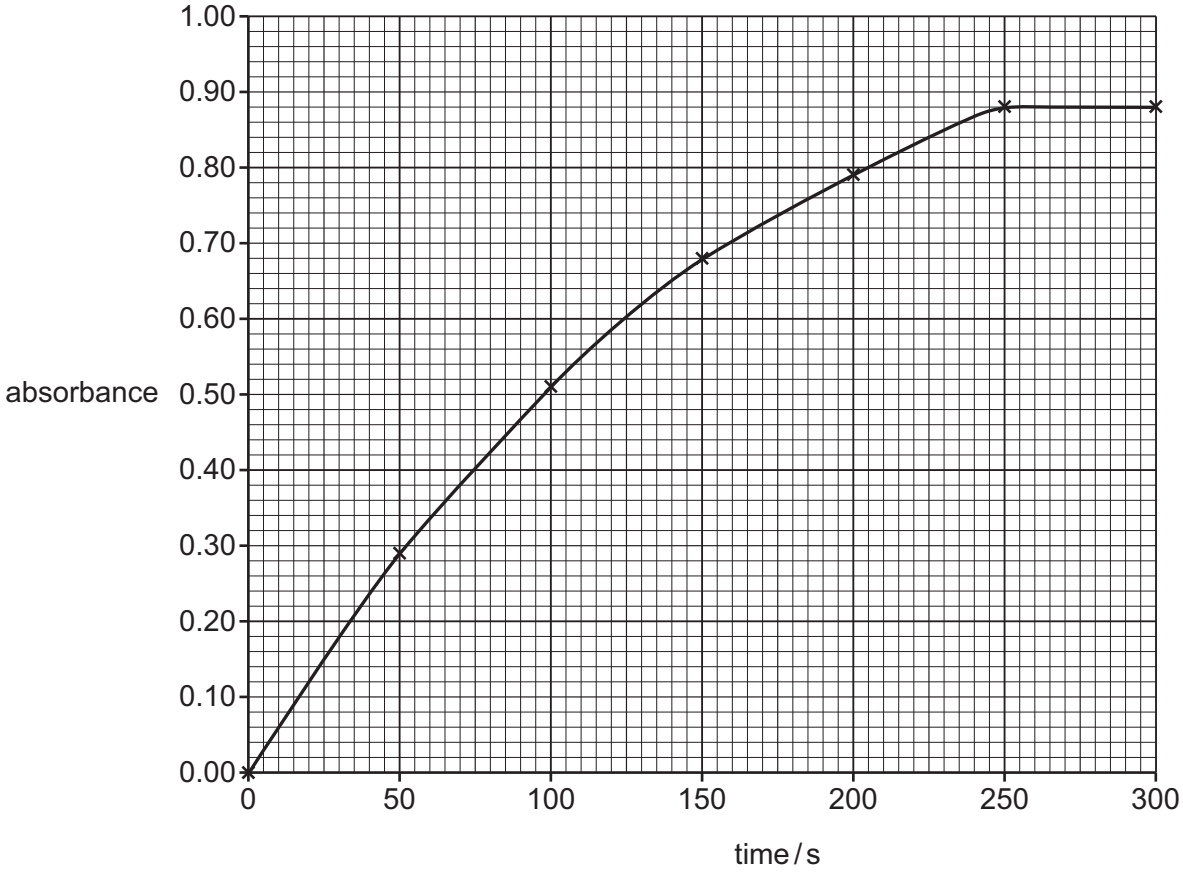



**Fig. 3.2**

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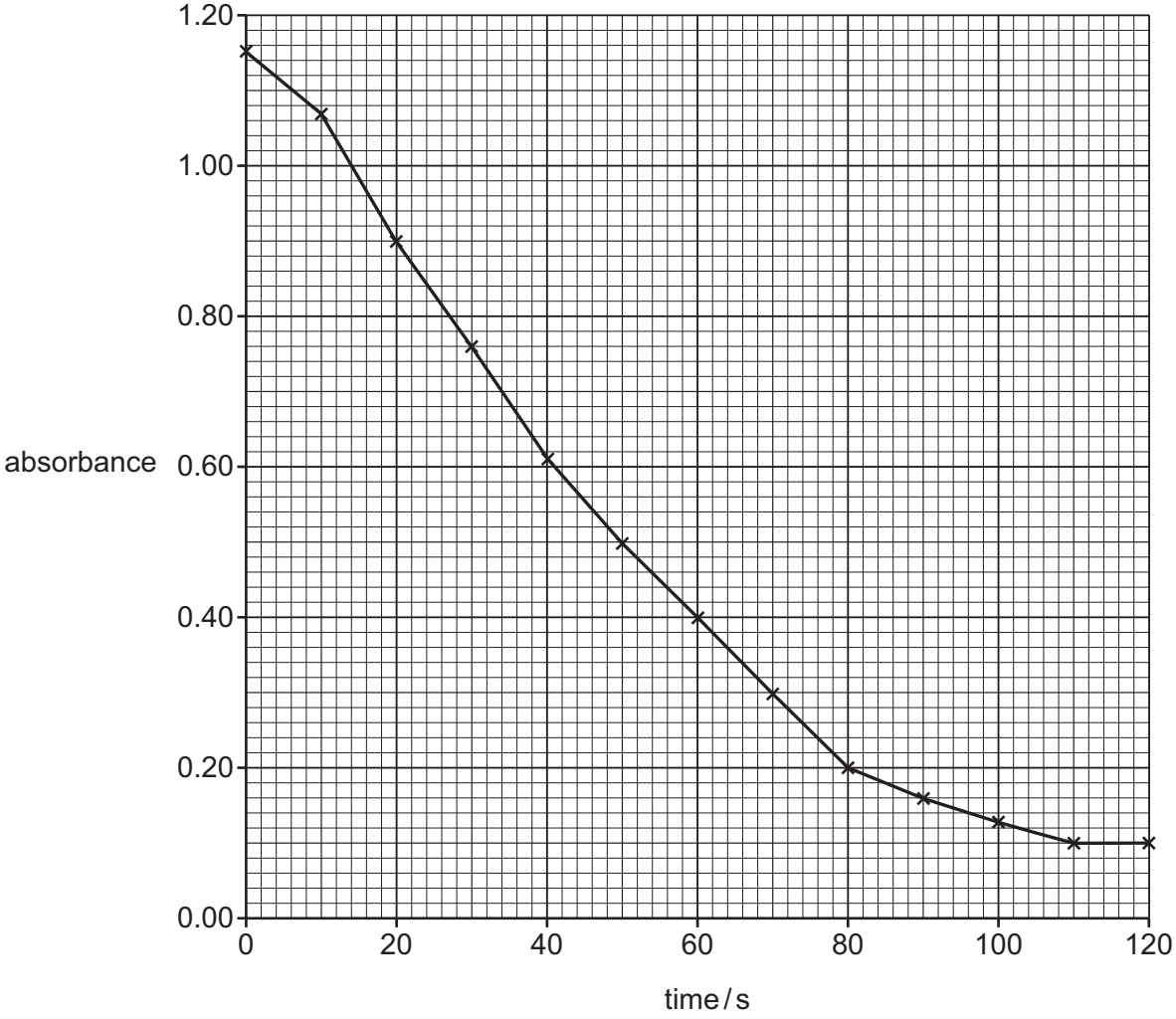



**Fig. 3.3**

**(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.

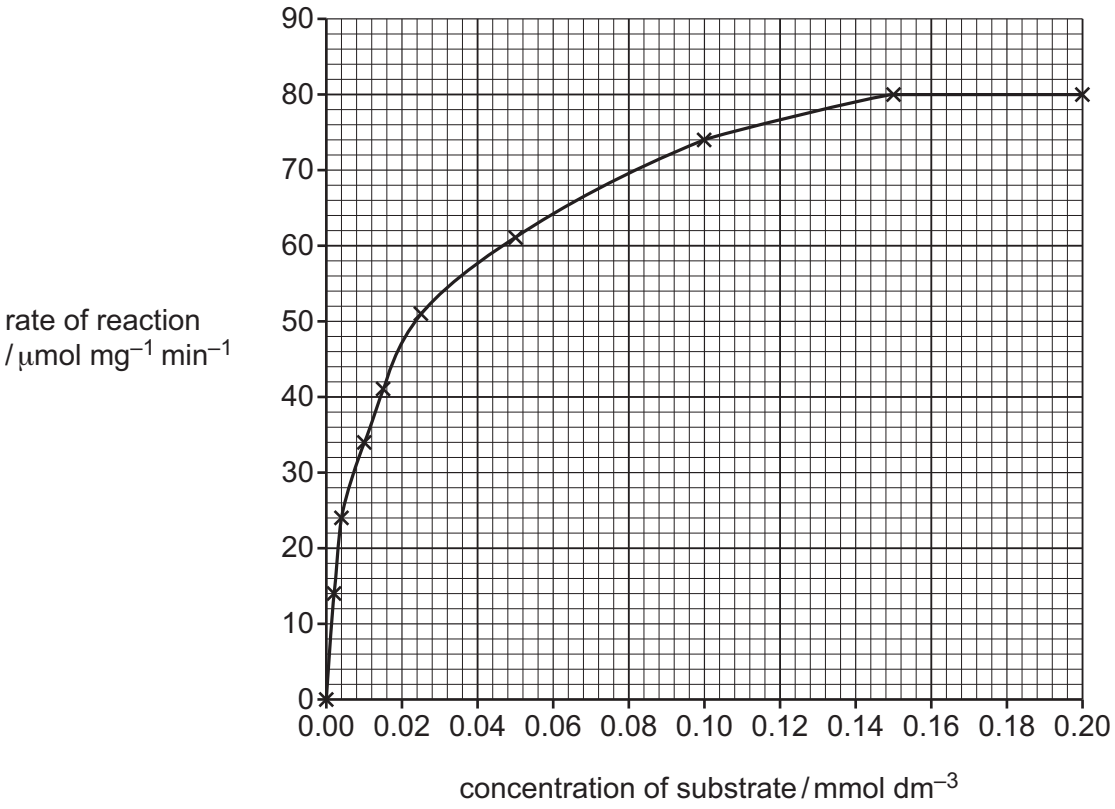



**Fig. 3.4**

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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.

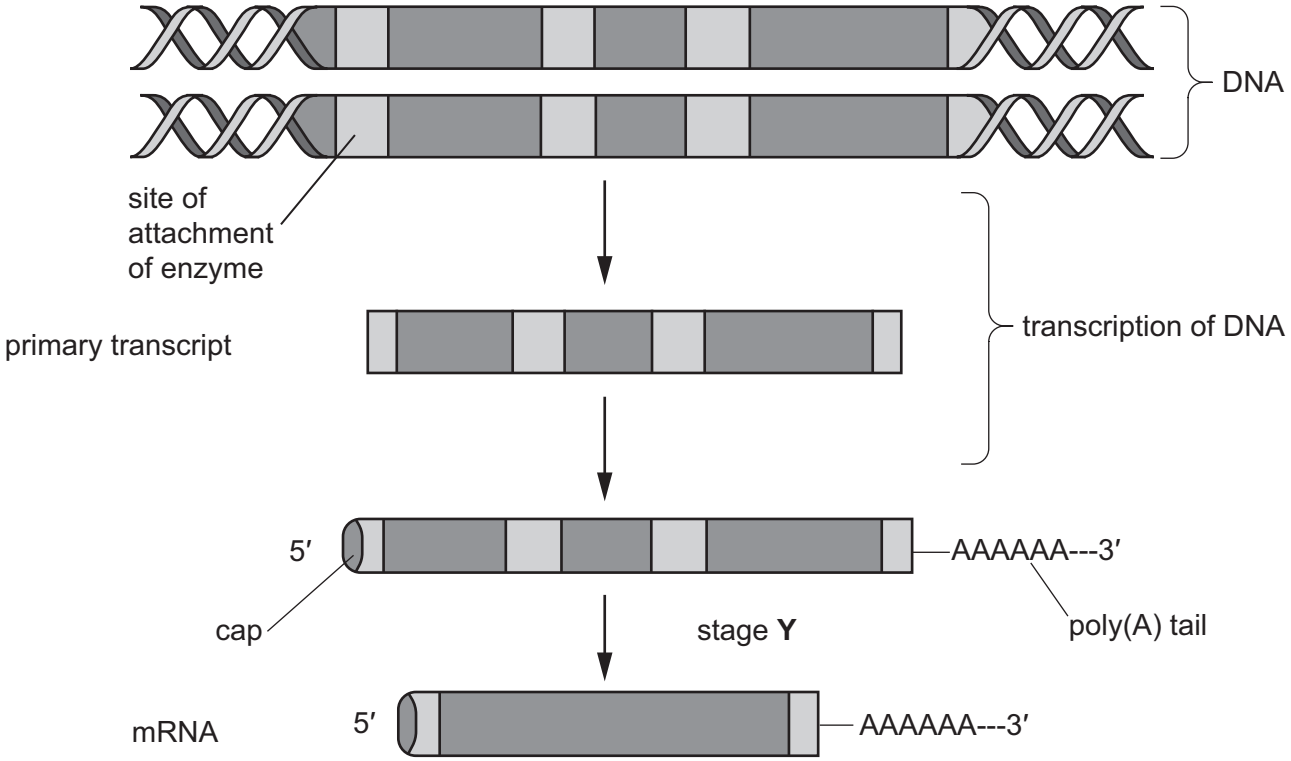



**Fig. 4.1**

**(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.

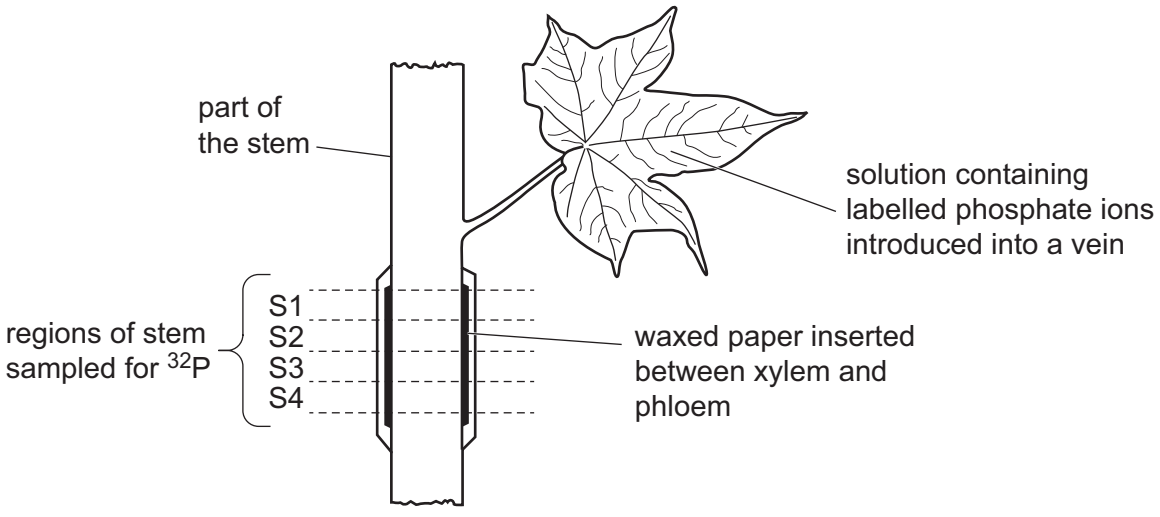



**Fig. 5.1**



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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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[Total: 6]

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

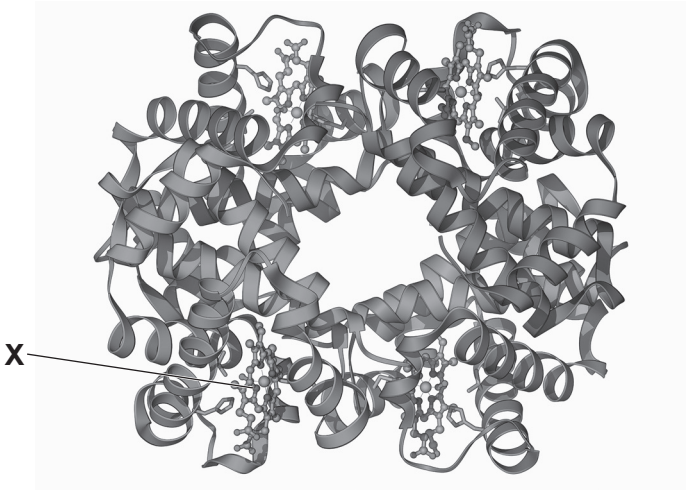



**Fig. 6.1**

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

..... [1]

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

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..... [1]

**(iii)** Haemoglobin is described as having quaternary structure.

State what is meant by quaternary structure.

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..... [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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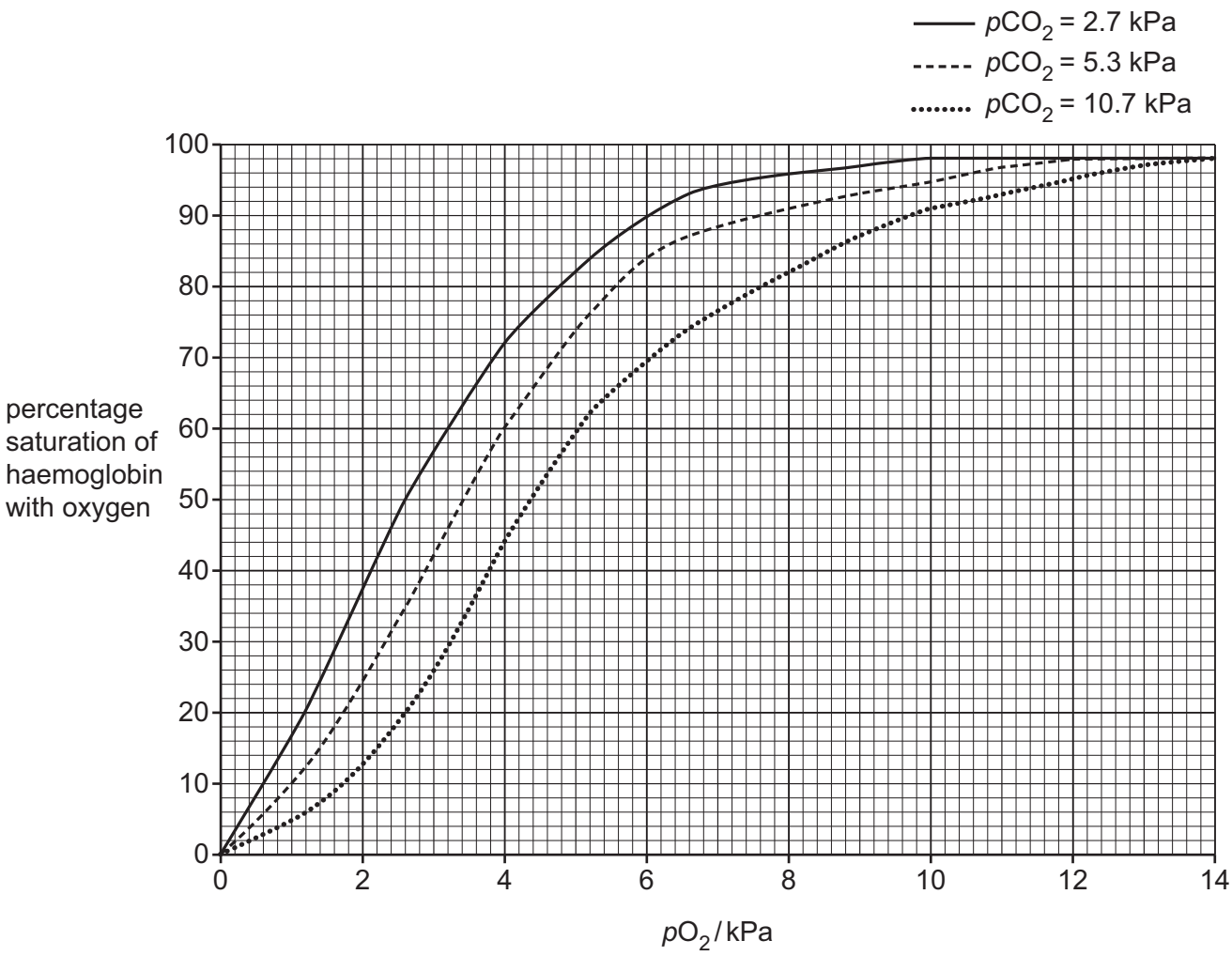



**Fig. 6.2**

**(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.

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**(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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