GradeMax

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Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER



BIOLOGY **9700/22**

Paper 2 AS Level Structured Questions **February/March 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 **24** pages. Any blank pages are indicated.

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1 *Smilax china* is a herbaceous plant.

Fig. 1.1 shows part of a transverse section of a root of *S. china* with root hair cells visible.

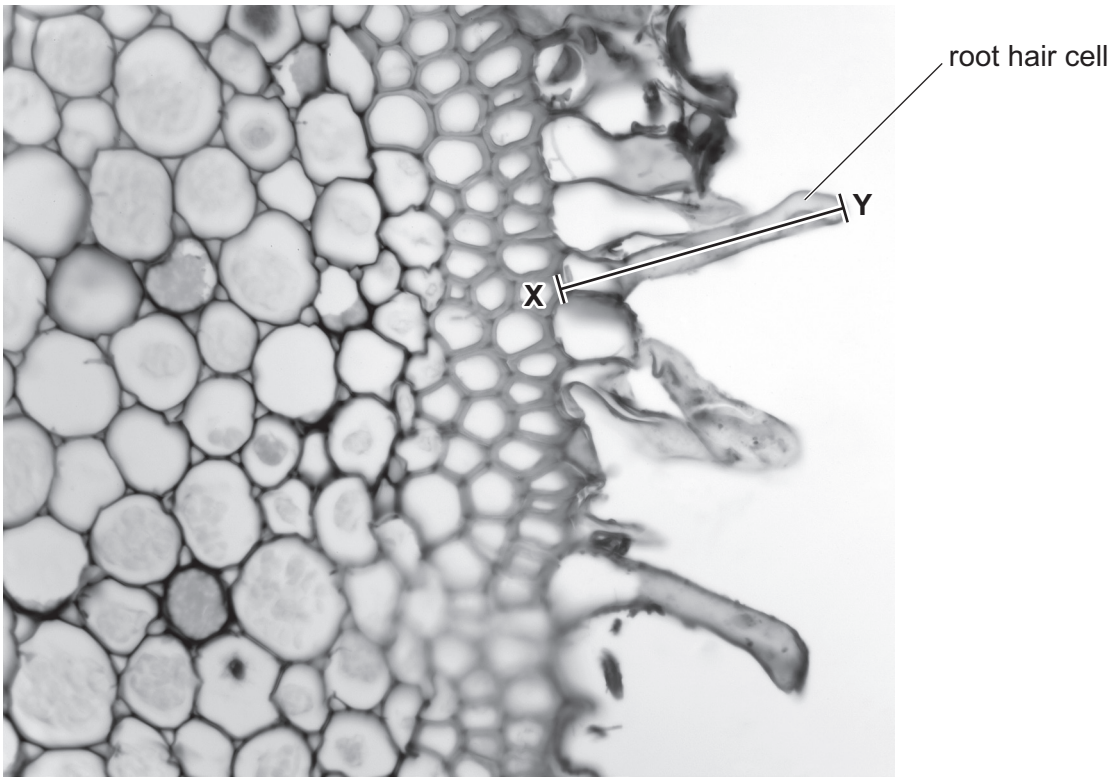


Fig. 1.1

(a) Name the type of microscope that has been used to obtain the image in Fig. 1.1.

..... [1]

(b) Calculate the **actual** length, in micrometres (μm), of the root hair cell labelled in Fig. 1.1. Use the **image** length of the root hair cell along line **X–Y** in your calculation.

actual length = ... μm [1]

(c) Root hairs are important adaptations of root hair cells for the uptake of water.

Explain **one** way in which root hairs adapt root hair cells for the uptake of water.

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(d) Mineral ions are taken up by root hair cells.

Table 1.1 shows the concentrations of sodium ions (Na^+) and potassium ions (K^+) inside the root hair cells of a plant root and in the soil solution surrounding the root.

Table 1.1

concentration of Na^+ / g dm^{-3}		concentration of K^+ / g dm^{-3}	
root hair cell	**soil solution**	**root hair cell**	**soil solution**
0.35	3.34	5.46	0.16

With reference to Table 1.1:

- suggest the mechanisms involved in the transport of Na^+ and K^+ from the soil solution into the root hair cells
- state the reasons for your suggestions.

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(e) The region between the outer layer of a root and the endodermis is known as the cortex. Table 1.2 shows the water potential of two adjacent cells, **A** and **B**, in the cortex of a root.

Table 1.2

water potential / kPa	
cortex cell A	**cortex cell B**
–120	–350

With reference to Table 1.2, explain the direction of water movement between cell **A** and cell **B**.

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(f) Some types of soil are made of small negatively charged clay particles that attract and bind to positive ions such as iron ions (Fe^{2+}).

Fe^{2+} that is bound to clay particles **cannot** be absorbed by root hair cells. This reduces the concentration of free Fe^{2+} that is available in soil solution for absorption.

Some plants that grow in soils containing a high proportion of clay particles are able to increase the concentration of free Fe^{2+} in the soil solution for absorption. In these plants, the carbon dioxide released by the respiration of root hair cells reacts with water in the soil solution, which changes the pH of the soil solution. This affects the binding of positively charged ions, such as Fe^{2+}, to clay particles.

Fig. 1.2 shows the results of one investigation into the effect of pH on the concentration of free Fe^{2+} that is available in soil solution for absorption by root hair cells. The soil sample analysed in this investigation was from a soil that contained a high proportion of clay particles.

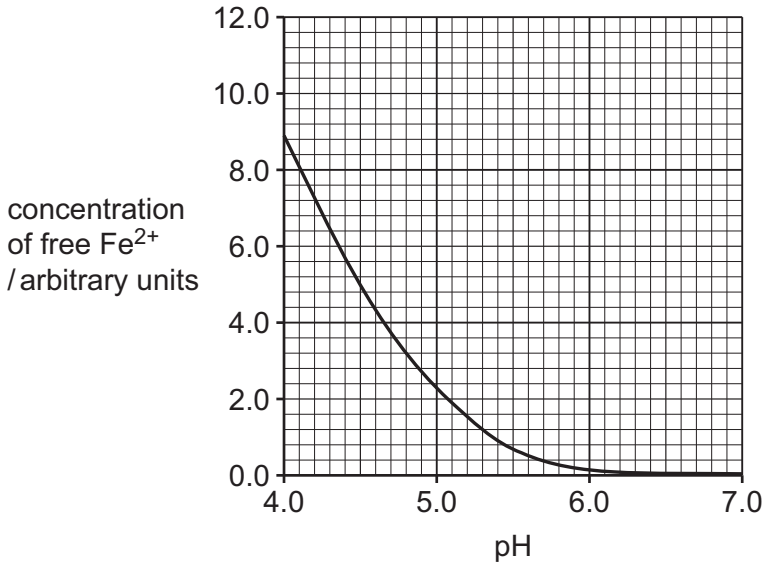


Fig. 1.2

(i) With reference to Fig. 1.2, suggest **and** explain how the carbon dioxide released by the respiration of root hair cells can increase the concentration of free Fe^{2+} for absorption by root hair cells.

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(ii) Dissolved Fe^{2+} is transported across the tissues of the root to the xylem.

When the amount of dissolved Fe^{2+} absorbed by root hair cells is greater than the amount that is needed by the plant, not all of the Fe^{2+} that is absorbed is transported to the xylem.

Suggest how the endodermis can reduce the amount of Fe^{2+} reaching the xylem.

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2 **(a)** Fig. 2.1 is an incomplete diagram of the structure of an α-glucose molecule.

Complete Fig. 2.1 to show the structure of an α-glucose molecule.

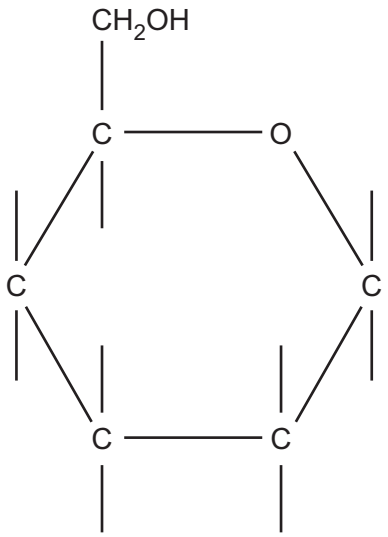


Fig. 2.1

[2]

(b) Fig. 2.2 shows part of a glycoprotein molecule.

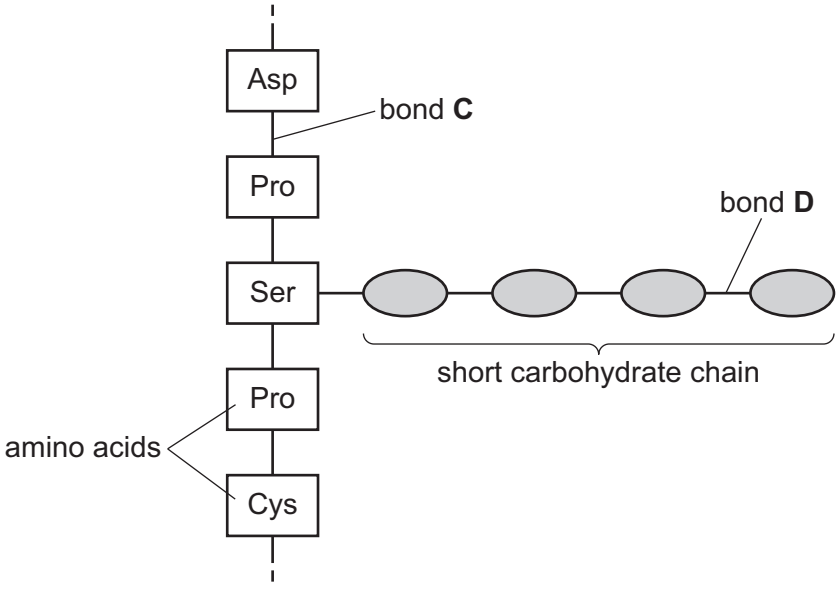


Fig. 2.2

(i) State the types of covalent bond labelled **C** and **D** in Fig. 2.2.

C .....

D .....

[2]

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(ii) Many glycoproteins in the cell surface membrane are involved in cell signalling.

State the role in cell signalling of glycoproteins in cell surface membranes.

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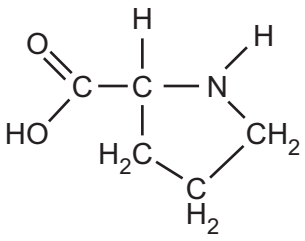
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(c) One of the proteins found in milk is β-casein.

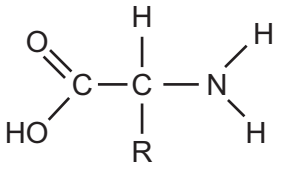
A molecule of β-casein consists of a single polypeptide of approximately 200 amino acids.

Molecules of β-casein have a **high** proportion of the amino acids proline and leucine. These amino acids have hydrophobic R-groups.

Fig. 2.3 compares the structure of proline (Pro) with the general structure of an amino acid. This shows that proline is an unusual amino acid because it has a cyclic R-group and the nitrogen atom is attached to only one hydrogen atom.



proline



general structure of an amino acid

Fig. 2.3

When a molecule of proline becomes part of a polypeptide, the hydrogen atom is lost from the nitrogen atom and is therefore **not** available for the formation of hydrogen bonds.

Molecules of β-casein have a relatively **low** proportion of the amino acids cysteine and serine. Table 2.1 shows the R-groups of cysteine and serine.

Table 2.1

amino acid	R-group	feature of R-group
cysteine (Cys)	$—CH_2SH$	can form a disulfide bond
serine (Ser)	$—CH_2OH$	hydroxyl group present

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Compared to other protein molecules with a similar number of amino acids, β-casein molecules have:

- a much less organised secondary structure
- relatively little tertiary structure.

With reference to the four named amino acids, proline, leucine, serine and cysteine, suggest possible explanations for these **two** observations.

less organised secondary structure .....

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relatively little tertiary structure .....

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3 Fig. 3.1 and Fig. 3.2 are diagrams of transverse sections of the human heart during different stages of the cardiac cycle. The sections pass through the heart at a level that is just above the valves.

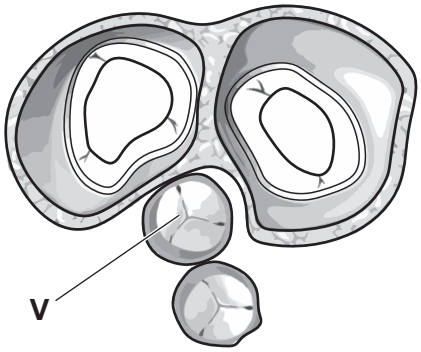


Fig. 3.1

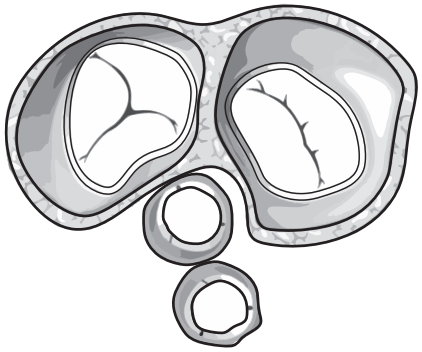


Fig. 3.2

(a) (i) Name the valve labelled **V** on Fig. 3.1.

..... [1]

(ii) With reference to the chambers of the heart and the main blood vessels, describe the flow of blood through the heart that occurs when the transverse section of the heart appears as shown in Fig. 3.1.

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(b) Identify the stage of the cardiac cycle shown in Fig. 3.2.

Give a reason for your answer.

stage of cardiac cycle .....

reason .....

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[2]

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(c) The rate and rhythm of the heartbeat are controlled by an area of specialised muscle tissue in the wall of the right atrium, called the sinoatrial node.

Describe the sequence of events that control contraction of the ventricles during the cardiac cycle.

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4 **(a)** Vaccination programmes are widely used to help control the spread of infectious diseases.

(i) State why some diseases are described as infectious.

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(ii) A person was given an injection to give protection against infectious disease **E**. The person had **not** previously been infected with disease **E**. 26 days later, a second injection to give protection against disease **E** was given.

The concentration in the blood of the antibody specific to disease **E** was measured over a period of 60 days from the time of the first injection.

Fig. 4.1 shows the concentration of the antibody in the blood over the period of 60 days.

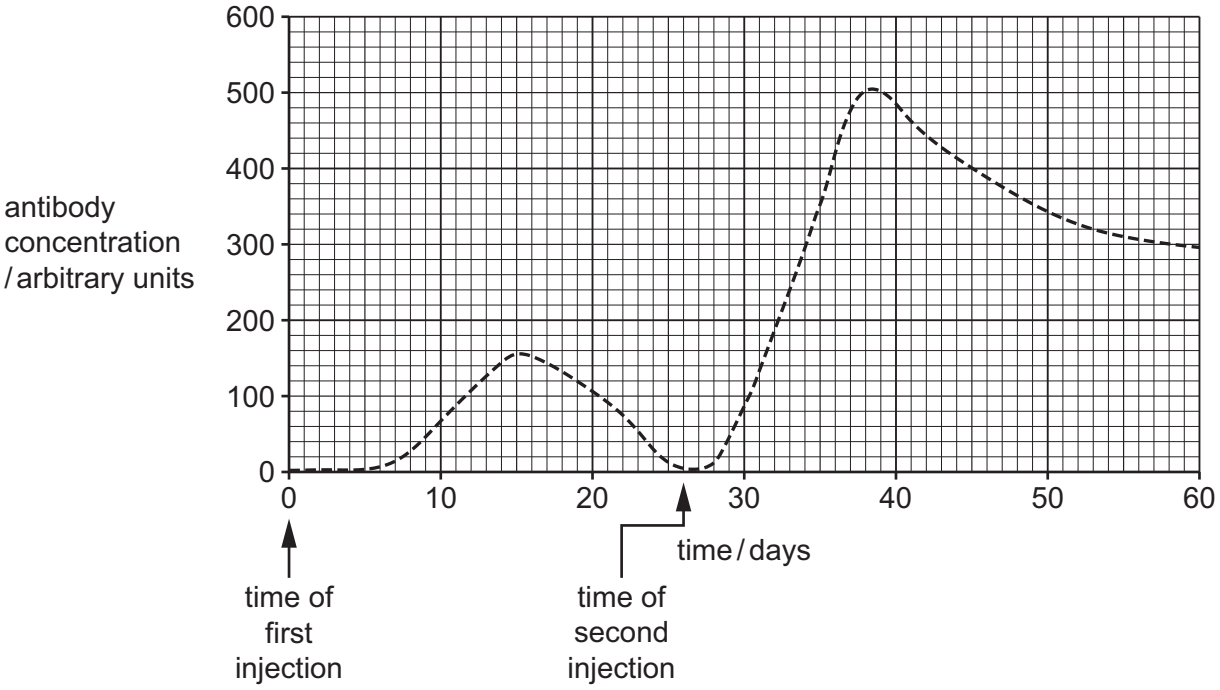


Fig. 4.1

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The concentration of the antibody in the blood after the second injection was higher than the concentration after the first injection.

Explain why the concentration of the antibody in the blood was higher after the second injection than after the first injection.

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(b) A second person was given a different injection to give protection against another infectious disease, infectious disease **F**. The person had **not** previously been infected with disease **F**.

The concentration in the blood of the antibody specific to disease **F** was measured over a period of 60 days from the time of the injection.

Fig. 4.2 shows the concentration of the antibody in the blood over the period of 60 days.

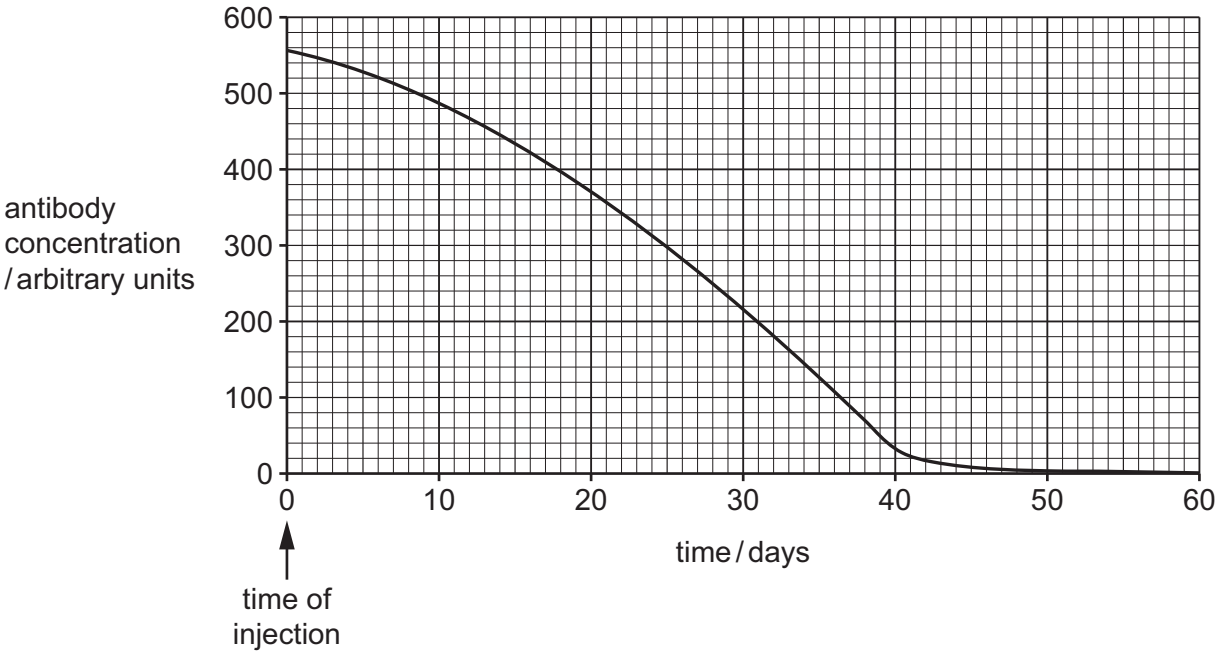


Fig. 4.2

(i) State the type of immunity that results from the injection given as protection against disease **F**.

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(ii) Describe features of the type of immunity resulting from the injection given as protection against disease **F**.

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Question 4 continues on page 18.

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(c) In 2021, the number of new cases of tuberculosis (TB) was estimated to be 10.6 million.

(i) Name the bacterium that causes TB.

..... [1]

(ii) TB is often treated with several different drugs at the same time. This is necessary to kill multiple drug resistant (MDR) strains of bacteria. This treatment is usually lengthy, taking 6 months or more to make sure all bacteria are killed.

Researchers investigated how the bacteria that cause TB react to the presence of rifampicin. Rifampicin is an antibiotic often used in the successful treatment of TB.

- Researchers combined rifampicin with a coloured marker dye and added the coloured rifampicin to a culture of living bacteria.
- When initially viewed under the microscope, the researchers could see that the coloured rifampicin was present inside the cytoplasm of the bacterial cells.
- Hours later, the coloured rifampicin was **not** visible inside the bacterial cells but was visible in the medium surrounding the bacterial cells.
- The researchers concluded that rifampicin was being pumped out of the bacterial cells through the cell surface membrane.
- Further research showed that when some drugs commonly used to treat indigestion were added to bacterial cultures containing coloured rifampicin, the coloured rifampicin stayed inside the bacterial cytoplasm.

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Suggest **and** explain how knowledge gained from this research could improve TB treatment **and** reduce the chance of rifampicin-resistant bacteria developing.

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5 **(a)** Eukaryotic cells and prokaryotic cells contain DNA.

Complete the passage about DNA in eukaryotic cells and prokaryotic cells, using the most appropriate terms.

In eukaryotic cells, the DNA is located mainly in the chromosomes of the nucleus. Chromosomal DNA is associated with proteins called ..... . Two other eukaryotic cell structures that contain DNA are mitochondria and ..... .

In prokaryotic cells, for example ....., the DNA is found in the ..... and is usually circular.

[4]

(b) Fig. 5.1 shows transcription of the first six nucleotides of a gene by the enzyme RNA polymerase. The bases of the first six nucleotides on DNA strand **X** are shown, but the bases on the template DNA strand are **not** shown.

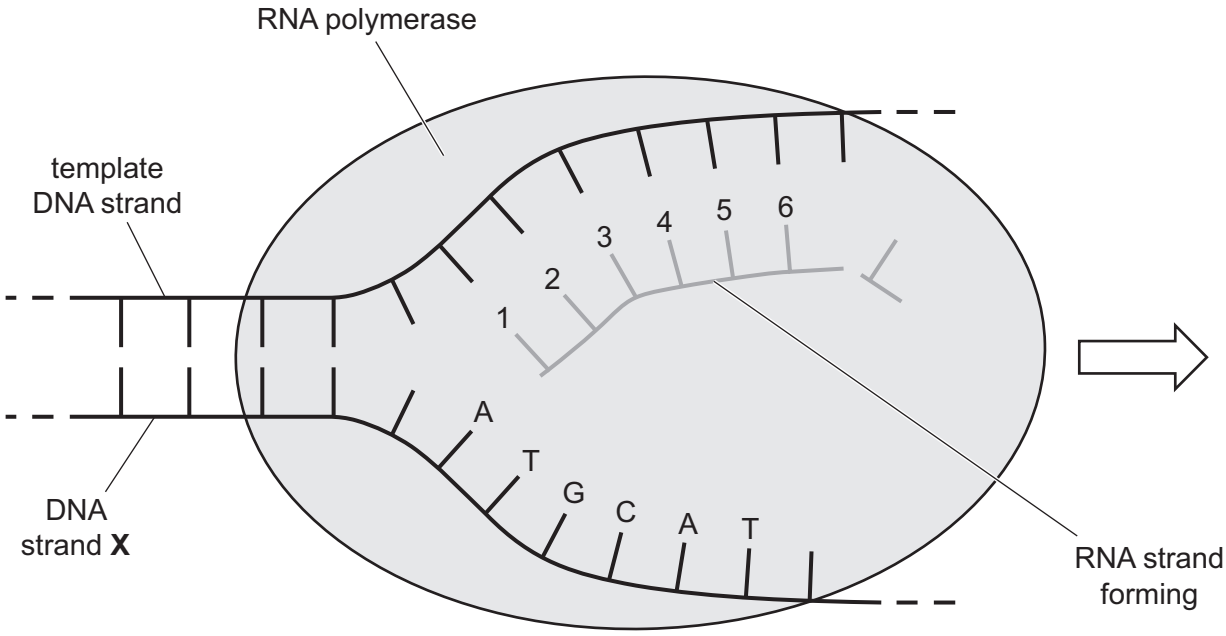


Fig. 5.1

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(i) State the term used to describe the non-template DNA strand labelled **X** in Fig. 5.1.

..... [1]

(ii) Name the RNA strand formed during transcription of a eukaryotic gene.

..... [1]

(iii) Complete Table 5.1 to show the letters of the six bases indicated on Fig. 5.1 by the numbers 1 to 6.

Table 5.1

1	2	3	4	5	6

[1]

(c) RNA polymerase is composed of several polypeptides that move together and change shape as the enzyme performs its functions.

The death cap mushroom, *Amanita phalloides*, produces a toxin called alpha-amanitin, which binds to RNA polymerase at a site other than the active site. Alpha-amanitin reduces the activity of RNA polymerase.

Use the information provided to suggest how alpha-amanitin reduces the activity of RNA polymerase.

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6 **(a)** Fig. 6.1 shows photomicrographs of individual cells from the root tip of an onion, *Allium sp.*, at different times in the mitotic cell cycle.

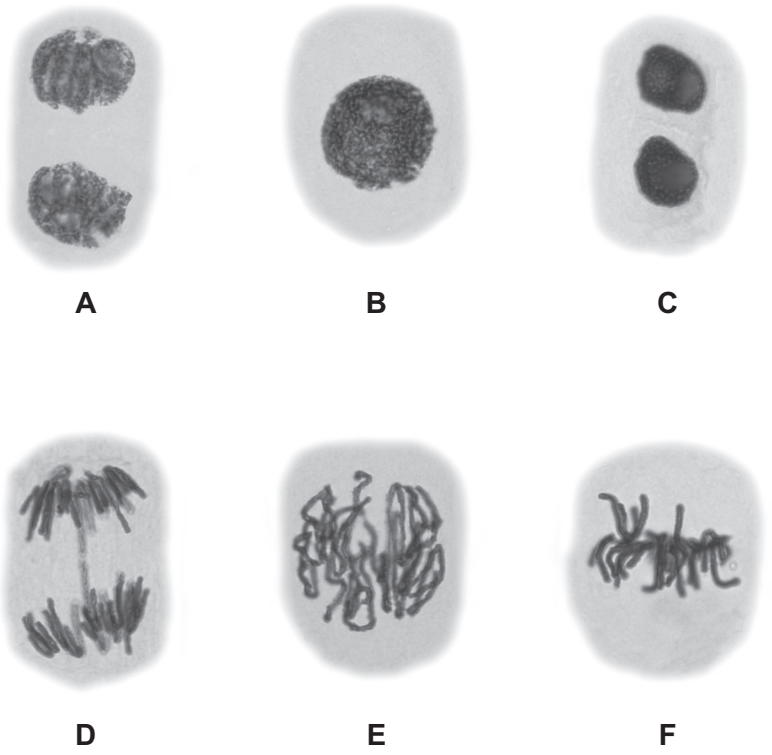


Fig. 6.1

(i) Place the letters representing the individual cells in the correct sequence of the mitotic cell cycle. The first letter has already been filled in.

B					

[1]

(ii) Cell **A** in Fig. 6.1 is in one of the main stages of mitosis.

Describe the events that occur during this main stage of mitosis.

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(b) Complete Table 6.1 by stating the term that matches each of the descriptions.

Table 6.1

term	description
	region of DNA with repeated nucleotide sequences located at the ends of chromosomes
	organises microtubules to form the spindle in animal cells
	point of attachment between two sister chromatids

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