Cambridge Assessment International Education

Cambridge International AS & A Level

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1995506884

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **May/June 2024**

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 Fig. 1.1 is a diagram showing part of a cell surface membrane of an animal cell.

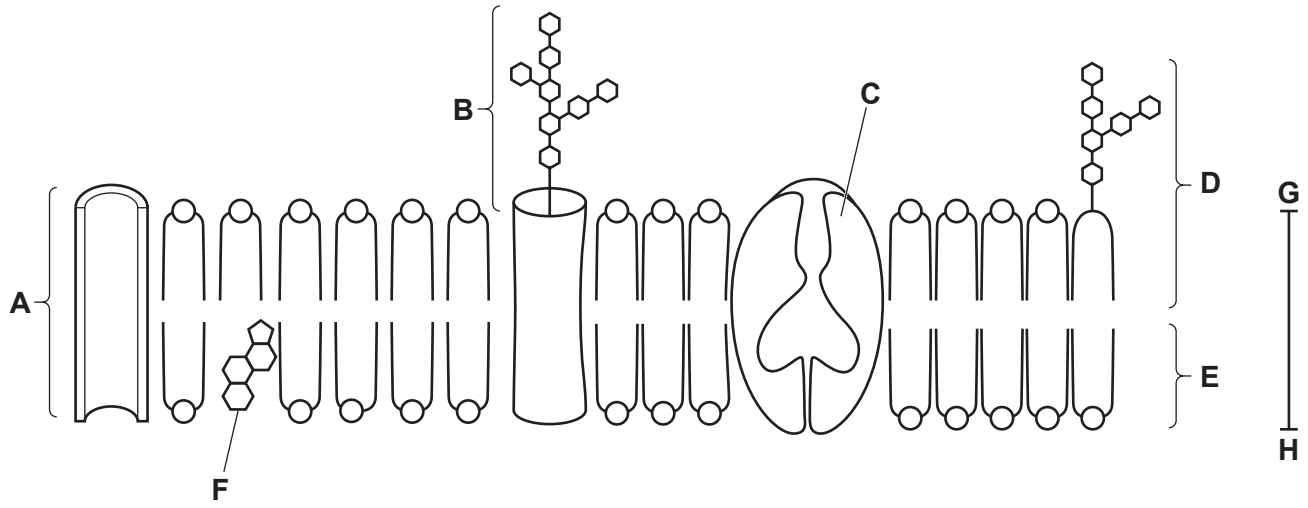


Fig. 1.1

(a) (i) State the approximate thickness of the membrane as shown by the line **G**–**H**.

..... [1]

(ii) Complete Table 1.1 to show:

- the names and functions of the components of the cell surface membrane
- the letters of the labels in Fig. 1.1 that identify each component.

Table 1.1

component	function	letter on Fig. 1.1
channel protein		
phospholipid		
	receptor for cell signalling	
		F

[4]

(b) Fig. 1.2 is a drawing of a transmission electron micrograph (TEM) of a cell from the palisade mesophyll of a leaf.

The drawing does **not** show all of the organelles visible in a transmission electron micrograph.

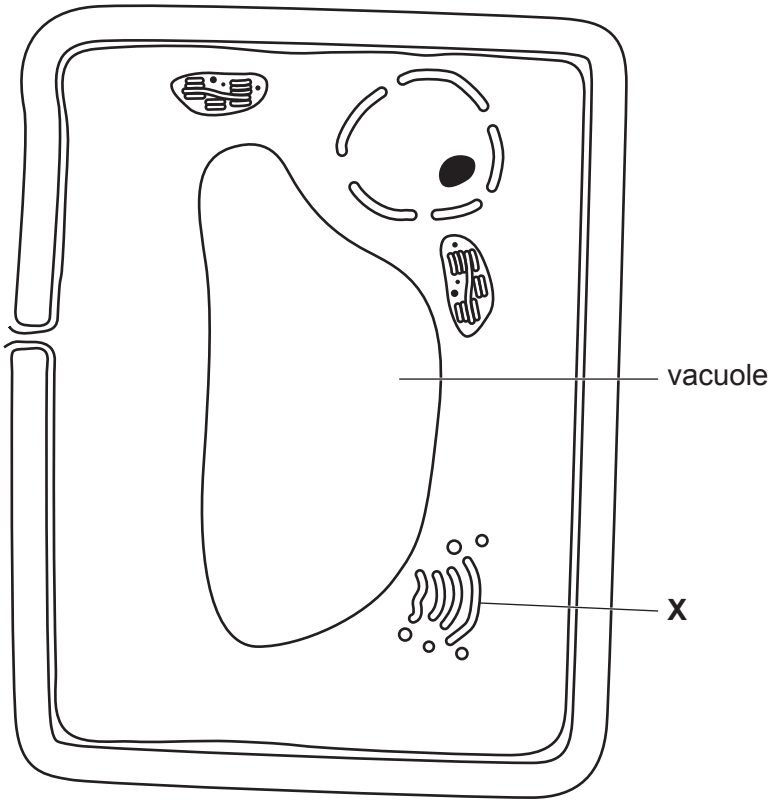


Fig. 1.2

(i) Complete Fig. 1.2 by drawing **and** labelling:

- a mitochondrion
- rough endoplasmic reticulum
- smooth endoplasmic reticulum.

Your drawings should show the detail that can be seen in a transmission electron micrograph. [3]

(ii) Identify the organelle labelled **X and** state **one** function of this organelle.

name .....

function .....

.....

[2]

[Total: 10]

2 **(a)** Water is the main component of blood.

Explain how the properties of water make it suitable as the main component of blood.

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..... [3]

(b) Fig. 2.1 is a diagram of the circulation in a mammal.

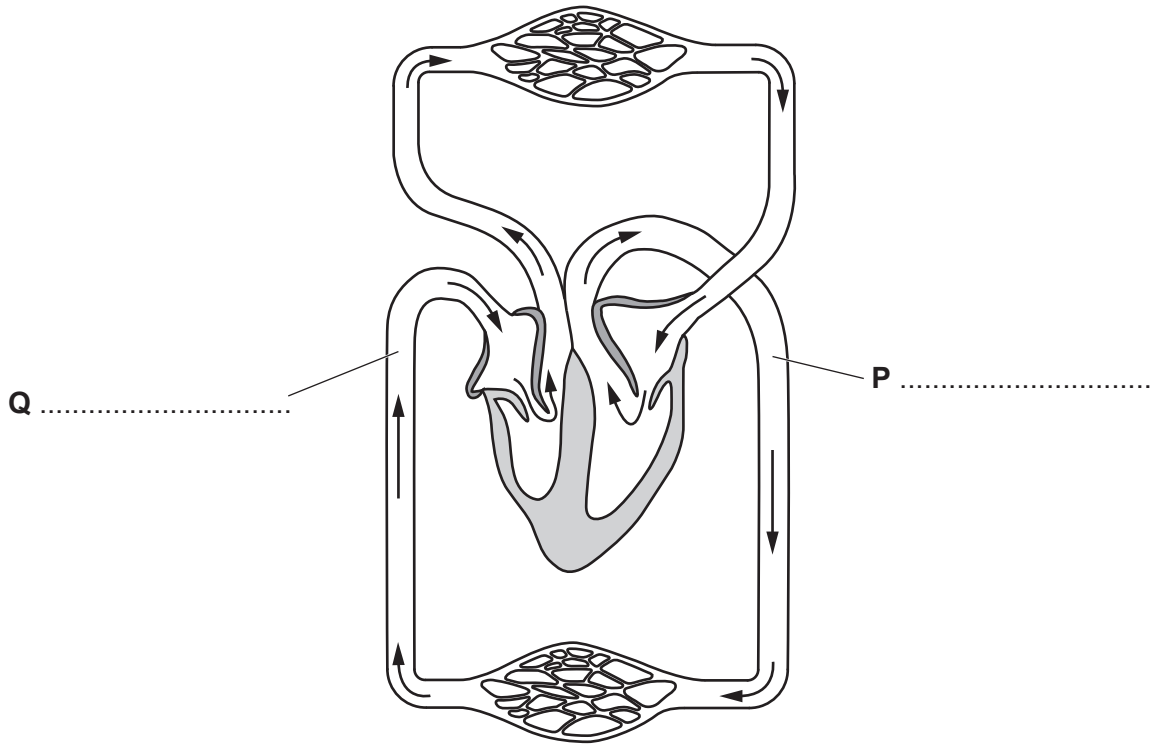


Fig. 2.1

(i) Complete Fig. 2.1 by naming **P** and **Q**. Write your answers on Fig. 2.1. [1]

(ii) Describe the functions of **P** and **Q**.

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..... [2]

(iii) Explain why the mammalian circulation is described as a closed, double circulation.

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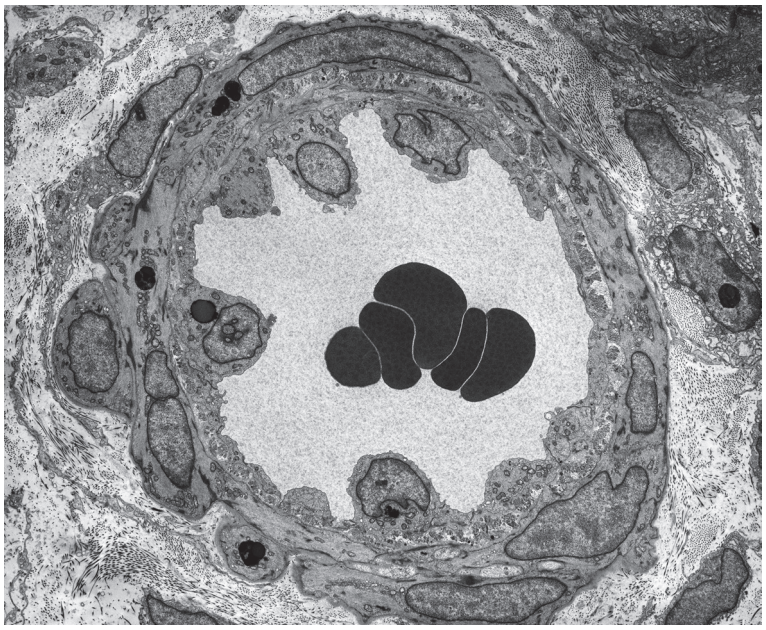
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..... [2]

(c) Fig. 2.2 is a transmission electron micrograph of a cross-section of an arteriole. Blood flows from muscular arteries through arterioles into capillary networks.

The lining of the arteriole is folded because the arteriole has constricted. This constriction causes the blood pressure to decrease from 12.7 kPa in the muscular artery to 2.7 kPa at the end of the arteriole.



magnification ×2000

Fig. 2.2

(i) Explain why it is important that the pressure of blood decreases as it passes through arterioles.

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..... [2]

(ii) Compare the structure of a muscular artery with the structure of the arteriole shown in Fig. 2.2.

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..... [3]

[Total: 13]

3 **(a)** A class of students was studying the features of some human pathogens. One of the students constructed a flow chart to identify four different human pathogens. The student used information about the structure and mode of transmission of each of these pathogens.

Fig. 3.1 shows the partially completed flow chart.

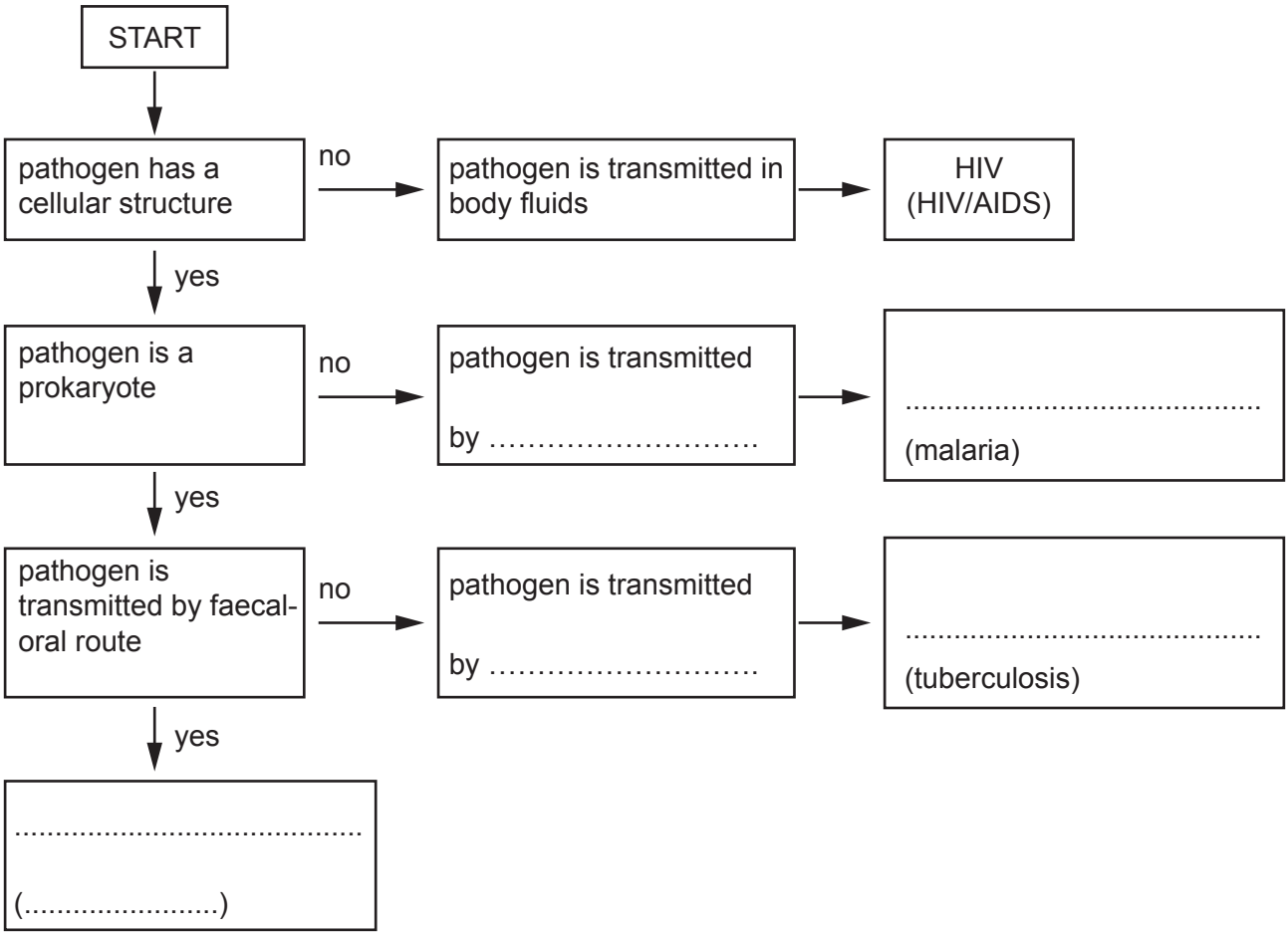


Fig. 3.1

Complete the flow chart in Fig. 3.1 by identifying:

- the modes of transmission
- the scientific names of the pathogens
- the name of one of the diseases.

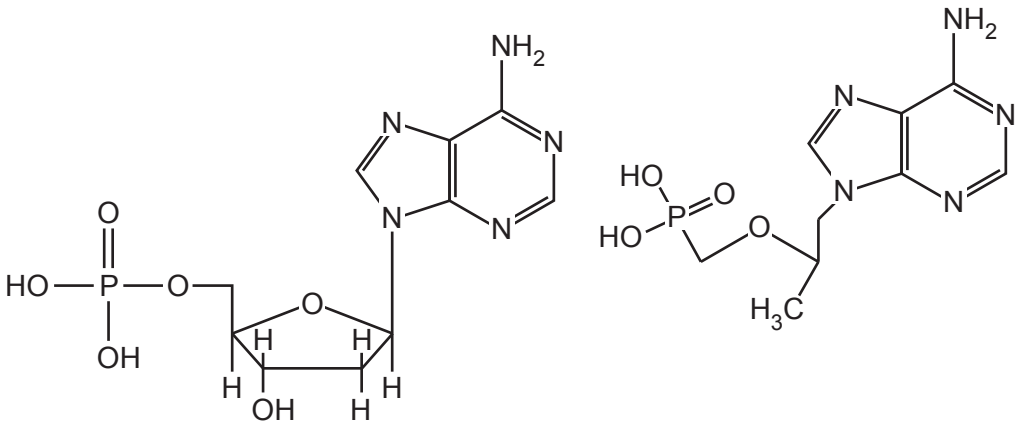
[5]

(b) HIV has a nucleic acid core of RNA. The virus also contains the enzyme reverse transcriptase.

After HIV enters T-lymphocytes, reverse transcriptase catalyses the formation of DNA using activated DNA nucleotides with the viral RNA as a template.

Some drugs, such as tenofovir, have been developed to inhibit the action of reverse transcriptase.

The structure of tenofovir is similar to the structure of deoxyribose adenosine monophosphate, as shown in Fig. 3.2.



deoxyribose adenosine monophosphate

tenofovir

Fig. 3.2

After tenofovir is absorbed into cells it is phosphorylated twice and can be used by reverse transcriptase in the synthesis of DNA.

When a tenofovir molecule is added to the DNA strand being synthesised, the process stops.

Suggest the mechanism of action of tenofovir to prevent the synthesis of DNA by reverse transcriptase. Use the information in Fig. 3.2 in your answer.

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..... [2]

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(c) Pre-exposure prophylaxis (PrEP) is the use of therapeutic drugs to prevent the replication of HIV in the body following infection. The drugs are taken by people who are at risk of becoming infected. Tenofovir is one of these therapeutic drugs.

In 2016, the United Nations (UN) set a global target of 3 million PrEP users by 2020.

Table 3.1 shows the number of people across the world who received a therapeutic drug for PrEP in each of the years between 2012 and 2019.

Table 3.1

year	number of people who received PrEP
2012	10 000
2013	15 000
2014	27 500
2015	57 500
2016	95 000
2017	145 000
2018	340 000
2019	605 000

(i) Calculate the percentage of people who received PrEP in 2019 as a percentage of the target set by the UN in 2016.

Give your answer to the nearest whole number.

..... % [1]

(ii) PrEP does not prevent transmission of HIV.

State **and** explain how health authorities can reduce the transmission of HIV.

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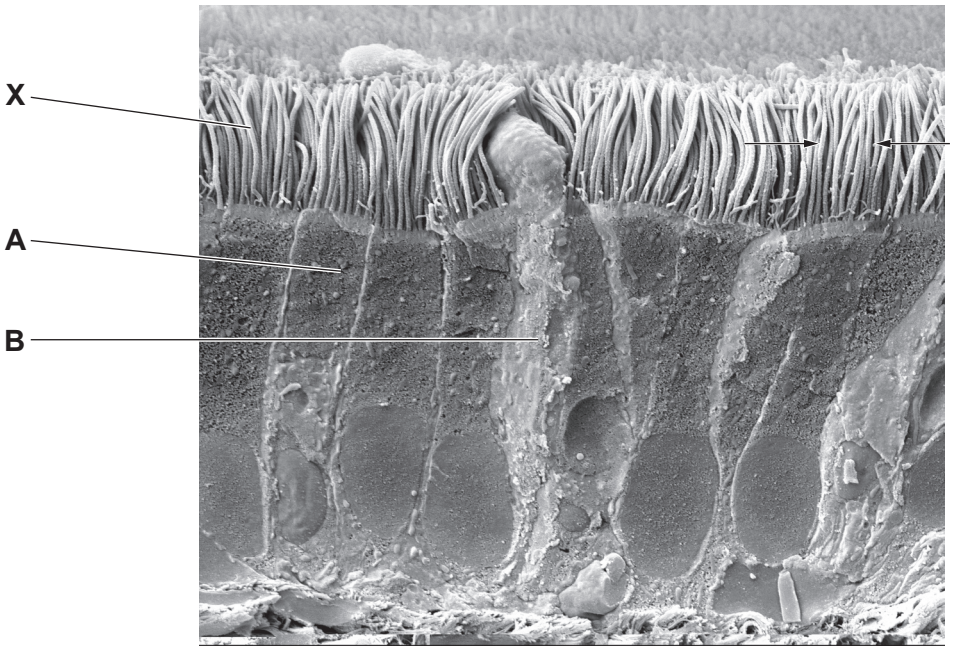
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[Total: 12]

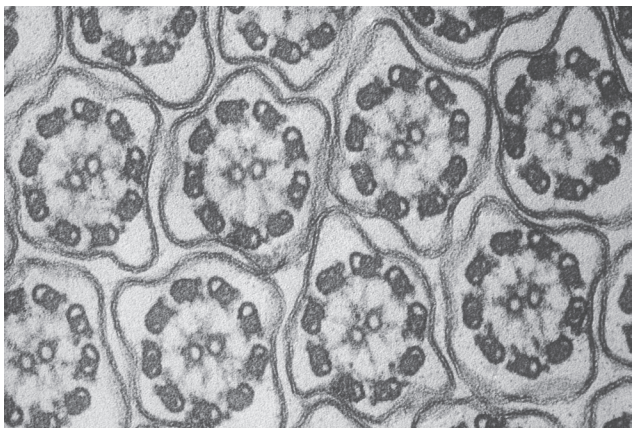
4 Fig. 4.1 is a scanning electron micrograph showing the tissue that lines the bronchi in the gas exchange system.

Fig. 4.2 is a transmission electron micrograph of a horizontal section made at the position indicated by the two arrows in Fig. 4.1.



magnification ×3000

Fig. 4.1



magnification ×80 000

Fig. 4.2

(a) (i) Name the cells labelled **A** and **B** in Fig. 4.1.

A .....

B .....

[2]

(ii) Describe how the tissue shown in Fig. 4.1 is adapted to its function in the gas exchange system.

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..... [3]

(b) (i) The structures labelled **X** in Fig. 4.1 have a characteristic internal appearance, as seen in Fig. 4.2.

Describe the internal appearance of the structures labelled **X**.

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..... [2]

(ii) Explain how Fig. 4.2 shows that each of the structures labelled **X** are intracellular.

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..... [1]

(c) Stem cells are found in the lining of the bronchi.

Describe the function of centrioles **and** explain how they are involved in the cell cycle of a stem cell.

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..... [4]

[Total: 12]

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5 The pressure of water vapour inside and outside leaves can be measured. The difference between these pressures is known as the leaf vapour pressure deficit (LVPD).

LVPD is one of the factors that influences the rate of transpiration.

Scientists measured the effect of changing the LVPD on the rate of transpiration in several species of flowering plant that live in a variety of different habitats. Two of these species were:

- *Nerium oleander*, a species that is adapted to grow in hot, dry conditions
- *Helianthus annuus*, a species that is not adapted for survival in hot, dry conditions.

Fig. 5.1 shows the effect of increasing the LVPD on the transpiration rates of the two species.

All other factors were kept constant.

key

——— *Helianthus annuus*

– – – – – – *Nerium oleander*

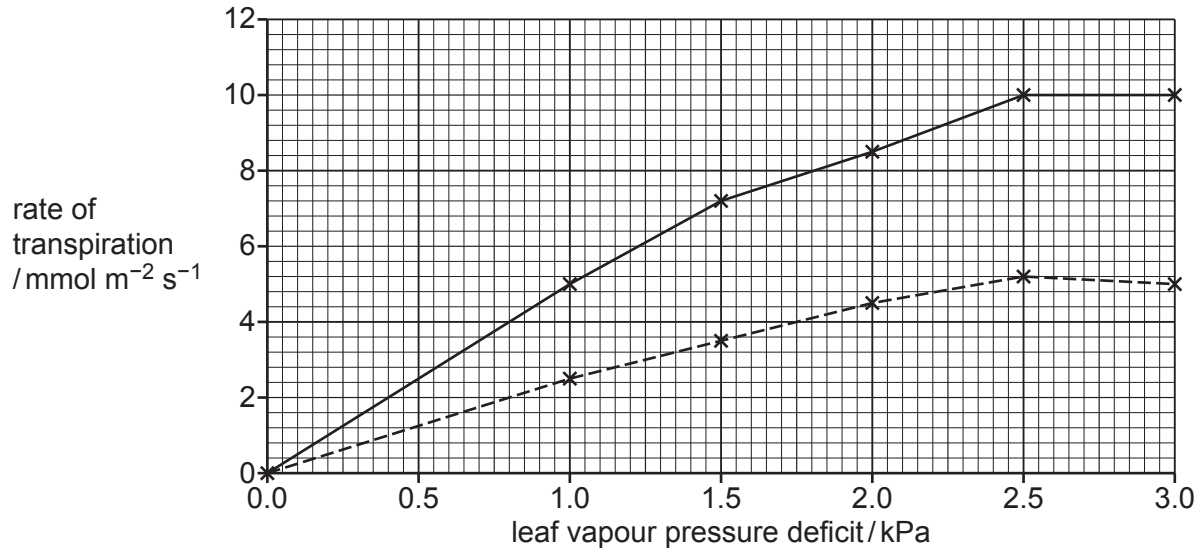


Fig. 5.1

(a) Compare the results of the two species shown in Fig. 5.1.

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..... [3]

(b) Fig. 5.2 shows part of a plant of *N. oleander*.



Fig. 5.2

Fig. 5.3 shows a cross-section of part of an oleander leaf.

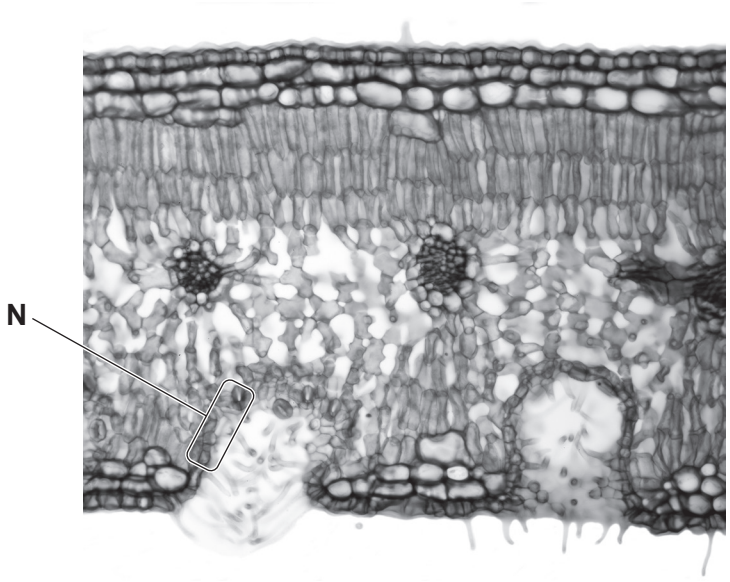


Fig. 5.3

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Fig. 5.4 is a drawing of a high-power view of region **N** on Fig. 5.3.

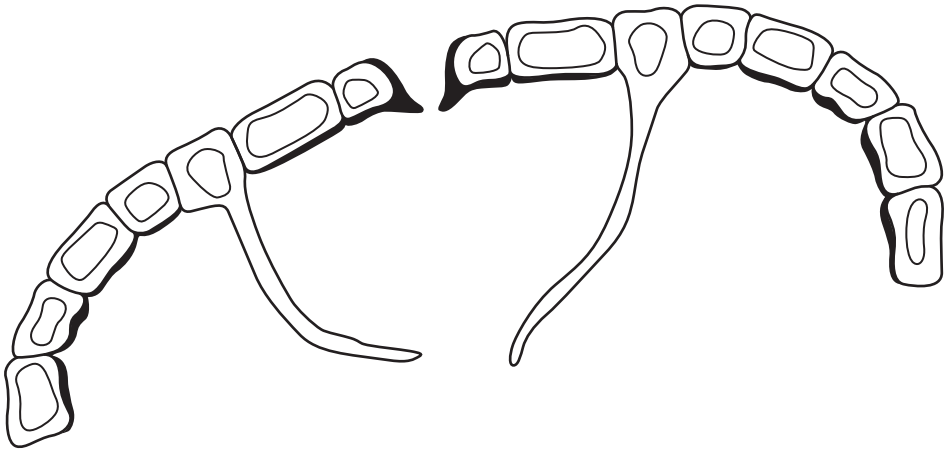


Fig. 5.4

State **and** explain **two** adaptations shown by the leaves of *N. oleander* that are visible in Fig. 5.3 and Fig. 5.4.

one adaptation visible in Fig. 5.3 .....

.....

explanation .....

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.....

.....

one adaptation visible in Fig. 5.4 .....

.....

explanation .....

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[4]

[Total: 7]

6 Antibodies are produced by plasma cells.

Fig. 6.1 shows antigens bound to antigen-binding sites of an antibody molecule.

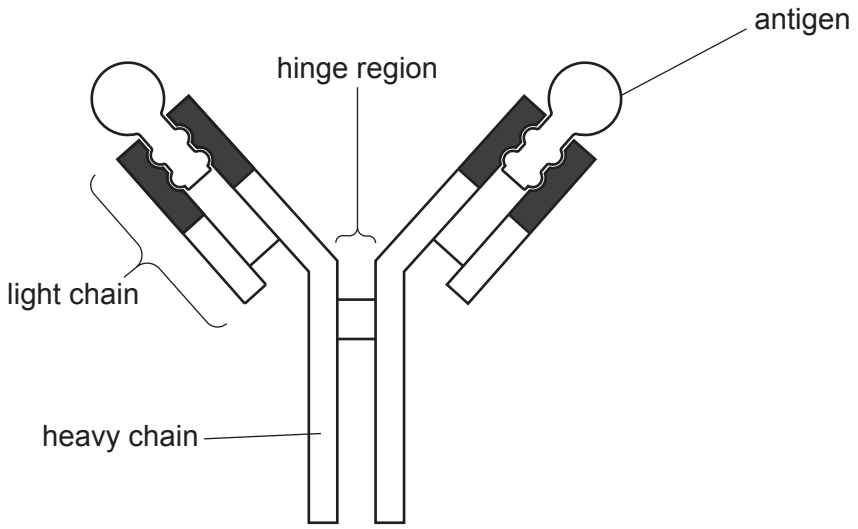


Fig. 6.1

(a) (i) Explain how the structure of an antigen-binding site makes it specific to a particular antigen, as shown in Fig. 6.1.

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..... [2]

(ii) State the function of the hinge region of the antibody shown in Fig. 6.1.

..... [1]

(iii) Antibodies can bind to membrane receptors on cells of the immune system, such as macrophages.

Suggest an advantage of antibodies binding to receptors on macrophages.

.....

.....

..... [1]

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(b) It is estimated that the immune system of each person can make enough antibodies to bind to over 10^{12} different antigens.

When plasma cells make antibody molecules they combine the polypeptides produced by the expression of genes for heavy chains and the genes for light chains.

Research has shown that producing this very large number of antibodies is only possible by modifying the primary transcripts of the genes that code for heavy chains and the genes that code for light chains.

Suggest how this modification of the primary transcripts occurs in plasma cells.

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..... [2]

[Total: 6]

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BIOLOGY **9700/22**

Paper 2 AS Level Structured Questions **May/June 2024**

1 hour 15 minutes

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INFORMATION

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[Turn over

1 Smooth muscle is a tissue composed of smooth muscle cells. The cells contain cytoplasm packed with proteins that are involved in contraction and relaxation.

(a) Smooth muscle is present in the airways of the gas exchange system.

Explain how smooth muscle cells in the walls of the **bronchioles** contribute to the function of these airways.

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..... [2]

(b) When viewed in longitudinal section (LS), smooth muscle cells are elongated and taper at both ends. This is known as a fusiform shape. Each cell has a central nucleus, which also appears elongated.

Fig. 1.1 is a diagram of a smooth muscle cell to show the fusiform shape.

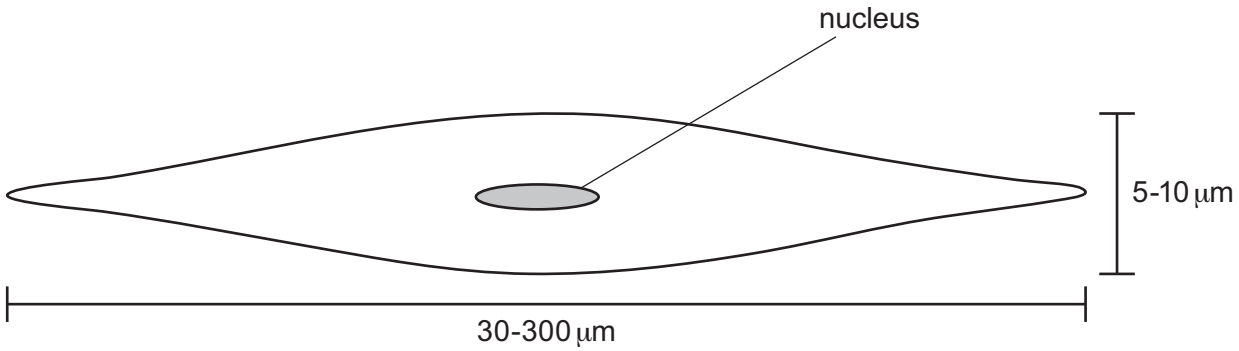


Fig. 1.1

A student used a microscope fitted with a calibrated eyepiece graticule to estimate that the length of one smooth muscle cell was 250 micrometres (μm).

(i) Name the type of microscope slide that the student used to calibrate the eyepiece graticule.

..... [1]

(ii) The smallest object the student can see without the use of a microscope is 0.2 mm in length.

Explain whether the student would be able to see a cell of length 250 μm without the use of a microscope.

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..... [1]

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(c) Fig. 1.2 is a photomicrograph of smooth muscle tissue in the wall of the intestines. A capillary is visible in addition to smooth muscle cells.

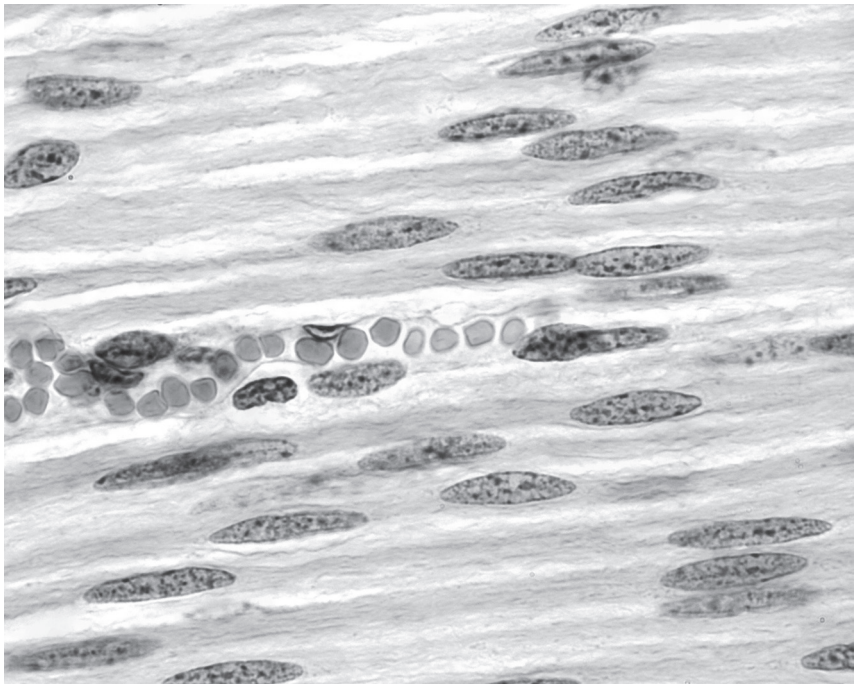


Fig. 1.2

(i) Outline the features that help to identify the blood vessel in Fig. 1.2 as a capillary.

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..... [2]

(ii) Explain how the structure of a capillary is related to its function in smooth muscle.

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..... [3]

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(d) Caldesmon is a large protein with a number of binding sites to attach to other proteins.

Caldesmon exists in two different forms, H-caldesmon and L-caldesmon.

H-caldesmon helps to regulate contraction and relaxation in smooth muscle cells.

L-caldesmon is found in some non-muscle cells, where it also acts as a regulatory protein.

- Caldesmon is coded for by a gene known as *CALD1*.
- *CALD1* has 17 exons.
- The primary structure of H-caldesmon has a repeating sequence in the middle of the amino acid chain that is **not** present in L-caldesmon.

(i) Researchers have discovered that a gene mutation is **not** the cause of the two different forms of caldesmon.

Explain what is meant by a gene mutation.

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..... [2]

(ii) Researchers now know that the two different forms of caldesmon are the result of events occurring **directly after** transcription of DNA. Changes occur to the primary transcript that is formed by DNA transcription.

Suggest how the smooth muscle cells and non-muscle cells can produce different forms of caldesmon from the same primary transcript.

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..... [2]

(iii) Suggest how the two different forms of caldesmon can still have similar functions, even though they have a different primary structure.

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..... [1]

[Total: 14]

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2 Alveolar macrophages are cells of the immune system that remain in the alveolar region of the gas exchange system. The macrophages protect against infection caused by pathogens that have been inhaled.

(a) Alveolar macrophages have the same cell structures as typical animal cells.

(i) Complete Table 2.1 to **name** the cell structures that match the functions stated.

Do **not** use abbreviations.

Table 2.1

cell structure	function
.....	manufactures ribosomal subunits from proteins and ribosomal RNA
.....	synthesises triglycerides and other lipids
pair of	organise microtubules of the cell cytoskeleton

[3]

(ii) Fig. 2.1 is a diagram of an alveolar macrophage showing:

- some of the cell structures that would be visible using an electron microscope
- a newly formed phagocytic vacuole (phagosome) containing two cells of *Mycobacterium tuberculosis*.

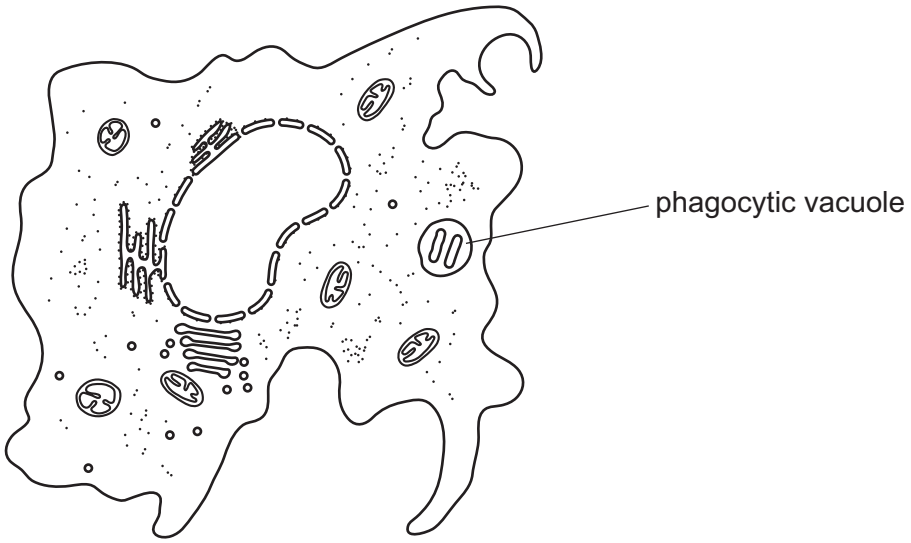


Fig. 2.1

The cell structures with the functions described in Table 2.1 are **not** shown in Fig. 2.1.

Complete Fig. 2.1 by drawing **and** labelling the cell structures described in Table 2.1. [2]

(b) Tuberculosis (TB) can be prevented if the bacterial cells that have reached the alveoli are rapidly destroyed. Alveolar macrophages can detect the presence of *M. tuberculosis* in the alveolar space and can carry out phagocytosis to form phagocytic vacuoles, such as the one shown in Fig. 2.1.

(i) Outline the sequence of events that leads to the formation of a phagocytic vacuole after detection of the bacterial cells by an alveolar macrophage.

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..... [2]

(ii) Name the cell structures that fuse with the phagocytic vacuole and release hydrolytic enzymes to destroy the bacterial cells.

..... [1]

(c) Research has shown that vaccination programmes are cost effective and are very helpful in the prevention and control of TB. The programmes may be aimed at particular groups of people that are at a high risk of getting the disease, or they may be aimed at an entire population because the country has a high number of cases of TB.

The Bacillus Calmette-Guérin (BCG) vaccine is freeze-dried and contains live, weakened (attenuated) *Mycobacterium bovis*.

Apart from being cost effective, suggest **and** explain the advantages of using the BCG vaccine for the prevention and control of TB.

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..... [4]

[Total: 12]

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3 Lysozyme is an antibacterial enzyme that was discovered in 1921 by Alexander Fleming, the scientist who discovered penicillin.

Lysozyme catalyses the hydrolysis of glycosidic bonds present in peptidoglycan molecules to form smaller products, NAG (N-acetylglucosamine) and NAM (N-acetylmuramic acid).

(a) Before the induced fit hypothesis was proposed in 1958, scientists believed that the lock and key hypothesis explained how lysozyme catalyses the hydrolysis of peptidoglycan to its products.

Draw labelled **and** annotated diagrams in the space provided to show how the **lock and key hypothesis** was used to explain the mechanism of action of lysozyme on peptidoglycan.

[3]

(b) Lysozyme and penicillin can be described as antibacterial agents.

Compare lysozyme **and** penicillin to show the similarities **and** differences between these two antibacterial agents.

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..... [3]

[Total: 6]

4 In the mesophyll tissue of leaves, products of photosynthesis can be used to synthesise organic compounds, such as the polysaccharide cellulose and some amino acids.

A source of nitrogen for amino acid synthesis can be provided by nitrate ions that have been taken up in the roots and transported to the leaves.

(a) Describe the structure of a cellulose molecule.

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..... [3]

(b) Studies of nitrate uptake and nitrate metabolism help to provide information to scientists who are investigating ways to increase the yield of crop plants.

The first step of nitrate metabolism in leaf cells is the reduction of nitrate to nitrite, catalysed by the enzyme nitrate reductase. The activity of the enzyme can be studied by detecting the presence of nitrite formed.

(i) Researchers have found that adding nitrate to leaf tissue results in an increase in messenger RNA (mRNA) molecules of the gene *NR*, which codes for nitrate reductase.

State **one** benefit to leaf cells of an increase in mRNA molecules of gene *NR* after the addition of nitrate.

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..... [1]

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(ii) One method used to detect the presence of nitrite formed from the reduction of nitrate in leaf tissue involves:

- using an inhibitor to prevent nitrite from taking part in further reactions in the leaf tissue
- immersing the leaf tissue in a solution containing a colourless test reagent.

The nitrite from the leaf tissue enters the surrounding solution, changing the colour of the solution to magenta (red-purple).

Suggest why using a colorimeter can improve this method to detect the presence of nitrite.

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..... [2]

(c) In the leaf, transport of amino acids from mesophyll cells to companion cells involves using a number of different membrane transport proteins called amino acid transporters.

There is evidence that amino acids can move from the apoplast into the cytoplasm of a companion cell using the same transport mechanism that is used for sucrose transport.

(i) Outline **and** explain the sequence of events that occurs, which allows amino acids to be transported from the apoplast into the cytoplasm of a companion cell.

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..... [4]

(ii) Suggest why amino acid transporters are **not** needed to move amino acids from the companion cell into a phloem sieve tube element.

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To investigate nitrate uptake, roots can be cut and removed (excised) and placed in a buffered solution containing nitrate ions. The root tissue can be analysed to determine the quantity of nitrate taken up over a set time period.

(d) Excised roots of the crop plant maize, *Zea mays*, were placed in three different concentrations of nitrate solution: 0.2 mmol dm^{-3}, 1.0 mmol dm^{-3} and 5.0 mmol dm^{-3}.

The solutions were maintained at 30 °C and were aerated to provide a continuous supply of oxygen to the root tissue.

Nitrate (NO_3^-) uptake by the root tissue was determined each hour for five hours.

The results are shown in Fig. 4.1.

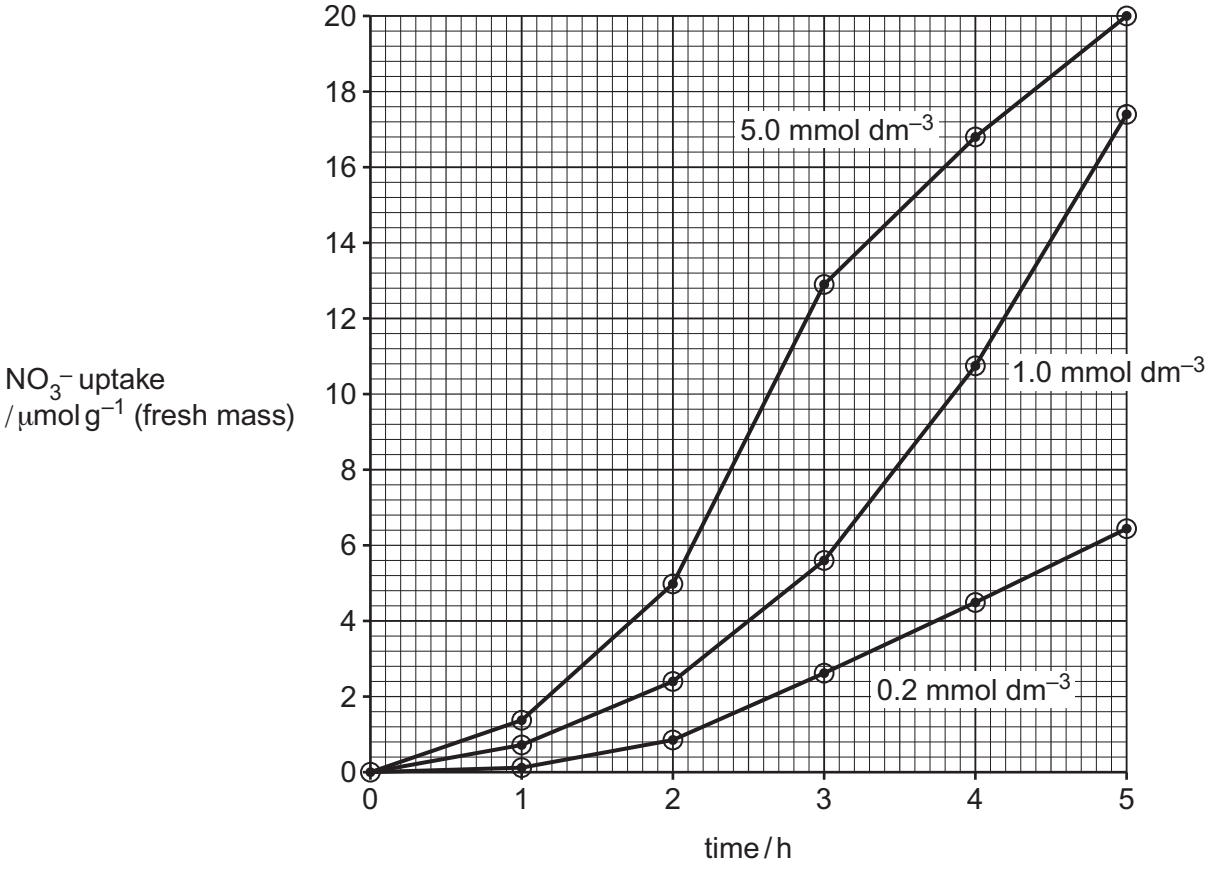


Fig. 4.1

Fig. 4.1 shows that the rate of nitrate uptake is very low initially and then increases for all three concentrations of nitrate solution tested.

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Describe the **differences** in the **rates** of nitrate uptake for 5.0 mmol dm^{-3} nitrate solution compared with 0.2 mmol dm^{-3} nitrate solution, between 2h and 5h

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..... [2]

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(e) The nitrate uptake of excised maize roots was investigated under different conditions.

Table 4.1 shows details and results for a control experiment and four modified experiments, **1**, **2**, **3** and **4**. The same concentration of nitrate solution was used throughout for all the experiments. All the results were taken after a set time period.

Table 4.1

experiment	temperature / °C	aeration	additional substances present in nitrate solution	nitrate uptake / μmol g^{-1} (fresh mass)
1	30	no	nitrogen gas bubbled through instead of oxygen	0.4
2	3	yes	none	0.6
3	30	yes	protein synthesis inhibitor	1.4
4	30	yes	antibacterial compound	10.0
control	30	yes	none	10.9

The results for experiments **1**, **2**, **3** and **4** in Table 4.1 can be compared to the results for the control experiment.

Discuss how comparing each of the results with the control provides information about:

- how nitrate ions are taken up by the root cells
- the factors affecting the uptake of nitrate ions.

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..... [4]

[Total: 17]

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5 During interphase of the cell cycle, individual chromosomes cannot be seen within the nucleus. The genetic material is termed chromatin during this stage.

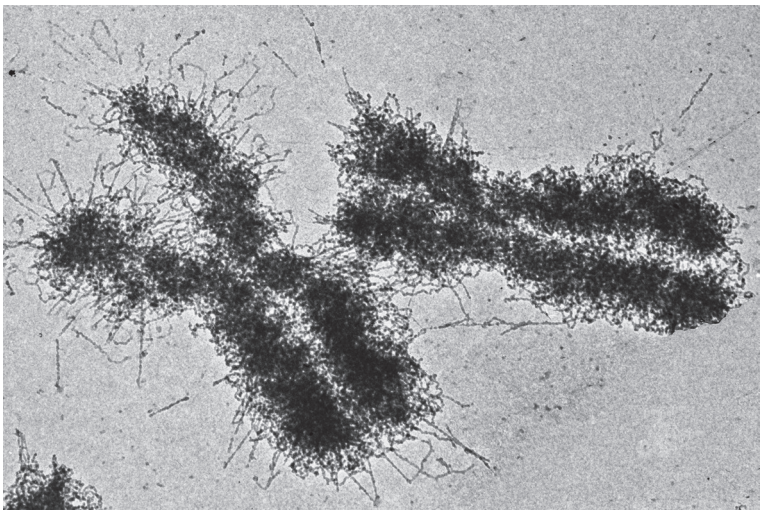
(a) Changes occur to chromatin during mitosis so that chromosomes become visible.

State what happens to chromatin so that individual chromosomes can be seen during mitosis.

.....

..... [1]

(b) Fig. 5.1 is a transmission electron micrograph of two human chromosomes at metaphase of mitosis.



magnification = ×14 000

Fig. 5.1

Describe the structure of chromosomes at metaphase, such as the two chromosomes shown in Fig. 5.1.

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[Total: 5]

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6 Some people who are infected with HIV have HIV/AIDS.

(a) State the full term for HIV.

..... [1]

(b) Following transmission of HIV, early diagnosis of infection and treatment with anti-retroviral therapy (ART) helps to control the spread of the pathogen and prevent HIV/AIDS.

Suggest why treating people who have developed HIV/AIDS with ART may help to reduce the number of overall deaths from infectious diseases, such as cholera, TB and malaria.

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..... [2]

(c) Studies suggest that people who are infected with HIV may be at a higher risk of heart disease. One cause of heart disease is the narrowing of the lumen of one or both of the main coronary arteries.

A coronary artery bypass graft (bypass graft) is a surgical operation that uses healthy blood vessels to divert blood around diseased sections of coronary arteries. The main choice of blood vessel to use for a bypass graft is known as the internal thoracic artery.

Fig. 6.1 is a diagram of an external view of the heart to show a **double** bypass graft.

The blood vessels used in the bypass graft shown in Fig. 6.1 are the great saphenous vein from the leg and the internal thoracic artery.

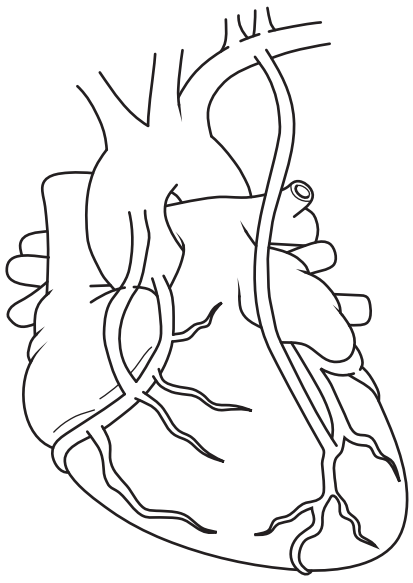


Fig. 6.1

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(i) Draw a cross (**X**) on Fig. 6.1 to show an area of the **right** coronary artery that has been bypassed. [1]

(ii) After surgery, the wall of the great saphenous vein becomes thicker.

Suggest **and** explain why it is important for the wall of the vein to become thicker after surgery.

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..... [2]

[Total: 6]

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9211408766

BIOLOGY **9700/23**

Paper 2 AS Level Structured Questions **May/June 2024**

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 Zika virus is a pathogen that can infect human cells.

(a) Fig. 1.1 is a drawing of the structure of a Zika virus.

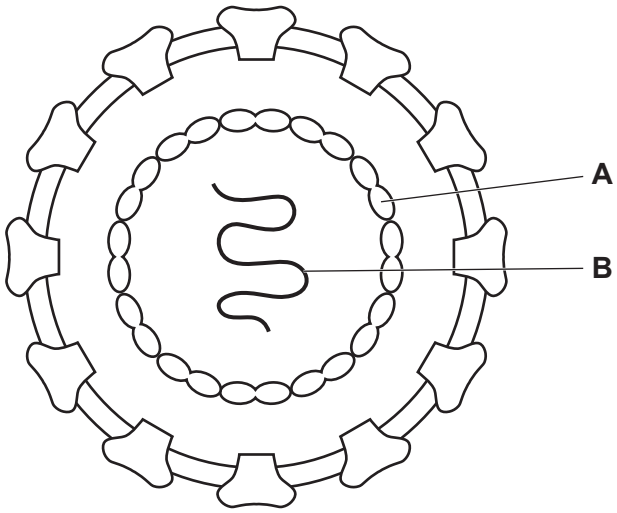


Fig. 1.1

(i) In Fig. 1.1, structure **A** is made of protein.

Name structure **A**.

..... [1]

(ii) In Fig. 1.1, structure **B** is a single-stranded molecule.

Suggest the name of structure **B**.

..... [1]

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(b) Fig. 1.2 is a transmission electron micrograph of human kidney cells infected with Zika viruses.



magnification ×200 000

Fig. 1.2

(i) Calculate the actual diameter of a Zika virus using the line **X**–**Y** in Fig. 1.2.

Show your working.

Give your answer in nanometres (nm).

diameter = ... nm [2]

(ii) A magnification of ×200 000 cannot be achieved by a light microscope. The resolution of a transmission electron microscope is also higher than a light microscope.

Describe what is meant by the resolution of a microscope.

.....

.....

..... [1]

(c) The vector for Zika virus is the mosquito *Aedes aegypti*. The mosquito feeds on the blood of an infected person and transmits the virus to another person when it feeds again.

Describe the similarities and differences between the transmission of Zika virus disease and the transmission of malaria.

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..... [3]

(d) Zika virus vaccines have been developed by scientists.

One of the vaccines contains small proteins from the Zika virus.

(i) Explain how giving this vaccine to a person can lead to the development of long-term immunity against Zika virus disease.

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..... [4]

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(ii) Explain how a vaccination programme may limit the spread of Zika virus disease through a population.

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.....

..... [2]

[Total: 14]

2 Collagen is a fibrous protein that is found in many tissues in animals.

(a) Describe the structure of a collagen molecule **and** the structure of a collagen fibre.

collagen molecule .....

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collagen fibre .....

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[5]

(b) Some amino acids in collagen can be modified to improve the stability of the protein. For example, the amino acid lysine can be modified to form hydroxylysine.

Fig. 2.1 shows a disaccharide bonded to the amino acid hydroxylysine in a collagen molecule. The disaccharide is made from two monosaccharides, which are indicated by the labels **D** and **E** in Fig. 2.1.

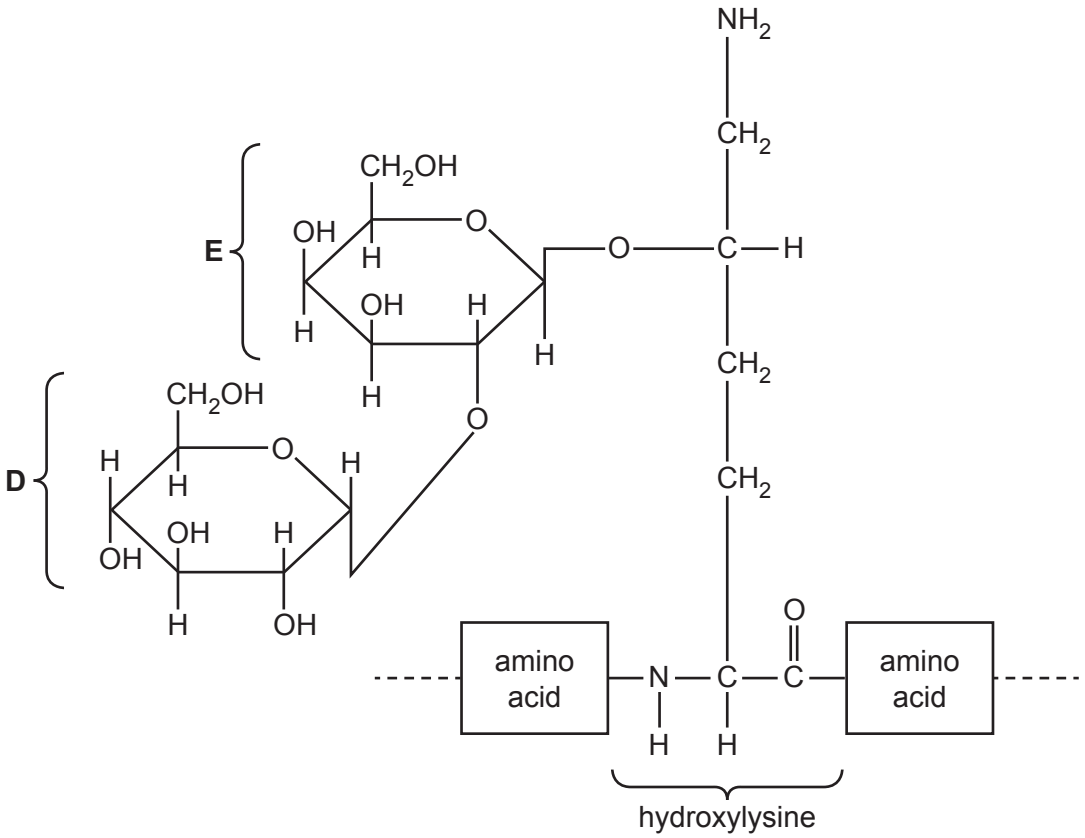


Fig. 2.1

(i) Give the precise name of the monosaccharide labelled **D** in Fig. 2.1.

..... [1]

(ii) On Fig. 2.1, label the glycosidic bond with the letter **G**.

Write your answer on Fig. 2.1. [1]

(iii) On Fig. 2.1, draw a circle around the R group of hydroxylysine and label the circle with the letter **R**.

Write your answer on Fig. 2.1. [1]

(c) Osteogenesis imperfecta is a disease that results from a deficiency in collagen.

Suggest how a **named** tissue or structure is affected in a person who has this disease.

.....

.....

.....

..... [2]

[Total: 10]

3 Arteries, capillaries and veins are three types of blood vessel.

(a) Table 3.1 shows some features of these three types of blood vessel.

Complete Table 3.1 by using a tick (✓) if the feature is present in the blood vessel and a cross (✗) if the feature is absent from the blood vessel.

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

Table 3.1

feature	artery	capillary	vein
smooth muscle			
endothelium			
tunica media			

[3]

(b) Fig. 3.1 shows a transmission electron micrograph of part of an alveolus and part of the adjacent capillary.

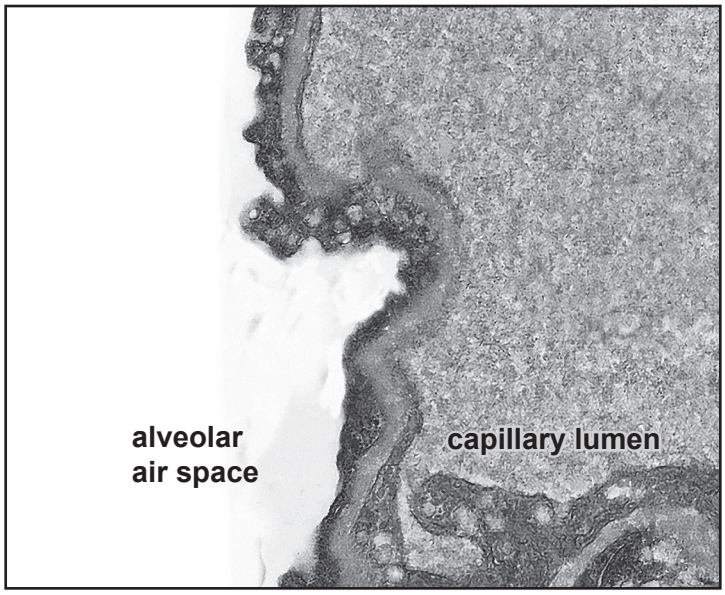


Fig. 3.1

(i) Draw **two** labelled arrows on Fig. 3.1 to show the direction of movement of oxygen and the direction of movement of carbon dioxide during gas exchange in the lungs. [1]

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(ii) Suggest **and** explain how a steep oxygen concentration gradient is maintained in the lungs.

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..... [4]

(c) The passage outlines the roles of blood vessels associated with the heart.

Complete the passage by using the most appropriate scientific terms.

The ……. carries blood to the left atrium. After passing from the left atrium to the left ventricle, blood is pumped into the aorta. The aorta is one of two large arteries that carry blood away from the ventricles of the heart. Blood that leaves the heart to enter these arteries must pass through the ……. valves.

Oxygenated blood is supplied to the cardiac muscle cells through the

……. arteries.

[3]

[Total: 11]

4 Lignin and suberin are polymers that are present in plant tissues.

(a) Describe **and** explain the roles of lignin and suberin in the transport of water through the roots and stem of a plant.

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..... [4]

(b) The enzyme laccase catalyses the formation of lignin in plants.

Fig. 4.1 is a diagram of the mode of action of laccase.

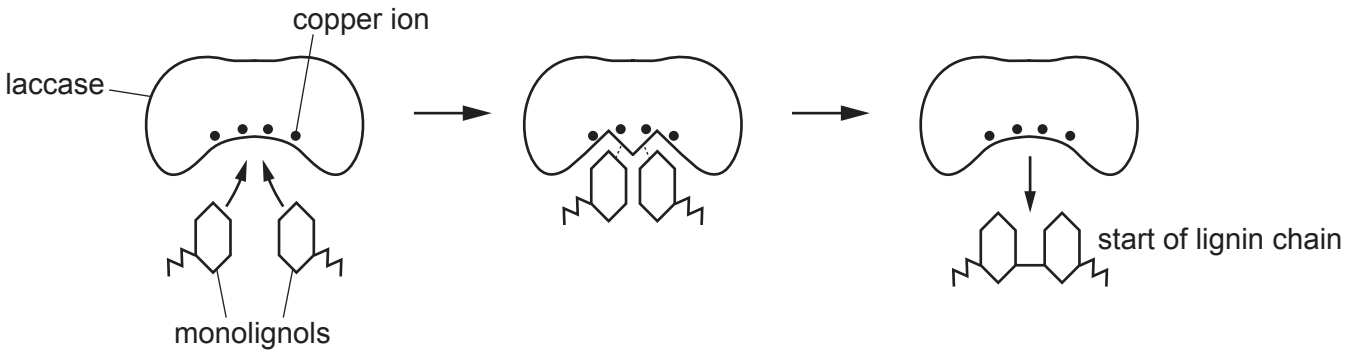


Fig. 4.1

Describe **and** explain the mode of action of laccase when catalysing the formation of lignin.

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..... [5]

[Total: 9]

5 Cyclin-dependent kinases (CDKs) are enzymes that regulate the cell cycle.

(a) Cell signalling by ligands causes the activation of CDKs in target cells.

Outline the main stages in the process of cell signalling by ligands that can cause specific responses in target cells.

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..... [2]

(b) The activity of CDKs is reduced by CDK inhibitors. Many of these inhibitors occur naturally in cells.

Fig. 5.1 is a diagram of a CDK inhibitor binding to a CDK molecule.

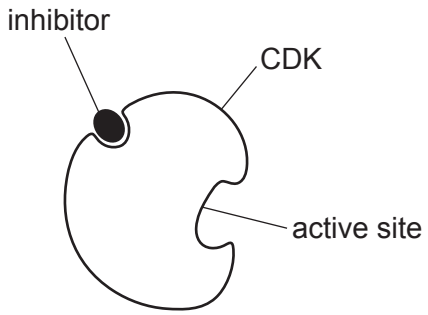


Fig. 5.1

State **and** explain how the CDK inhibitor in Fig. 5.1 prevents the activity of the CDK molecule.

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..... [2]

(c) Table 5.1 lists three different CDKs, their roles in the cell cycle and molecules that inhibit them.

Table 5.1

name of CDK	role of CDK in the cell cycle	CDK inhibitor
CDK1	regulates cell progression from G_2 to mitosis	RO-3306
CDK2	regulates the processes of the S phase	p21Cip1
CDK4	regulates cell progression from G_1 to the S phase	palbociclib

(i) With reference to Table 5.1, state which CDK inhibitor is likely to result in a cell containing **one** chromatid per chromosome. Explain your answer.

inhibitor .....

explanation .....

.....

[2]

(ii) With reference to Table 5.1, state which CDK inhibitor is likely to result in a cell with:

- a relatively high concentration of mitochondria
- **two** chromatids per chromosome.

Explain your answer.

inhibitor .....

explanation .....

.....

.....

[2]

(d) Scientists have developed CDK inhibitors that are synthetic.

Explain why CDK inhibitors can be used to treat cancerous tumours.

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..... [2]

[Total: 10]

6 DNA and RNA are polynucleotides.

(a) Describe **three** ways in which the structure of messenger RNA (mRNA) differs from the structure of DNA.

In each of your answers, include information about the structure of mRNA **and** the structure of DNA.

1 .....

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2 .....

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3 .....

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[3]

(b) Scientists have synthesised four synthetic bases, Z, P, S and B. The base pairings of the synthetic bases are shown in Fig. 6.1.

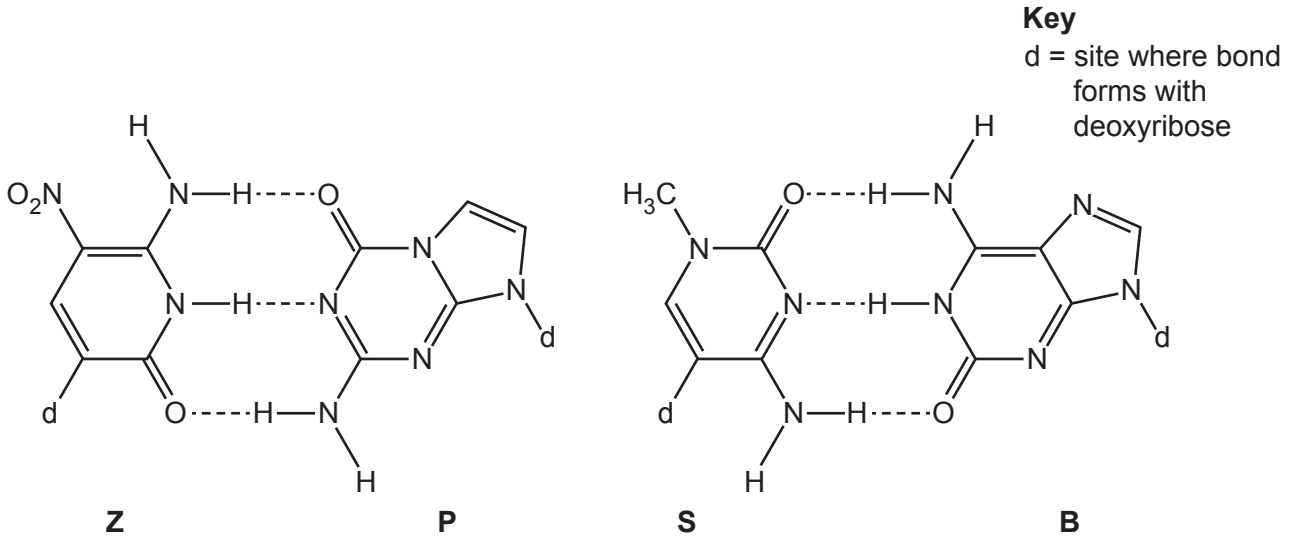


Fig. 6.1

(i) State the letters that represent the two purine synthetic bases in Fig. 6.1.

..... [1]

(ii) State **and** explain which DNA base pair is most similar to the synthetic base pairs in Fig. 6.1.

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..... [2]

[Total: 6]

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