Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

5774596970

BIOLOGY **9700/21**

Paper 2 AS Level Structured Questions **October/November 2021**

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.

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Answer **all** the questions.

1 **(a)** Fig. 1.1 is a transmission electron micrograph of cells from the leaf of a plant.

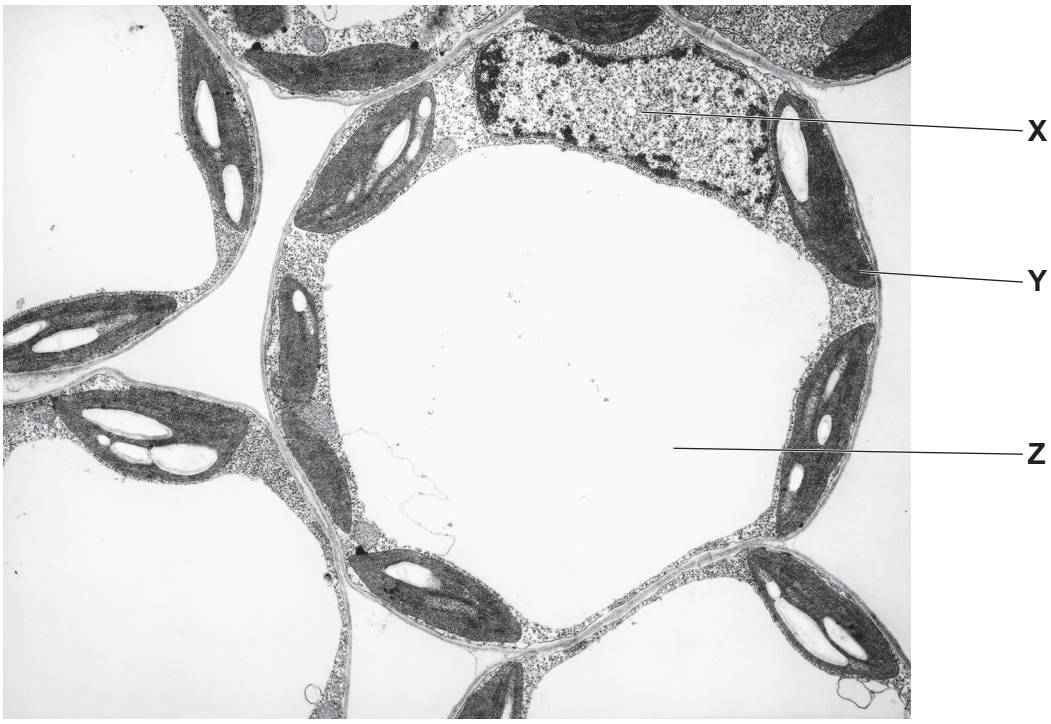


Fig. 1.1

(i) Name the cell structures **X**, **Y**, and **Z**.

X .....

Y .....

Z .....

[3]

(ii) State **two** ways in which the structure of an animal cell differs from plant cells such as those shown in Fig. 1.1.

1 .....

.....

2 .....

.....

[2]

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(b) (i) Cell structure **Y** in Fig. 1.1 contains a large starch granule (grain).

Name the chemical reagent used to test for starch **and** state the colour change that will be seen if starch is present.

reagent .....

colour change ..... [2]

(ii) Starch granules contain amylose and amylopectin.

Describe the similarities **and** differences between the structure of amylose and the structure of amylopectin.

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..... [4]

[Total: 11]

2 **(a)** Fig. 2.1 is a transmission electron micrograph of a transverse section through a blood capillary that is surrounded by actively respiring cells.

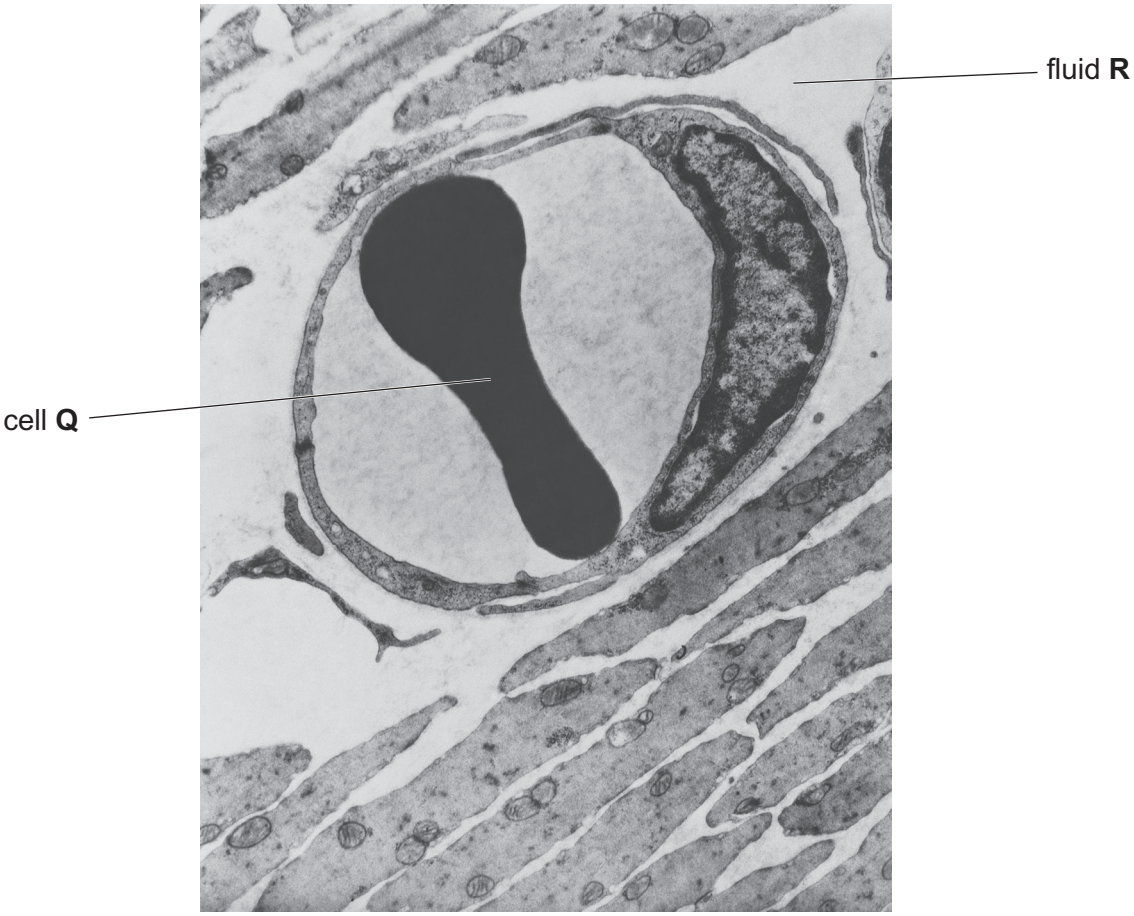


Fig. 2.1

(i) Identify cell **Q** shown in Fig. 2.1.

..... [1]

(ii) Fluid **R** is formed from blood in the blood capillary.

State **and** explain **one** difference between the composition of fluid **R** and the composition of the blood in the capillary.

difference .....

explanation .....

.....

.....

.....

..... [3]

(b) (i) The cell surface membranes of the respiring cells have a role in regulating the exchange of substances between the cells of the body and the blood.

Draw a diagram in the space below to show the arrangement of phospholipid molecules in the cell surface membrane.

[2]

(ii) Cholesterol is a molecule found in the cell surface membrane.

Describe **one** role of cholesterol in the cell surface membrane.

.....

.....

..... [1]

(c) Nicotine is one of the components of tobacco smoke. Nicotine can cross cell surface membranes and enter the bloodstream.

(i) Describe the short-term effects of nicotine on the cardiovascular system.

.....

.....

.....

.....

.....

..... [2]

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[Turn over

(ii) Nicotine is absorbed from the blood plasma into the cells of the capillary wall. Scientists have suggested that nicotine is transported from the blood plasma into these cells using a type of co-transporter mechanism.

Fig. 2.2 shows how nicotine may be transported from the blood plasma into a cell.

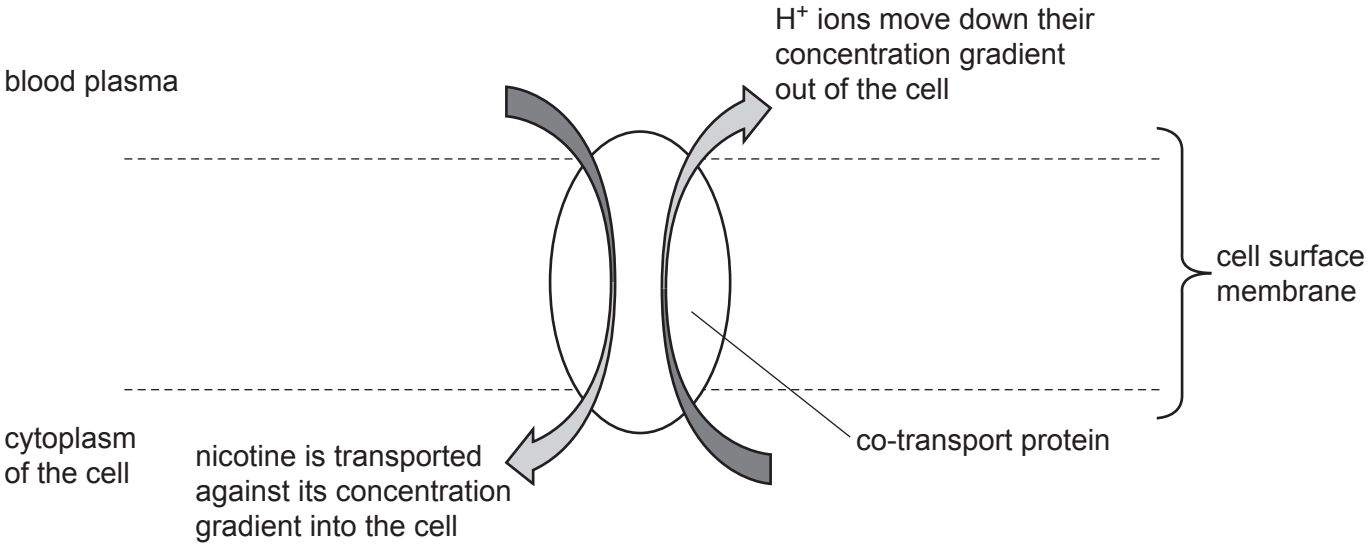


Fig. 2.2

The co-transporter mechanism shown in Fig. 2.2 is different from the co-transporter mechanism that moves sucrose into the cytoplasm of a companion cell in phloem tissue.

Outline the similarities **and** differences between the co-transport of nicotine and the co-transport of sucrose.

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.....

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.....

.....

..... [3]

[Total: 12]

Question 3 starts on page 8.

3 Cholera is an infectious disease caused by the bacterial pathogen *Vibrio cholerae*.

(a) Describe how *V. cholerae* is transmitted from an infected person to an uninfected person.

.....

.....

.....

.....

..... [2]

V. cholerae releases a toxin called choleragen. Choleragen is a protein molecule made up of six polypeptides (subunits).

(b) Fig. 3.1 is a ribbon diagram of a molecule of choleragen.



Fig. 3.1

Describe what is shown by the part of the molecule labelled **T**.

.....

.....

.....

.....

.....

.....

..... [3]

(c) Vaccination can be used to prevent the spread of cholera. The vaccine used contains part of the choleragen molecule and also contains dead cells of *V. cholerae*.

(i) Phagocytes play an important role in the immune response to a vaccine. Phagocytes contain many lysosomes.

Describe the function of lysosomes in phagocytes.

.....

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.....

..... [2]

(ii) Suggest the advantage of having a vaccine that includes dead cells of *V. cholerae* and part of the choleragen molecule.

.....

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.....

.....

..... [2]

(d) The World Health Organization states that most cases of cholera can be treated with oral rehydration therapy. To reduce the risk of antibiotic resistance developing, antibiotics are only recommended for the most serious cases.

Discuss the consequences of the development of antibiotic resistance in *V. cholerae*.

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..... [4]

[Total: 13]

Question 4 starts on page 12.

4 **(a)** Fig. 4.1 is a drawing made by a student of a plant cell, showing one of the stages of mitosis.

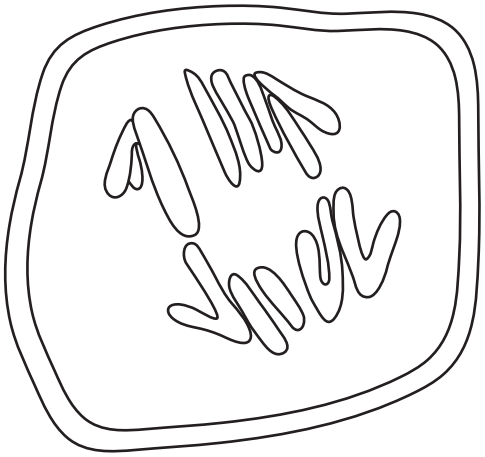


Fig. 4.1

(i) Describe the role of the spindle during this stage of mitosis.

.....

.....

.....

..... [2]

(ii) The chromosomes are composed of DNA.

Describe the structure of a monomer of a DNA molecule.

.....

.....

.....

..... [2]

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(b) Telomeres are located at the ends of each chromosome.

Telomeres progressively shorten each time a healthy human cell divides, until the cell is no longer able to divide.

Stem cells have an enzyme called telomerase that prevents the telomeres shortening during the cell cycle.

(i) Suggest why telomerase activity is important in stem cells.

.....

.....

.....

..... [2]

(ii) Suggest why tumour cells produce high concentrations of telomerase.

.....

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..... [1]

(iii) Scientists have researched the possibility of treating cancer by inhibiting the action of telomerase.

One method that has been studied involves inserting small, single-stranded DNA into cancer cells. These sections of DNA have a base sequence that is complementary to a section of the mRNA transcribed from the gene coding for telomerase.

Explain how inserting small, single-stranded DNA could prevent **translation** of the mRNA to produce telomerase.

.....

.....

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..... [3]

[Total: 10]

5 A student investigated the effects of air movement on the rate of transpiration by using a potometer.

(a) Define the term transpiration.

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..... [2]

The potometer used by the student is shown in Fig. 5.1.

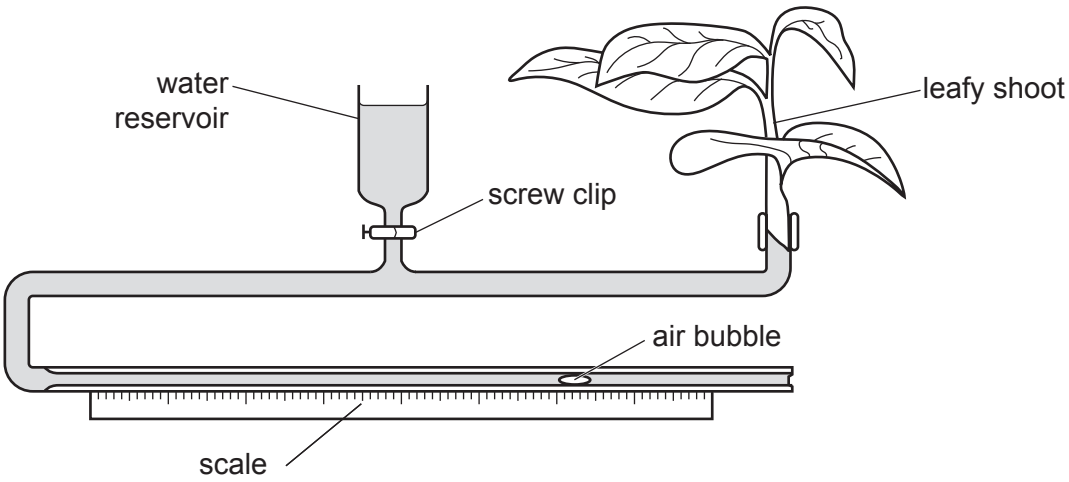


Fig. 5.1

The student recorded the distance the air bubble in the apparatus had moved after ten minutes with no air movement.

The rate of water uptake was used as a measure of the rate of transpiration.

The apparatus was then reset using the reservoir, and the experiment was repeated a further two times. All other variables were standardised during the three experiments.

Table 5.1 shows the results recorded by the student.

Table 5.1

experiment	distance moved by the bubble in 10 minutes / mm
1	12.5
2	12.0
3	11.5

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(b) Use Table 5.1 to calculate the mean rate of movement of the bubble.

..... mm min^{-1} [1]

(c) The student carried out another experiment using the same plant. In this experiment a fan was used to blow air across the leaves of the plant. All other variables were standardised.

The results showed that the bubble moved further in 10 minutes.

The student concluded that air movement increases the rate of transpiration.

Explain why air movement increases the rate of transpiration.

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..... [2]

(d) Explain how water moves up through a xylem vessel in the stem of the plant in the potometer, shown in Fig. 5.1.

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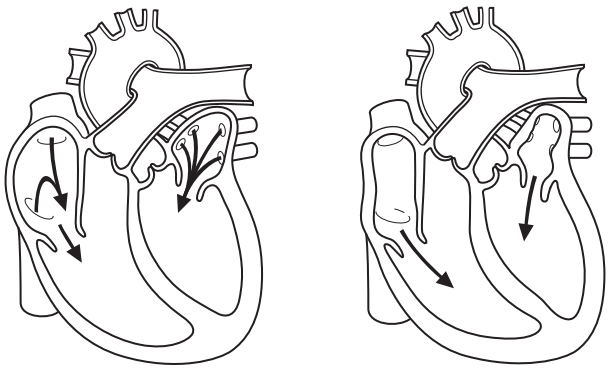
.....

.....

..... [4]

[Total: 9]

6 Fig. 6.1 is a diagram of sections through the heart showing two stages of the cardiac cycle, **A** and **B**.



Stage A **Stage B**

Fig. 6.1

(a) Name stage **B** in Fig. 6.1 **and** state one piece of evidence from the diagram that supports your answer.

stage **B** .....

evidence .....

.....

.....

.....

..... [2]

(b) **(i)** Draw a label line on Fig. 6.1 to identify **one** semilunar valve. Label the valve **S**. [1]

(ii) Describe the role of the semilunar valves in the cardiac cycle.

.....

.....

.....

.....

..... [2]

[Total: 5]

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Cambridge International AS & A Level

CANDIDATE NAME

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1627253449

BIOLOGY **9700/22**

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Answer **all** questions.

1 There are two types of cell, prokaryotic and eukaryotic. Bacterial cells are prokaryotic and plant cells are eukaryotic.

(a) There are differences in the structural features that are common to bacterial cells and plant cells. For example, the cell surface membrane in a plant cell contains cholesterol, but in a bacterial cell the membrane contains molecules known as hopanoids. Cholesterol and hopanoids have the same function.

Some of the main structural features common to both types of cell are shown in Table 1.1.

Complete Table 1.1 by giving **one** difference between a bacterial cell and a plant cell for each structural feature listed.

The difference between the cell surface membranes of the two types of cell has been completed for you.

Table 1.1

feature common to bacterial and plant cells	bacterial cell	plant cell
cell surface membrane	contains hopanoids	contains cholesterol
ribosome		
DNA		
cell wall		

[3]

(b) One role of the cell surface membrane of bacterial cells and plant cells is the transport of substances into and out of cells.

Explain how membrane carrier proteins and membrane channel proteins are involved in the transport of substances into and out of cells.

.....

.....

.....

.....

.....

.....

..... [3]

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(c) Fig. 1.1 is a photomicrograph showing chloroplasts in plant leaf cells.

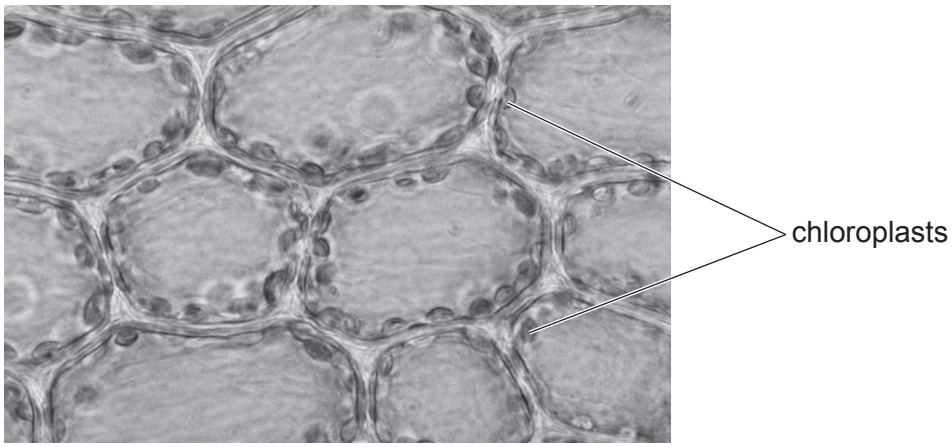


Fig. 1.1

Explain why the chloroplasts are seen only around the periphery (edge) of each plant cell.

.....

.....

..... [1]

(d) Fig. 1.2 shows plant cells in a root tip where cell division by mitosis is taking place.

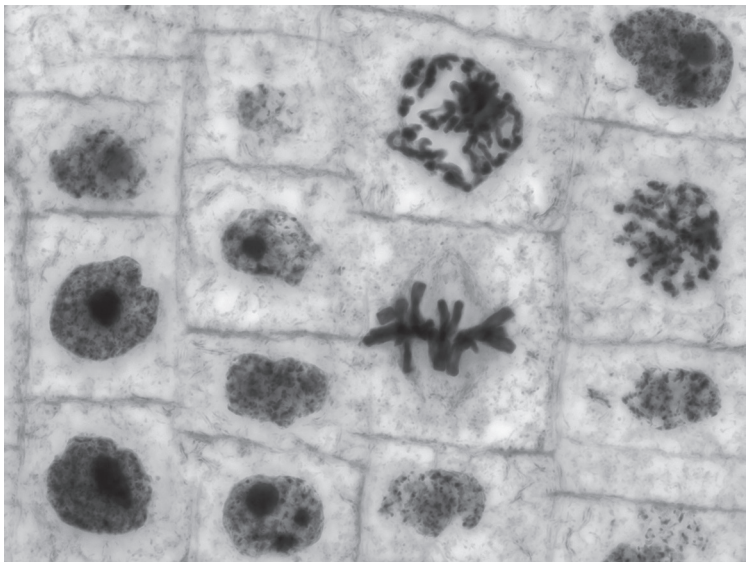


Fig. 1.2

Identify **two** cells in Fig. 1.2 that are in different stages of mitosis.

Draw a label line to each cell and add the name of the stage of **mitosis** that is shown by the cell. [2]

[Total: 9]

2 The high blood pressure at the arterial end of a capillary network results in some components of blood leaving the capillaries and forming tissue fluid. At the venous end, the presence of plasma proteins allows movement of water by osmosis back into the capillaries.

Fig. 2.1 is a diagram showing a capillary network. The lymph vessels and the blood vessels at the arterial and venous ends of the network are also shown.

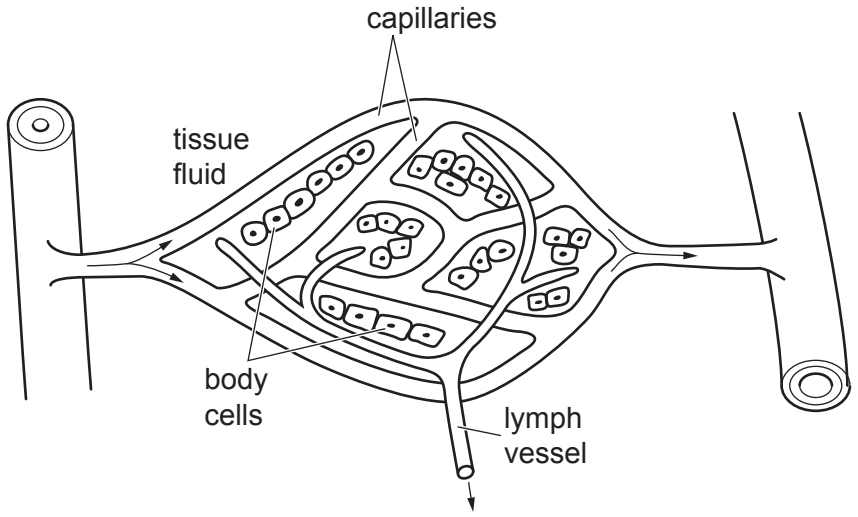


Fig. 2.1

(a) Red blood cells and plasma proteins, such as albumin, remain in the capillaries and are not found in tissue fluid.

Explain why red blood cells and albumin do not leave the capillary.

.....

.....

.....

..... [2]

(b) Name the chemical reagent or reagents used to test for proteins in a sample of blood plasma **and** state the colour change that will be seen if protein is present.

reagent or reagents .....

.....

colour change .....

.....

[2]

(c) When a person moves from sea level and stays at high altitude for a few months, there is an increase in the number of red blood cells per mm^3 of blood.

Explain why this increase occurs.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(d) A low blood albumin concentration can lead to a condition known as oedema.

Oedema is a swelling of tissues caused by the accumulation of tissue fluid surrounding the body cells in the capillary network.

Suggest **and** explain how a low blood albumin concentration can lead to oedema.

.....

.....

.....

.....

.....

.....

..... [3]

(e) Albumin transports some cell signalling molecules from the cells where they are synthesised to their target cells. The cell signalling molecules bind to specific cell surface membrane proteins on the target cells.

Name the type of membrane protein to which the cell signalling molecules bind.

..... [1]

[Total: 11]

3 Baculovirus is a virus that kills some of the insect pests of major crops. When the virus is released to the outside of the insect body, it is contained within stable, protective structures known as polyhedrons.

The main component of the polyhedron is a protein molecule, polyhedrin.

Polyhedrons can be sprayed onto plants as a bioinsecticide. They are ingested by feeding insect larvae and once inside the insect gut they break down to release the virus.

(a) Explain why the term infectious disease can be used to describe the effect of baculovirus on insects.

.....

.....

..... [2]

(b) Suggest **and** explain the conditions present in the insect gut that can cause the breakdown of polyhedrons.

.....

.....

.....

..... [2]

(c) A polyhedrin molecule is composed of three identical polypeptides. Each polypeptide is 245 amino acids long. The first 10 amino acids of the polypeptide are shown in Fig. 3.1.

1	2	3	4	5	6	7	8	9	10
met —	**pro —**	**asp —**	**tyr —**	**ser —**	**tyr —**	**arg —**	**pro —**	**thr —**	**ile —**

Fig. 3.1

Fig. 3.2 **A** is a ribbon diagram of a single polypeptide. Fig. 3.2 **B** shows a polyhedrin molecule composed of 3 polypeptides.

The two diagrams are not to the same scale.

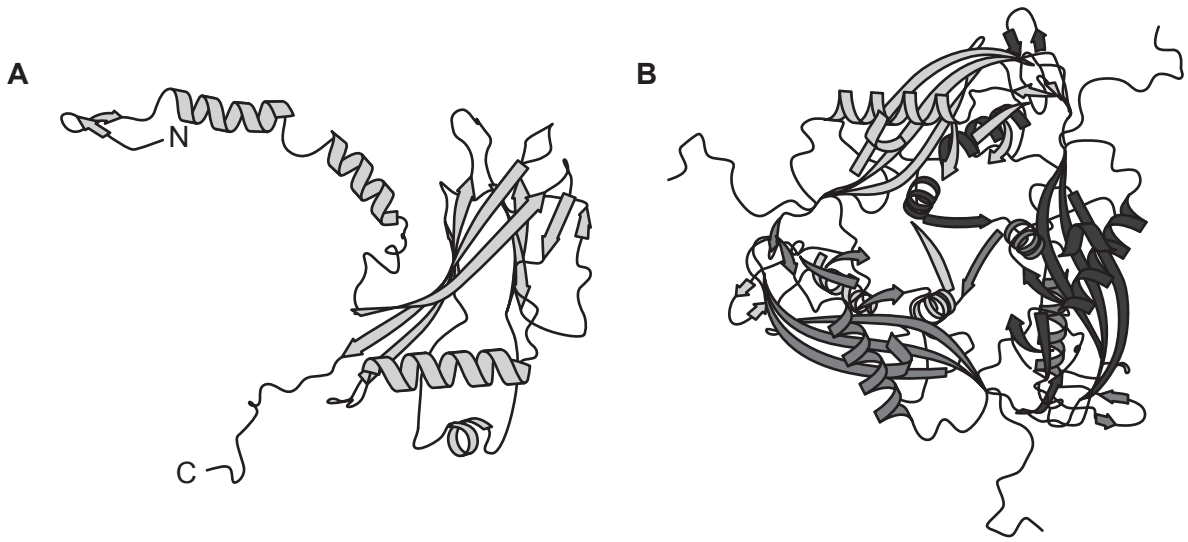


Fig. 3.2

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With reference to Fig. 3.1 and Fig. 3.2, describe the structure of a polyhedrin molecule.

.....

.....

.....

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.....

.....

..... [4]

(d) The sequence of DNA nucleotides for the gene in baculovirus that codes for the polyhedrin polypeptide has been determined.

Explain why the amino acid sequence of the polypeptide **cannot** be used to deduce this sequence of nucleotides in the gene that codes for the polyhedrin polypeptide.

.....

.....

.....

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.....

.....

..... [3]

[Total: 11]

4 Barlinka is a variety of the common grapevine, *Vitis vinifera*. Barlinka grapes are used for making wine and are sold as fruit. There are economic and ecological benefits from using less water to irrigate grapevine plants, while still producing a high crop yield.

The rate of flow of sap within xylem vessels from roots to leaves can be used as an estimate of the rate of transpiration. This also indicates water uptake.

(a) The hydrogen bonding of water molecules is important in the transport of sap within xylem vessels.

State the terms used to describe:

- water molecules sticking together within the xylem vessel

.....

- water molecules sticking to the cellulose molecules in the lining of the xylem vessel

.....
[2]

(b) An experiment was carried out to investigate the effect of leaf area on the rate of flow of the xylem sap during fruit development.

The flow rate was measured over a three-day period in three Barlinka grapevine plants with different total leaf area. The plants were growing in the same conditions.

The results are shown in Fig. 4.1.

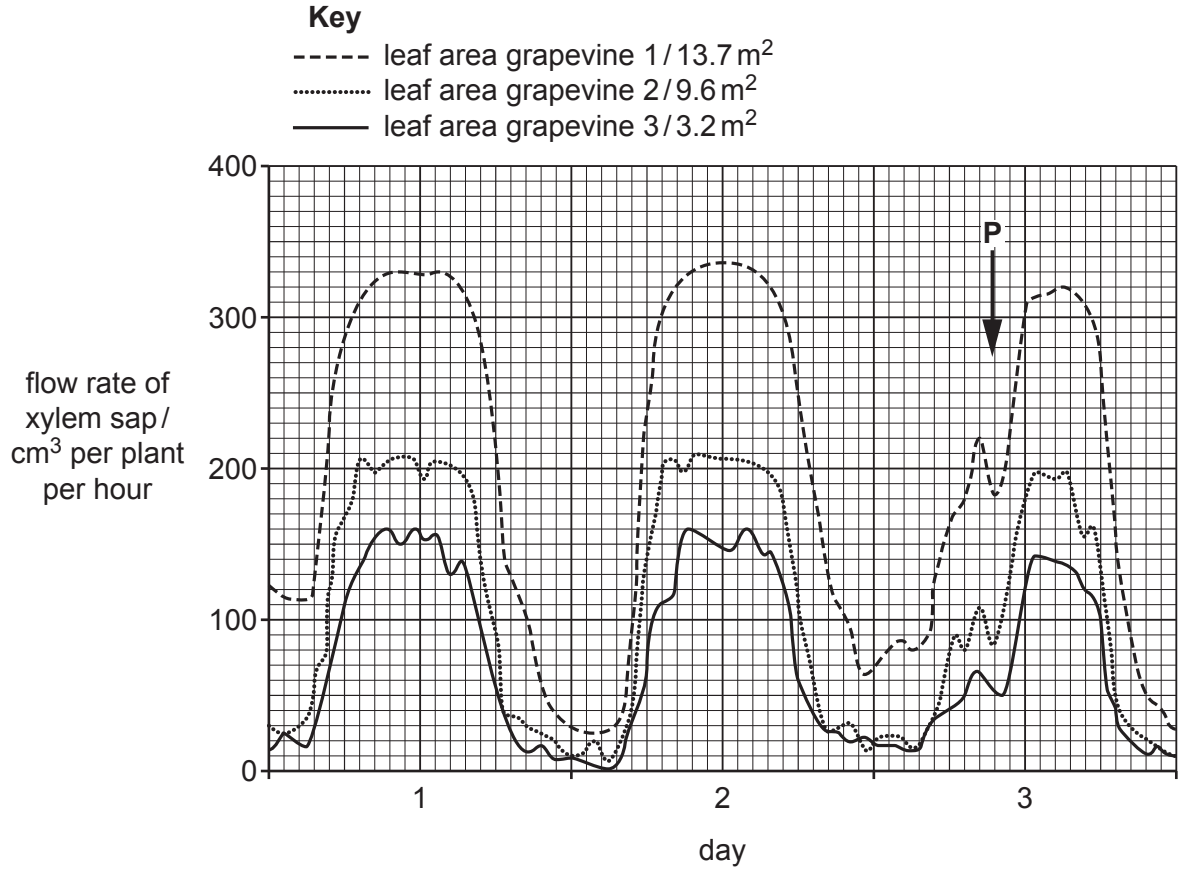


Fig. 4.1

(i) The general pattern of results in Fig. 4.1 is the same for the three Barlinka grapevines.

Explain why the general pattern of results is the same.

.....

.....

.....

.....

.....

..... [2]

(ii) With reference to Fig. 4.1, explain the differences in the results between the three grapevines, **1**, **2** and **3**.

.....

.....

.....

.....

.....

..... [2]

(iii) Suggest an explanation for the decrease in flow rate of xylem sap shown at time **P** in Fig. 4.1.

.....

..... [1]

(iv) Outline how you would determine the surface area of one side of a leaf.

.....

.....

.....

..... [2]

[Total: 9]

5 The causative organism of measles is *Morbillivirus*. Young children who have not been vaccinated for measles are at highest risk of becoming ill and of developing complications associated with the disease.

(a) The genetic material of *Morbillivirus* is a strand of RNA.

Statements **A**, **B** and **C** relate to the structure of RNA.

State the correct term or terms to match each of statements **A** to **C**.

A The names of the two purines and two pyrimidines in RNA.

purines .....

.....

pyrimidines .....

.....

B The type of covalent bond between RNA nucleotides.

.....

C The pentose sugar of the RNA nucleotide.

.....

[4]

(b) Describe how measles is transmitted.

.....

.....

.....

.....

.....

.....

..... [3]

(c) Young children with measles may develop difficulties with breathing. This is made worse if the child is continually exposed to tobacco smoke. Tobacco smoke contains harmful compounds, such as carbon monoxide.

(i) Inhaled tobacco smoke passes through the larynx (voice box) and other structures in the gas exchange system to reach the alveoli.

Complete Fig. 5.1 to list, in the correct sequence, the main structures of the gas exchange system through which the tobacco smoke passes to reach the alveoli.

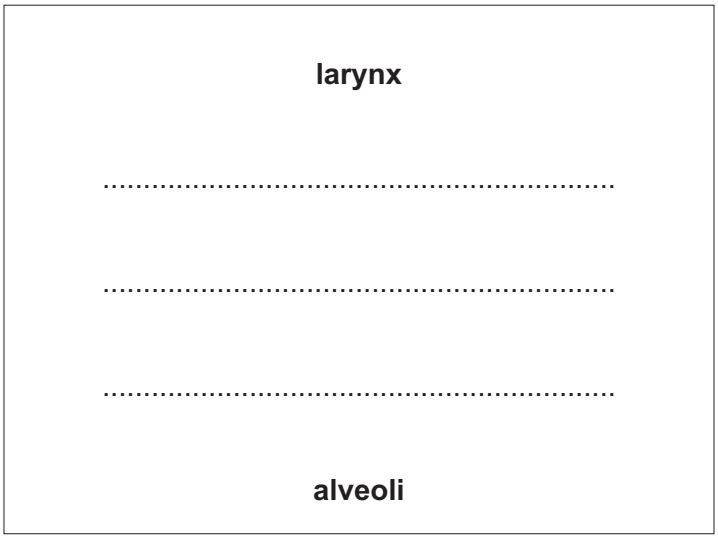


Fig. 5.1

[1]

(ii) State the short-term effects of carbon monoxide on the cardiovascular system.

.....

.....

.....

.....

..... [2]

(d) Smallpox is a disease that has been eradicated with the help of a global vaccination programme. Measles has not been eradicated, even though there is a global vaccination programme.

Fig. 5.2 is a graph showing the estimates of number of deaths from measles globally, between 2000 and 2017, for people who have **not** been vaccinated.

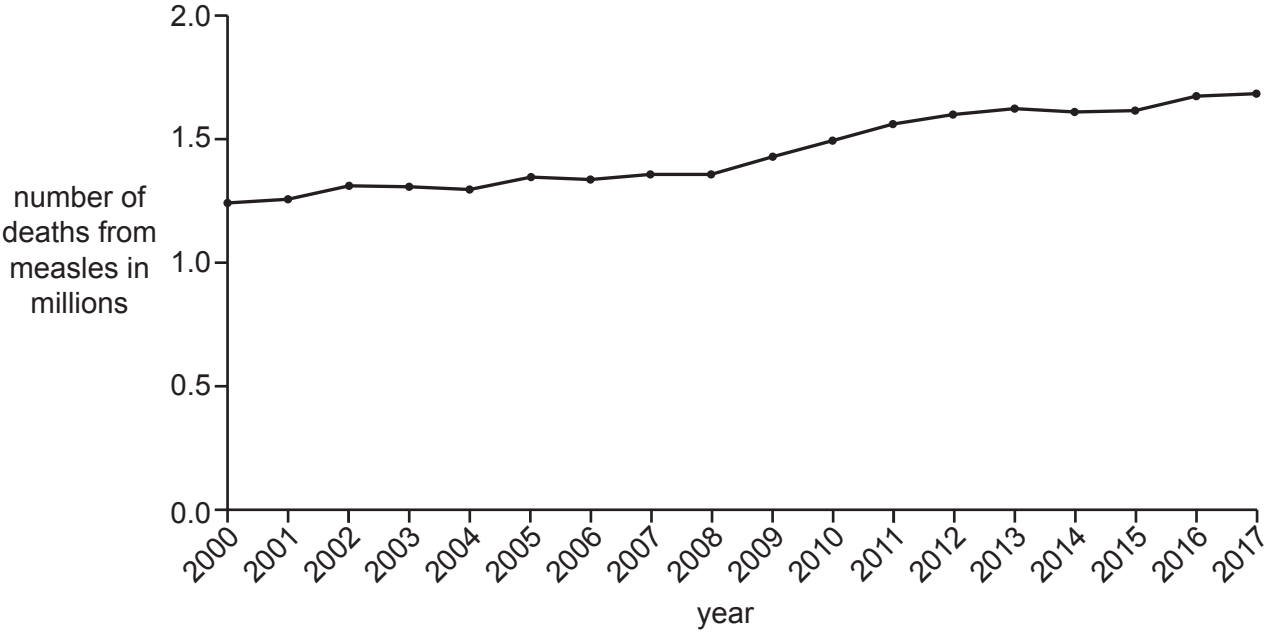


Fig. 5.2

(i) State the trend shown in Fig. 5.2 between 2000 and 2017.

.....

.....

.....

..... [1]

(ii) Suggest reasons for the trend shown in Fig. 5.2.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(e) A child with leukaemia is at high risk of developing measles even though the child has a high white blood cell count **and** has been vaccinated against the disease.

Explain why this child is at high risk of developing measles.

.....

.....

.....

.....

..... [2]

[Total: 16]

6 Amylase is an enzyme that catalyses the hydrolysis of starch into reducing sugars.

A student carried out an experiment to investigate the hydrolysis of starch using immobilised amylase. Fig. 6.1 is a diagram of the apparatus that was used in the investigation.

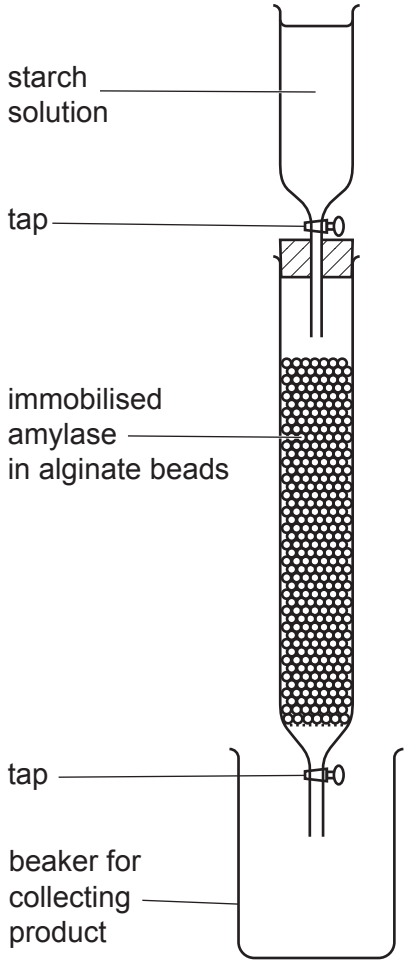


Fig. 6.1

The alginate beads were all the same size.

Both taps were opened to allow the starch solution to flow down the column and for the product to be collected.

The product was tested for the presence of reducing sugar and starch.

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(a) The results of the investigation showed that the product collected in the beaker contained reducing sugar **and** starch.

With reference to Fig. 6.1, describe a method that would allow the student to use the immobilised amylase to collect a product that contains **only** reducing sugar.

.....

.....

.....

.....

.....

.....

..... [3]

(b) One standardised variable in the investigation is the size of the alginate beads.

Suggest **one** reason why using larger or smaller alginate beads in the column would affect the results obtained.

.....

.....

..... [1]

[Total: 4]

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Cambridge International AS & A Level

CANDIDATE NAME

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1695804370

BIOLOGY **9700/23**

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1 hour 15 minutes

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Answer **all** questions.

1 Fig. 1.1 is a diagram showing a stage in protein synthesis.

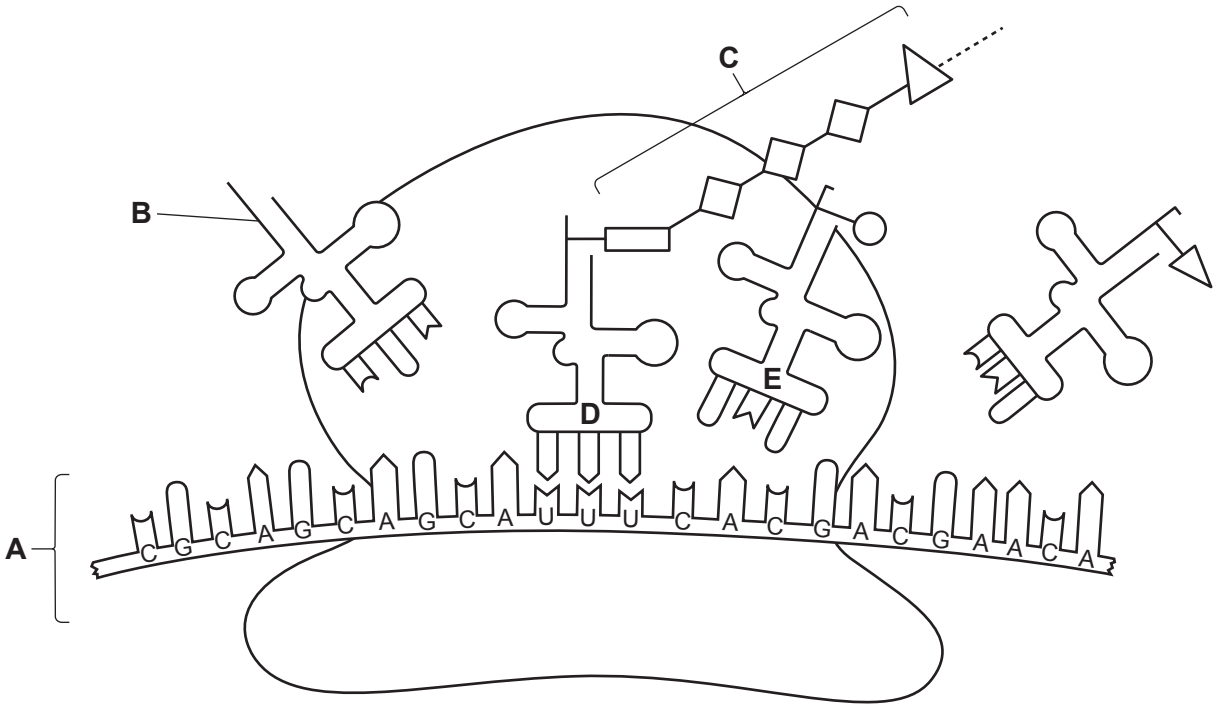


Fig. 1.1

(a) (i) Name the stage of protein synthesis that is shown in Fig. 1.1.

..... [1]

(ii) Identify **A**, **B** and **C** in Fig. 1.1.

A .....

B .....

C .....
[3]

(iii) State the base sequences at **D** and **E**.

D .....

E .....
[1]

(b) Mutagenesis is a process that leads to a change in the amino acid sequences of proteins. Scientists carry out mutagenesis to investigate the importance of particular amino acids in protein structure and function.

Outline how changing one amino acid in the β-globin polypeptide of haemoglobin may change the structure and function of a molecule of haemoglobin.

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..... [4]

[Total: 9]

2 Pepsin is an enzyme that hydrolyses proteins (protease). Some students used pepsin from the stomach of a mammal.

The activity of the pepsin was investigated by placing a small quantity of the enzyme with a known concentration of the protein albumen.

Fig. 2.1 shows the progress of the enzyme-catalysed reaction that was carried out at 20 °C.

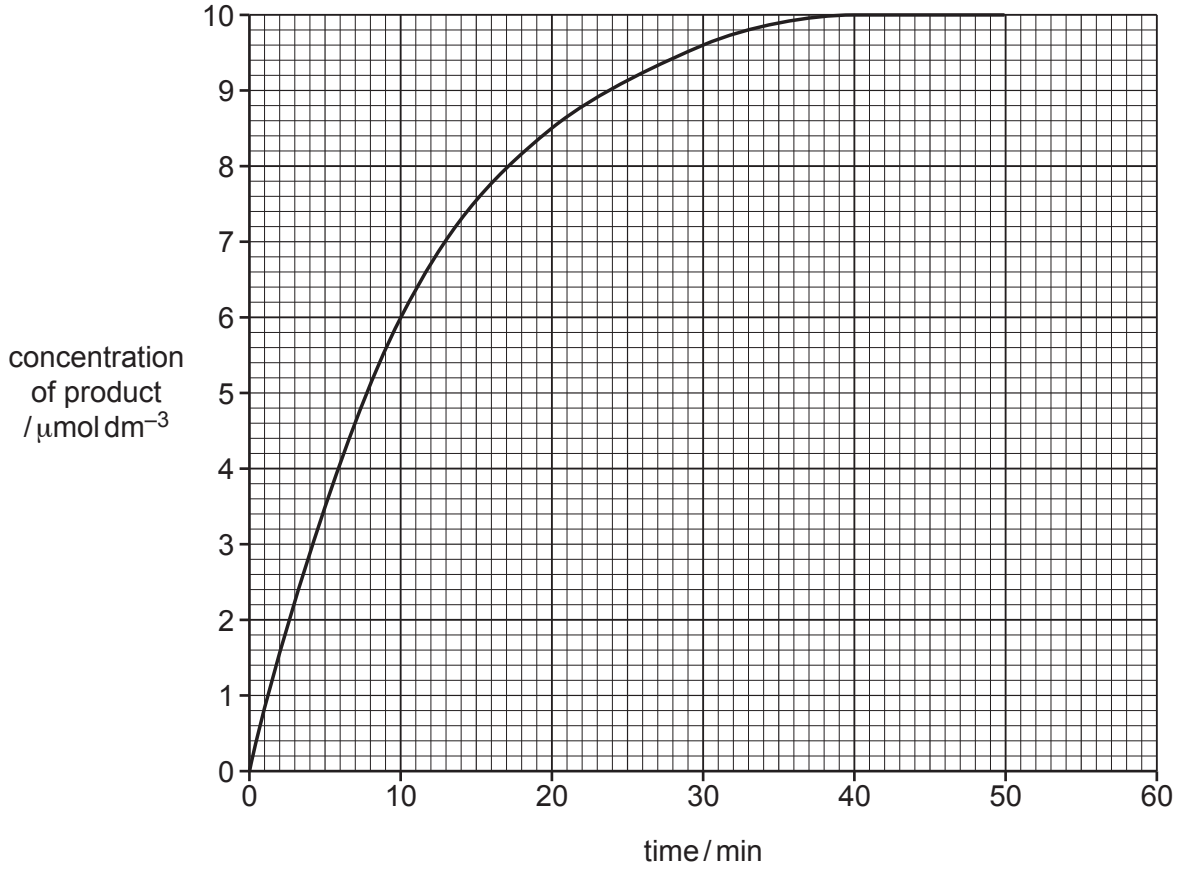


Fig. 2.1

(a) Calculate the initial rate of the reaction.

initial rate of reaction = ... [2]

(b) (i) The procedure was repeated to find the effects on the activity of the pepsin using a competitive inhibitor at the same temperature, 20 °C.

Predict the results that will be obtained using the competitive inhibitor.

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..... [2]

(ii) The procedure was repeated **without** the competitive inhibitor but at the higher temperature of 30 °C.

Predict the results that will be obtained at 30 °C.

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..... [2]

(c) The students extended their investigation by using pepsin from a different species of mammal. The experiments were carried out at 20 °C and **without** a competitive inhibitor.

With reference to Fig. 2.1, explain the advantage of calculating the initial rate of reaction in each experiment.

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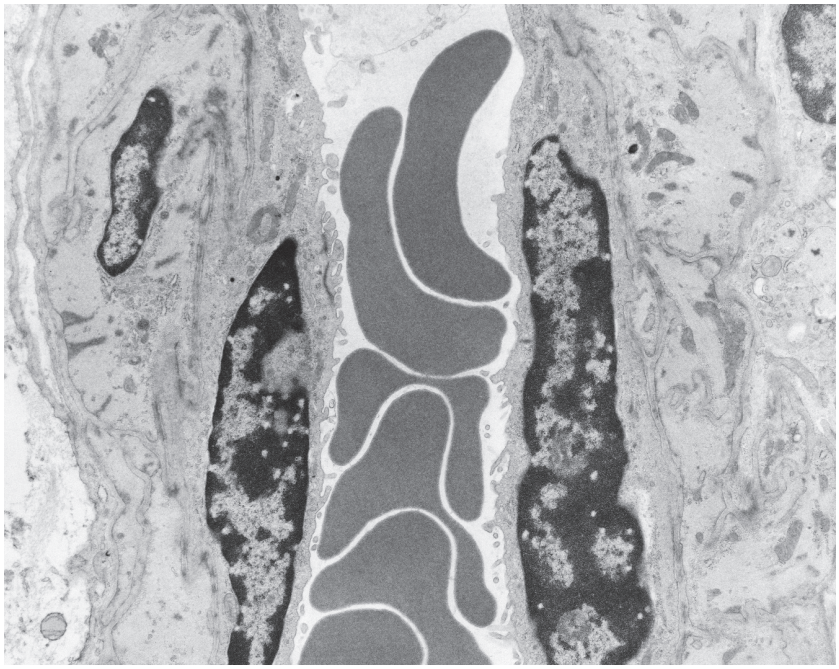
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..... [2]

[Total: 8]

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3 Fig. 3.1 is a transmission electron micrograph showing red blood cells in a capillary of a healthy adult.



magnification = ×4000

Fig. 3.1

(a) (i) Explain how the cells in the capillary shown in Fig. 3.1 can be identified as red blood cells.

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..... [3]

(ii) Capillaries are surrounded by tissue fluid.

Outline the ways in which the composition of tissue fluid differs from blood.

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..... [2]

(b) Scientists compared features of the physiology of three groups of people who live at different altitudes. These people were selected from populations that have lived at these altitudes for many thousands of years.

The scientists took blood samples from people in each location and measured:

- the concentration of haemoglobin in the blood
- the percentage saturation of haemoglobin with oxygen in blood leaving the lungs
- the oxygen concentration in the blood leaving the lungs.

The results are shown in Table 3.1.

Table 3.1

altitude / m	**location of group of people**	**mean haemoglobin concentration in blood / g 100 cm^{-3}**	**mean percentage saturation of haemoglobin with oxygen in blood leaving the lungs**	**mean oxygen concentration in blood leaving the lungs / cm^3 100 cm^{-3}**
100 (near sea level)	Peru	15.3	97.0	21.1
3500	East Africa mountains	15.6	95.5	21.1
3750 – 4000	Andes mountains	19.1	92.0	22.0

(i) Describe the changes in mean percentage saturation of haemoglobin with oxygen and the mean haemoglobin concentration in blood as altitude increases.

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..... [3]

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(ii) With reference to Table 3.1, suggest how the people living at high altitude can have an oxygen concentration in blood leaving the lungs similar to that of the people living at sea level.

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..... [3]

[Total: 11]

4 In thale cress, *Arabidopsis thaliana*, most of the stomata are on the lower surface of the leaves.

Fig. 4.1 is a diagram of an open stoma and two guard cells. Some of the cellulose fibres in the cell wall of the guard cells are shown.

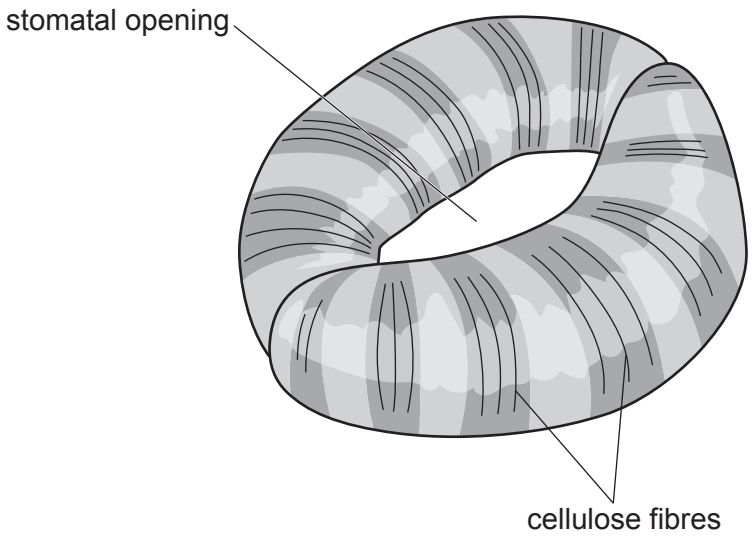


Fig. 4.1

(a) The cellulose fibres shown in Fig. 4.1 are composed of bundles of cellulose microfibrils.

Explain how molecules of cellulose are arranged into a microfibril.

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..... [2]

(b) The width of stomatal openings in *A. thaliana* is regulated by movement of ions. These ions move through channel proteins in the cell surface membranes of the guard cells.

(i) Draw a diagram to show part of a cell surface membrane with a channel protein.

Label your diagram.

[3]

(ii) Explain why channel proteins are needed for the movement of ions into and out of cells.

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..... [2]

(c) The outward movement of ions from guard cells causes stomata to close.

A variety of *A. thaliana* does **not** have channel proteins for the outward movement of ions in the cell surface membranes of the guard cells.

Suggest **and** explain the effect of **not** having these channel proteins on transpiration.

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..... [3]

[Total: 10]

5 Measles is a highly infectious disease. The World Health Organization (WHO) has coordinated a programme for controlling this disease by using vaccination.

(a) (i) Name the pathogen that causes measles.

..... [1]

(ii) Explain how the measles pathogen is transmitted.

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..... [3]

(b) Fig. 5.1 shows the number of cases of measles globally each month between January 2015 and March 2019.

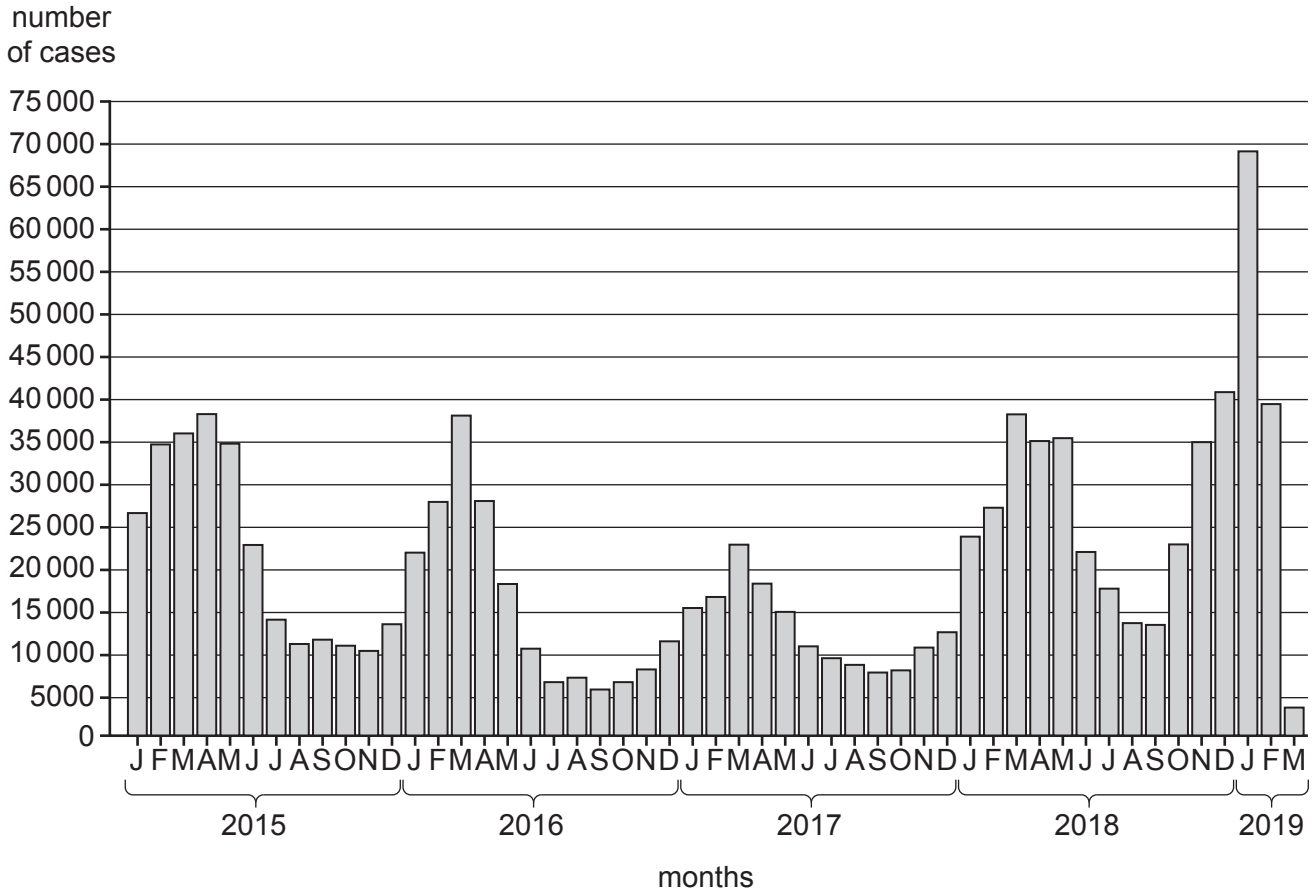


Fig. 5.1

Describe the pattern of measles cases as shown in Fig. 5.1.

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..... [3]

(c) Explain why measles has **not** yet been eradicated even though a vaccine has been available since the 1960s.

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..... [4]

[Total: 11]

6 **(a)** Table 6.1 compares some of the features of DNA with the protein collagen.

Complete Table 6.1.

Table 6.1

feature	DNA	collagen
elements		C H O N
monomers		
bond between monomers		
site of production in eukaryotic cells	nucleus	

[6]

(b) Most of the DNA in a eukaryotic cell is located in the nucleus.

State how the structure of a nucleus is suited to its function of containing DNA.

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..... [2]

(c) Fibroblast cells produce elastic fibres and collagen fibres in lung tissue.

Describe the function of elastic fibres in lung tissue.

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..... [2]

(d) Name the stage of the cell cycle during which DNA **and** proteins are synthesised.

..... [1]

[Total: 11]

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