UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

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8805759026

BIOLOGY **9700/21**

Paper 2 Structured Questions AS **October/November 2013**

1 hour 15 minutes

Candidates answer on the Question Paper.

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Answer **all** questions.
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Answer **all** the questions.

For Examiner's Use

1 Fig. 1.1 shows a cell of a female fruit fly, *Drosophila melanogaster*, during a stage of mitosis.

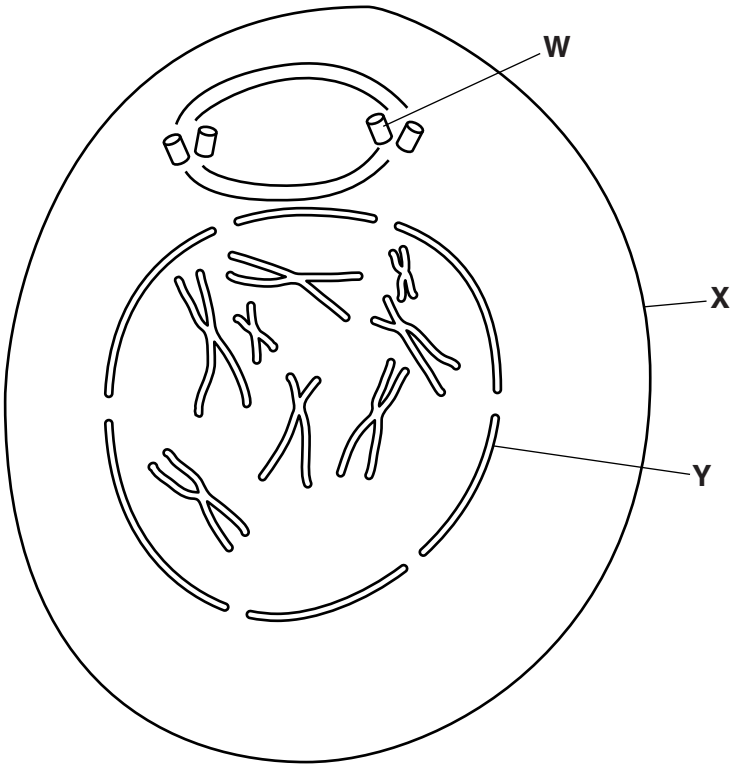


Fig. 1.1

(a) (i) Name the stage of mitosis shown in Fig. 1.1.

.....[1]

(ii) Shade a pair of homologous chromosomes. [1]

(iii) Name the structure labelled **W** and state its function.

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.....[2]

(b) State what happens to structure **X** and to structure **Y** between the stage shown in Fig. 1.1 and the end of cell division.

For Examiner's Use

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.....[3]

[Total: 7]

For Examiner's Use

2 **(a)** Table 2.1 shows eight ions that are biologically important.

Table 2.1

ammonium (NH_4^+)	**A**
hydrogen (H^+)	**B**
hydrogen carbonate (HCO_3^-)	**C**
iron (Fe^{2+})	**D**
magnesium (Mg^{2+})	**E**
nitrate (NO_3^-)	**F**
phosphate (PO_4^{3-})	**G**
sulfate (SO_4^{2-})	**H**

Choose one ion to match each of the following statements. In each case write **one** letter from Table 2.1. You may use each letter (**A** to **H**) once, more than once or not at all.

(i) A component of polynucleotides.

.....[1]

(ii) Ion produced by enzyme activity inside red blood cells.

.....[1]

(iii) Ion used in the production of all amino acids in chloroplasts.

.....[1]

(iv) Ion that diffuses through carrier proteins with sucrose into companion cells in phloem tissue.

.....[1]

(v) Component of haem group in haemoglobin that binds oxygen.

.....[1]

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(b) The enzyme nitrogenase is found in free-living and symbiotic nitrogen-fixing bacteria. Nitrogenase catalyses the reaction:

For Examiner's Use

$$N_{2\,(g)} + 6\,e^- + 8H^+_{(aq)} \longrightarrow 2NH_4{}^+_{(aq)}$$

Some nitrogenase enzymes have vanadium ions in their active sites; others have molybdenum ions.

Explain how the enzyme nitrogenase functions in the fixation of nitrogen.

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.....[4]

For Examiner's Use

(c) Some pea plants were grown with their roots in a solution of mineral ions. The solution was kept aerated for three days.
The concentrations of five ions in the solution and in the root tissue were determined after the three days. The results are shown in Table 2.2.

Table 2.2

ion	concentration / mmol dm^{-3}	
	surrounding solution	root tissue
potassium (K^+)	1.0	75.0
magnesium (Mg^{2+})	0.3	3.5
calcium (Ca^{2+})	1.0	2.0
phosphate (PO_4^{3-})	1.0	21.1
sulfate (SO_4^{2-})	0.3	19.7

With reference to Table 2.2, suggest how cell surface membranes of root cells are responsible for the concentrations of ions in the roots compared to the surrounding solution.

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.....[5]

[Total: 14]

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Question 3 starts on page 8

For Examiner's Use

3 **(a)** Tuberculosis (TB) and chronic obstructive pulmonary disease (COPD) are diseases that affect the lungs.

With reference to TB and COPD, explain how infectious diseases differ from non-infectious diseases.

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.....[2]

Macrophages are large phagocytic cells that are found in many tissues including alveolar tissue in the lungs. They provide the main means of defence against pathogens in this tissue.

Fig. 3.1 is a drawing made from an electron micrograph showing part of a capillary and two alveoli, with a macrophage.

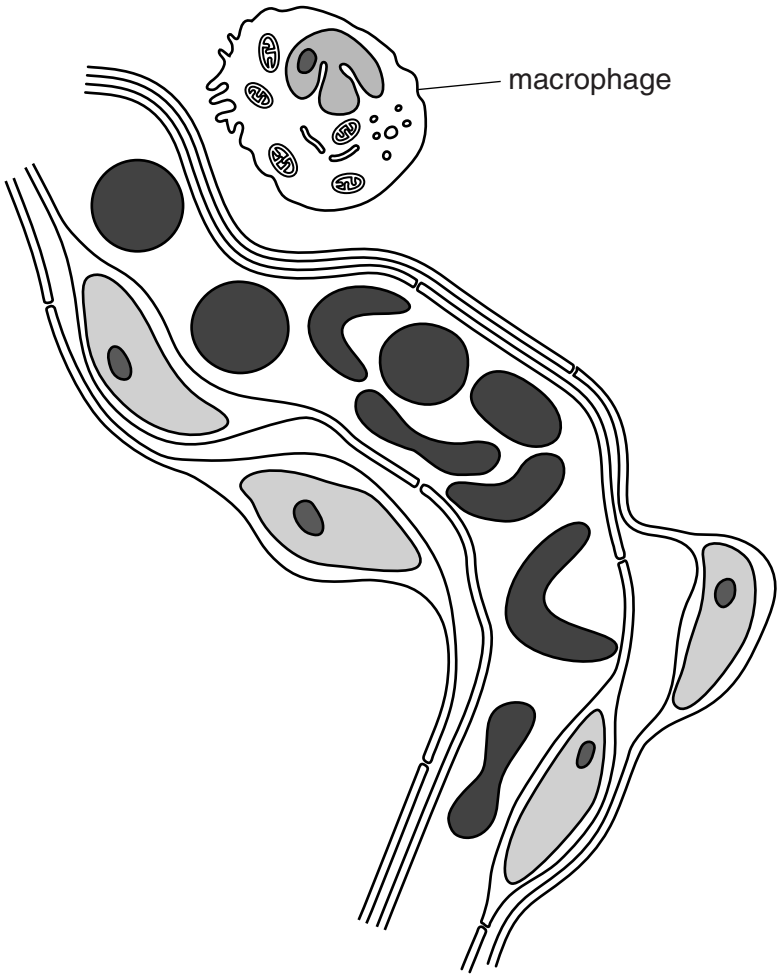


Fig. 3.1

(b) With reference to Fig. 3.1, explain:

For Examiner's Use

(i) how alveoli are adapted for gaseous exchange

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.....[3]

(ii) how macrophages function to protect the lungs from becoming infected.

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(c) Phagocytes release enzymes that digest proteins. In smokers, this may lead to the large-scale destruction of alveolar walls.

Outline the effects of this destruction on a person's health.

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.....[3]

[Total: 12]

4 Cholesterol is synthesised in the smooth endoplasmic reticulum (SER) in liver cells by a series of enzyme-catalysed reactions.

For Examiner's Use

Within the SER, molecules of cholesterol and triglycerides are surrounded by proteins and phospholipids to form lipoproteins. These lipoprotein particles enter the Golgi apparatus where they are packaged into vesicles and pass to the blood.

Fig. 4.1 is an electron micrograph of part of a liver cell showing lipoprotein particles within the Golgi apparatus.

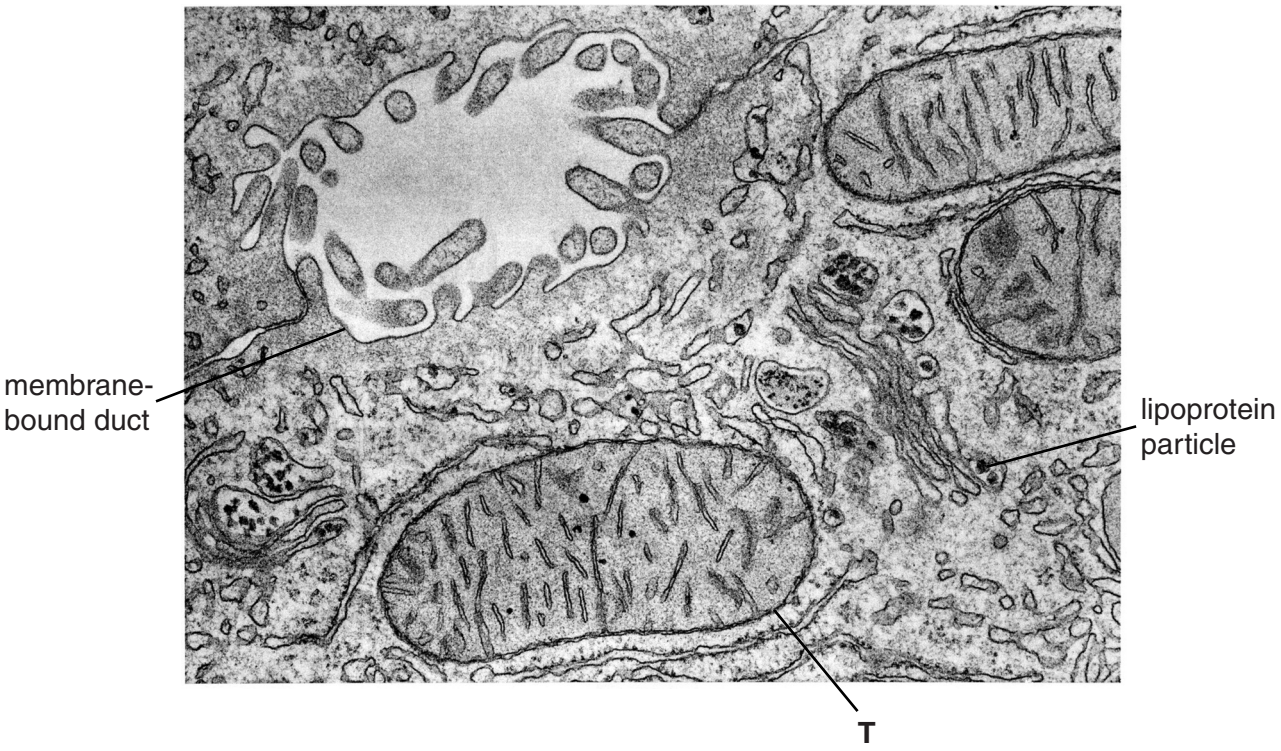


Fig. 4.1

(a) Name structure **T** in Fig. 4.1 and state its role in liver cells.

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.....[3]

(b) **(i)** Suggest why cholesterol is packaged into lipoproteins before release from liver cells into the blood.

For Examiner's Use

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.....[1]

(ii) Explain why cells of the body need to be supplied with cholesterol.

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.....[2]

(c) Cholesterol is also packaged into vesicles by the SER and then secreted from the cell into small fluid-filled spaces between the liver cells. These spaces form ducts that drain into the gall bladder to form bile.

Suggest how cholesterol is secreted into ducts, such as the duct in Fig. 4.1.

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.....[2]

(d) State **one** function of the Golgi apparatus **other than** the packaging of substances into vesicles for transport.

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.....[1]

[Total: 9]

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[Turn over

5 Table 5.1 shows the triplets of bases on the template polynucleotide of DNA for some amino acids.

For Examiner's Use

Table 5.1

amino acid		DNA triplets
glutamic acid	(glu)	CTT CTC
histidine	(his)	GTA GTG
leucine	(leu)	GAA GAG GAT GAC
proline	(pro)	GGA GGG GGT GGC
threonine	(thr)	TGA TGG TGT TGC
valine	(val)	CAA CAG CAT CAC

Fig. 5.1 shows the base sequences in DNA and mRNA for the first seven amino acids of the β chain of haemoglobin.

DNA	CAC	.....	GAC	TGA	GGA	CTC	CTC
mRNA	GUG	CAC	CUG	.....	CCU	GAG	GAG
β chain	val	his	.....	thr	pro	glu	glu

Fig. 5.1

(a) (i) Use Table 5.1 to complete Fig. 5.1. [3]

(ii) State the term used to describe the sequence of amino acids in a polypeptide.

.....[1]

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(b) In sickle cell anaemia, the amino acid at position 6 in the β chain is valine and not glutamic acid.

For Examiner's Use

Explain how a single change in the DNA triplet for the sixth amino acid of the gene coding for the β chain leads to the production of a different amino acid sequence.

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.....[5]

[Total: 9]

6 In some ecosystems, certain species fulfil important roles in maintaining biodiversity in communities. These species are often known as keystone species.

For Examiner's Use

The sea otter, *Enhydra lutris*, is found in waters of the northern and eastern coasts of the Pacific, where it occupies a niche as a predator. These coastal waters are rich in kelp communities. Kelp are very large seaweeds that form 'underwater forests'.

In the 19th century the sea otter was hunted for its fur, with the result that populations decreased. A consequence of this reduction in numbers was the disappearance of much of the kelp. Conservation measures in the 20th century restored the numbers of sea otters.

Fig. 6.1 shows the food web for this ecosystem.

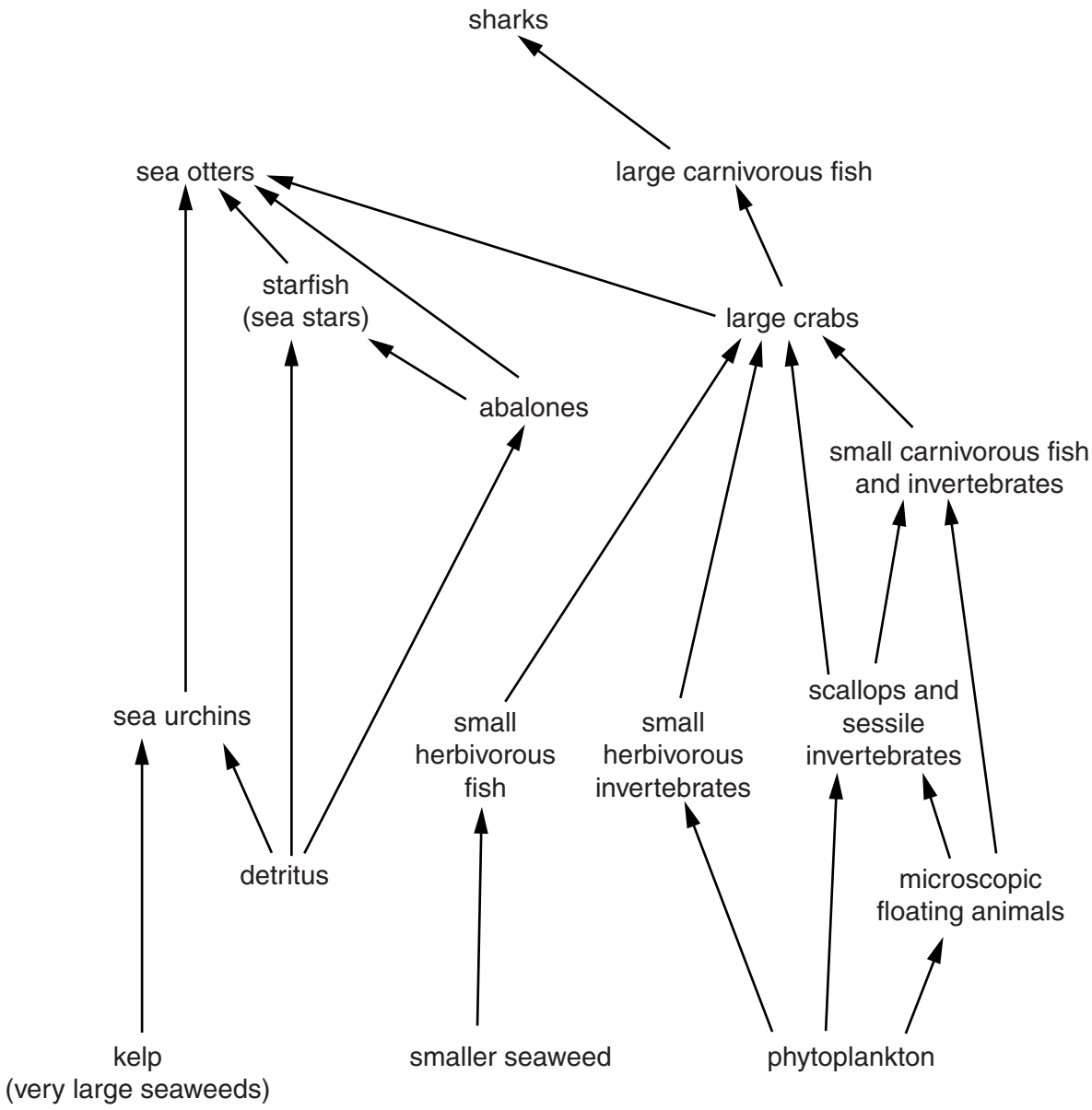


Fig. 6.1

(a) Explain the meaning of the terms *niche* and *community*.

For Examiner's Use

niche .....

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community .....

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.....[2]

(b) With reference to the food web in Fig. 6.1, suggest why sea otters are considered to be a keystone species.

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.....[4]

(c) Suggest how the efficiency of energy transfer from kelp to sea urchins could be determined.

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.....[3]

[Total: 9]

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BIOLOGY **9700/22**

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1 hour 15 minutes

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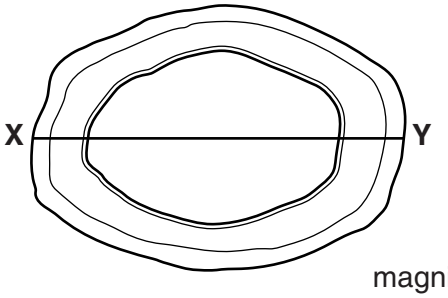
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Answer **all** the questions.

For Examiner's Use

1 Fig. 1.1 is a diagram of a transverse section through a vein.



magnification × 35

Fig. 1.1

(a) Calculate the actual diameter of the vein marked by the line **X**–**Y**.

Show your working and give your answer in millimetres (mm).

answer ..... mm [2]

(b) The presence of a valve would help to confirm that the blood vessel in Fig. 1.1 is a vein and not an artery.

Describe three structural features of the blood vessel shown in Fig. 1.1 that would help to identify it as a vein and **not** as an artery.

1. .....

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2. .....

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3. .....

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.....[3]

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(c) Explain how the following structural features of a capillary are related to its function.

For Examiner's Use

(i) The capillary wall is composed of a single layer of squamous epithelial cells.

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.....[1]

(ii) The diameter of the capillary lumen is approximately 8 μm.

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.....[1]

(d) The inner lining of arteries and veins is composed of a layer of epithelial cells supported by a layer of elastic and connective tissue. The epithelial cells are capable of cell division by mitosis.

(i) State the role of mitosis in cell division of epithelial cells.

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.....[2]

(ii) Explain why the epithelial cells undergo mitosis and **not** meiosis.

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.....[2]

(e) Fig. 1.2 is a diagram of a cell in late prophase of mitosis.

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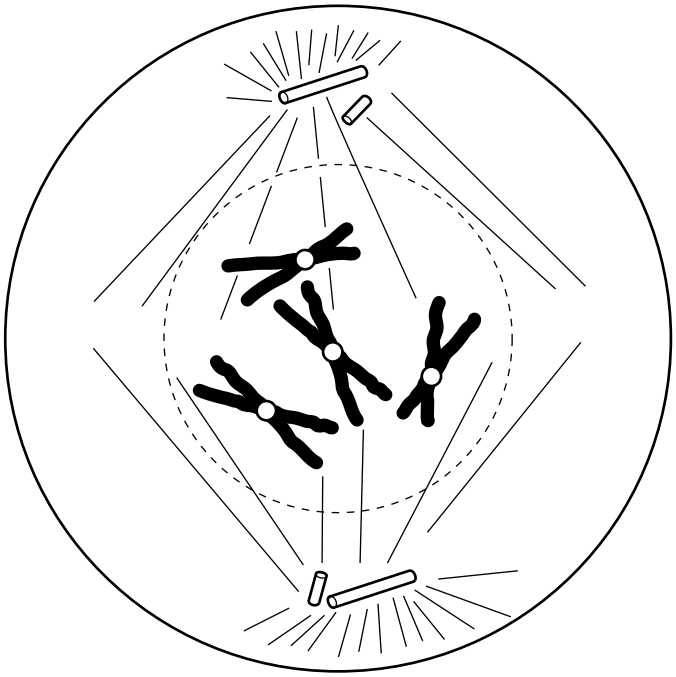


Fig. 1.2

Complete Fig. 1.3 to show the **same cell** in the **anaphase** stage of mitosis.

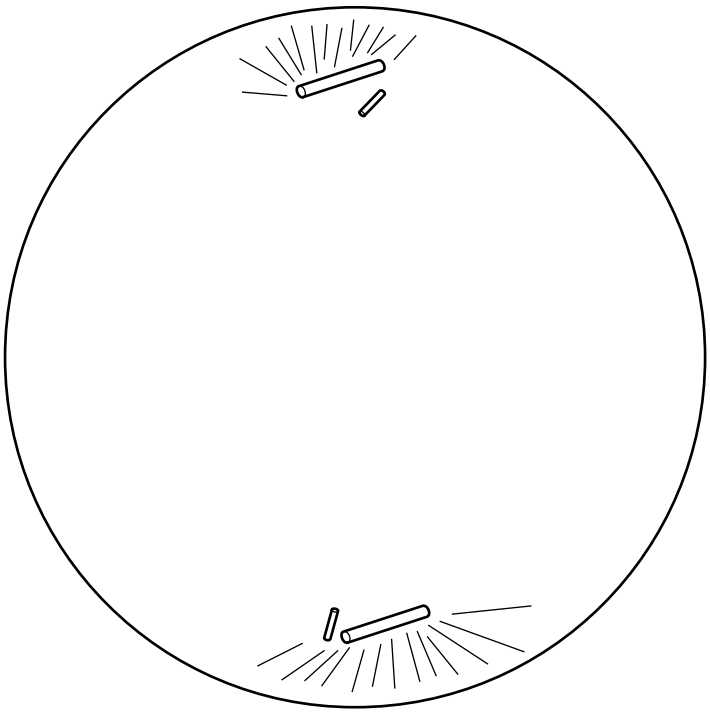


Fig. 1.3

[2]

[Total: 13]

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2 Keratin and chitin are two important biological molecules. Keratin is found in hair, fur and skin. Chitin is a modified polysaccharide found in a number of different organisms, for example in fungal cell walls and the hard outer skeletons of insects.

For Examiner's Use

(a) Features of chitin and keratin are shown in the boxes in Fig. 2.1.

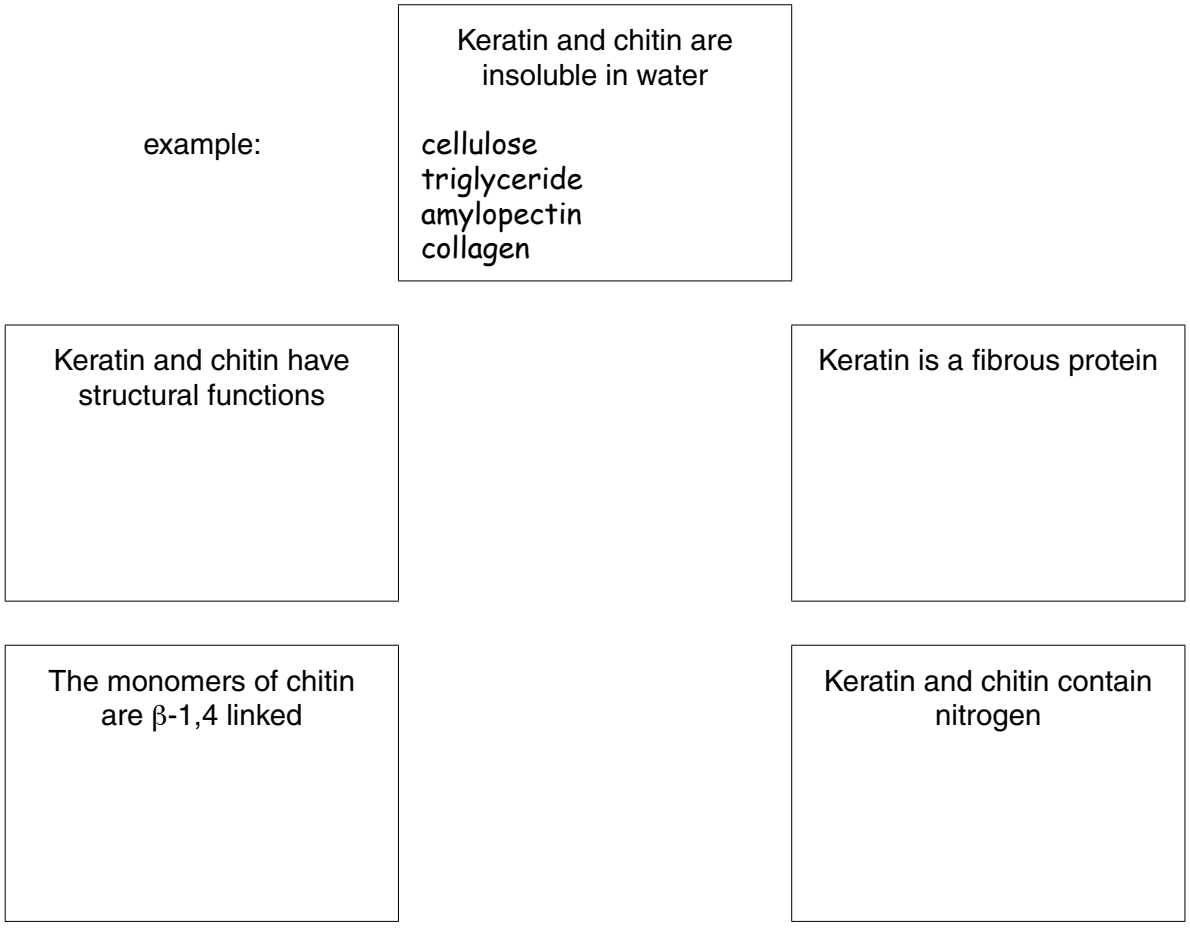


Fig. 2.1

Write, in each box, the biological molecules from the list below that have the same feature.

Each box may contain one, or more than one, biological molecule. The first box has been completed as an example.

amylopectin
cellulose
collagen
haemoglobin
mRNA
triglyceride

[5]

For Examiner's Use

(b) Chitin and the products of chitin hydrolysis have many useful medical and environmental applications. Chitinase enzymes can be used commercially to hydrolyse chitin. Enzyme stability and activity are important considerations in technological applications of chitinase.

Fig. 2.2 is a graph showing the effects of temperature on chitinase extracted from a soil bacterium.

The relative activity of the enzyme was measured at different temperatures, with 100% representing maximum enzyme activity.

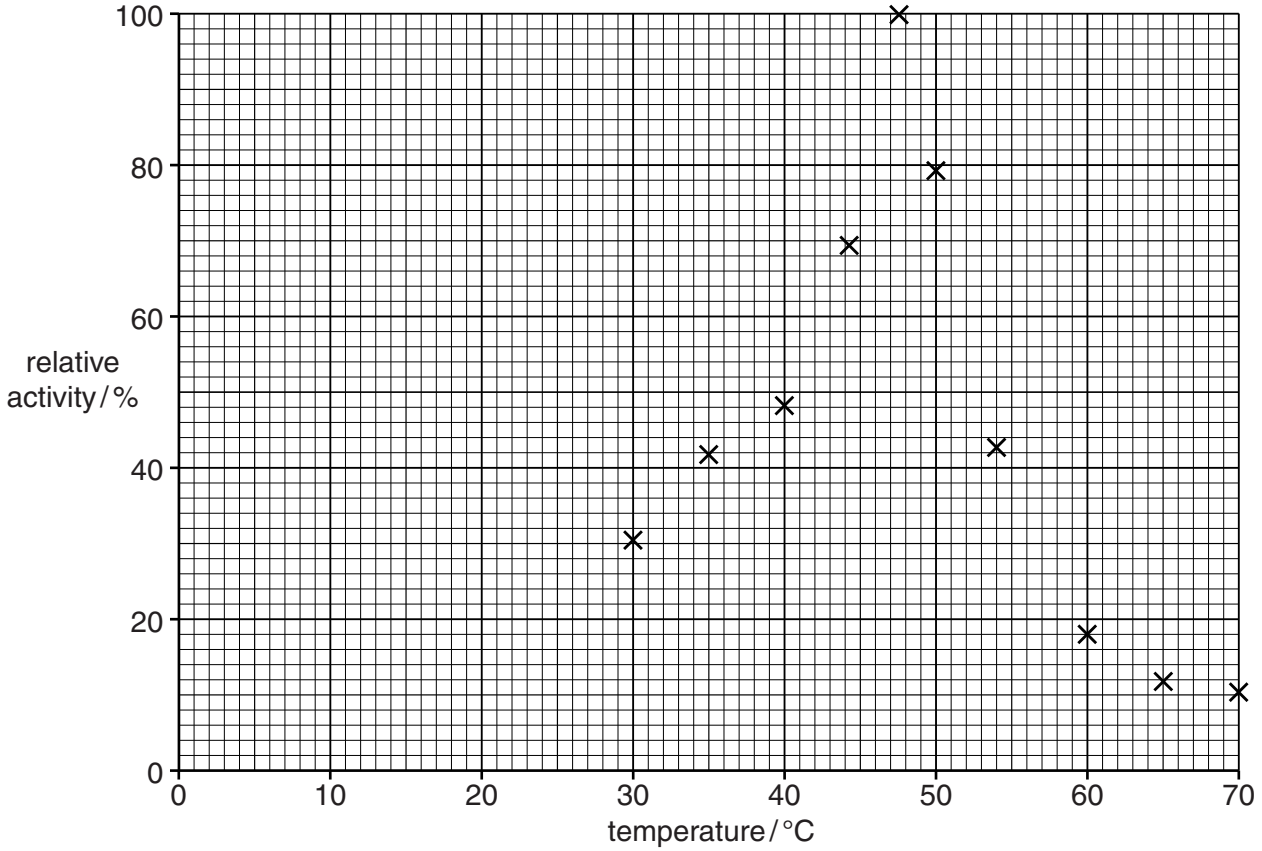


Fig. 2.2

(i) With reference to Fig. 2.2, state the optimum temperature for the chitinase enzyme.

.....[1]

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Fig. 2.3 is a graph showing how temperature affects the stability of chitinase. The activity of the enzyme was measured over a time period of 72 hours at each of five different temperatures.

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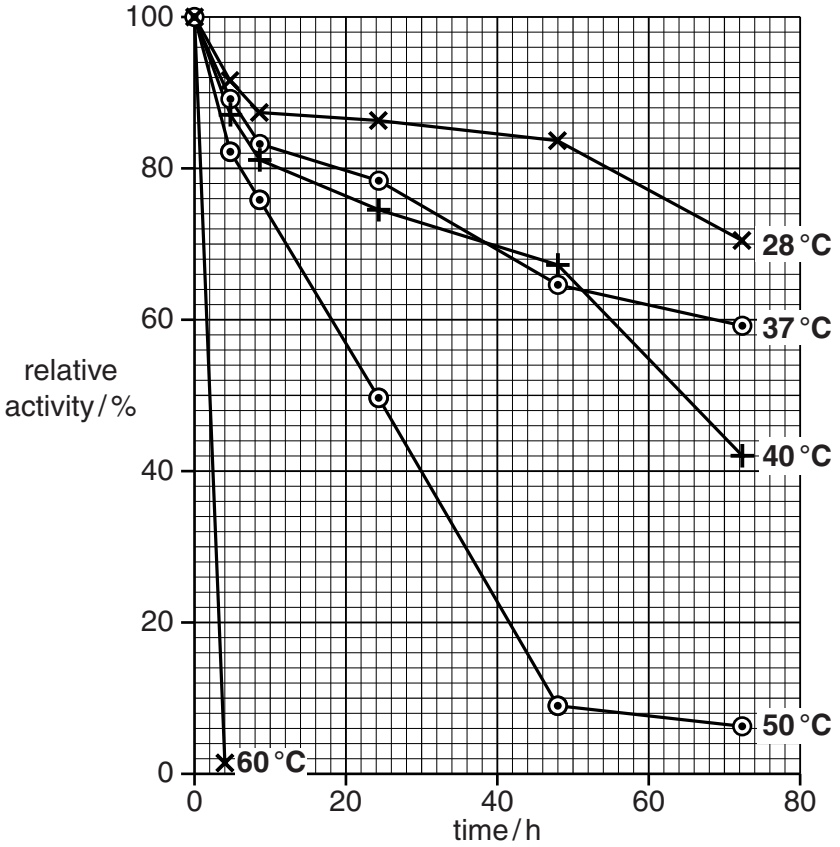


Fig. 2.3

(ii) With reference to Fig. 2.2 and Fig. 2.3, describe **and** discuss the effect of temperature on chitinase activity **and** stability.

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[Total: 11]

For Examiner's Use

3 **(a)** Explain the need for transport systems in plants.

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.....[3]

(b) Fig. 3.1 is a drawing of a transverse section through part of the stem of a dicotyledonous plant. Cell **A** and cell **B** are involved in the transport of dissolved organic molecules.

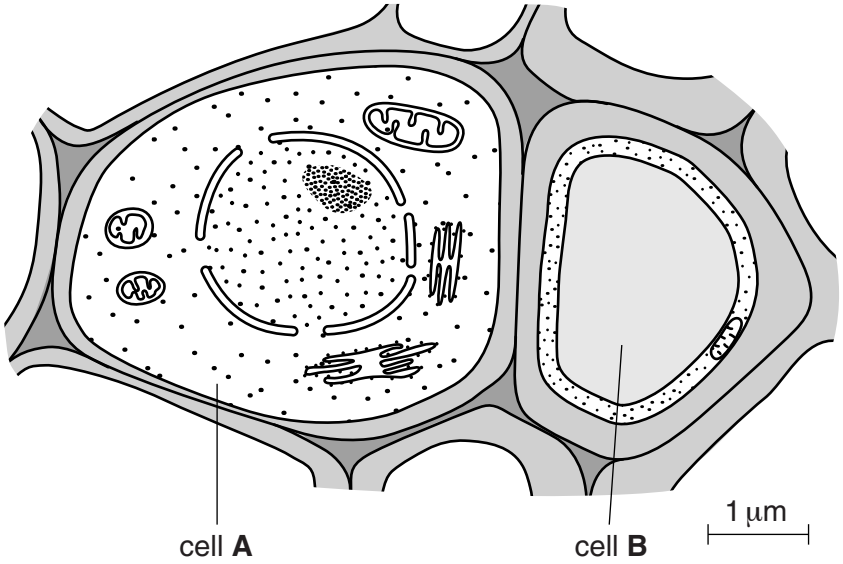


Fig. 3.1

(i) Name cell **A** and cell **B**.

*cell **A*** .....

*cell **B*** .....[1]

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For Examiner's Use

(ii) With reference to Fig. 3.1, explain how the different structures of cell types **A** and **B** are related to their function.

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.....[5]

(c) Complete Table 3.1 to state four differences between transport systems in mammals and in plants.

Table 3.1

transport system in mammals	transport system in plants

[4]

[Total: 13]

4 *Staphylococcus aureus* is a bacterium that is the cause of many different infectious diseases.

For Examiner's Use

(a) Fig. 4.1 is a diagram of *S. aureus*.

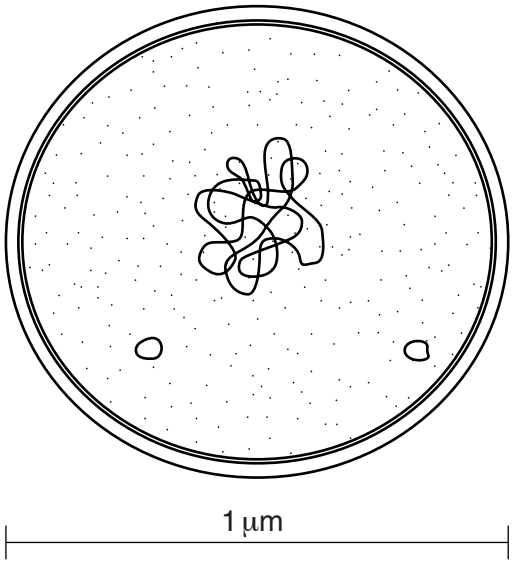


Fig. 4.1

(i) Cell structures, such as mitochondria, endoplasmic reticula (ER), Golgi apparatus, lysosomes and chloroplasts are found only in eukaryotic cells. These are not present in Fig. 4.1.

With reference to Fig. 4.1, describe **other features** that support the fact that *S. aureus* is a prokaryote.

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.....[3]

(ii) State the main difference in the composition of the plant cell wall compared to the bacterial cell wall.

plant cell wall .....

bacterial cell wall .....[2]

(b) Bacterial cells behave in a similar way to plant cells when immersed in solutions of different water potential.

For Examiner's Use

Suggest **and** explain what would happen to bacteria placed in a solution with a water potential more negative than their cell contents.

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.....[3]

(c) Some strains of *S. aureus* have become resistant to one or more of the antibiotics used to treat infections.

The mechanisms of antibiotic resistance involve proteins, for example:

- enzymes to breakdown antibiotics
- membrane proteins that inactivate antibiotics
- membrane proteins that pump out antibiotics.

Explain why antibiotic resistance arises as a result of mutation.

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.....[2]

[Total: 10]

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[Turn over

5 Read the following passage.

For Examiner's Use

The three-toed sloth, *Bradypus variegatus*, is a very slow-moving mammal found in Central and South America that spends most of its life living in trees.

The thick, long grey fur of the sloth in Fig. 5.1 has a green appearance. Individual hairs of the sloth have grooves in them where water can collect.



Fig. 5.1

Research has shown that the green colour is due to the presence of algae living on the sloth's fur, the most common species being *Trichophilus welckeri*. Algae are eukaryotic, photosynthetic organisms.

Many other species of non-photosynthetic eukaryotes, both unicellular and multicellular, have been found living on the sloth's fur. These include different species of roundworms, insects and saprotrophic fungi.

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(a) Explain the ecological terms *population* and *community*, **using examples given in the passage**.

For Examiner's Use

population .....

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community .....

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.....[4]

(b) Suggest why the sloth and its fur can be described as a small ecosystem.

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.....[3]

[Total: 7]

For Examiner's Use

6 **(a)** Nicotine, in cigarette smoke, is highly addictive. A nicotine vaccine has been developed to try and reduce the effects of addiction. The vaccine stimulates an immune response to produce antibodies that bind to the nicotine molecule. Fig. 6.1 is a diagram of an antibody molecule.

On Fig. 6.1:

- label **three** structural features that enable an antibody molecule to carry out its function.
- next to each label, state the function of the feature.

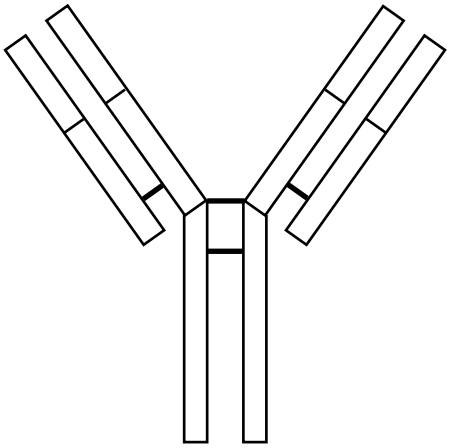


Fig. 6.1

[3]

(b) Nicotine has an effect on the cardiovascular system, such as making platelets sticky, so causing blood to clot. This increases the risk of thrombosis and reduces blood flow.

Outline **other** effects of nicotine on the cardiovascular system.

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.....[3]

[Total: 6]

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BIOLOGY **9700/23**

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Answer **all** the questions

For Examiner's Use

1 Fig. 1.1 is a diagram of an antibody molecule.

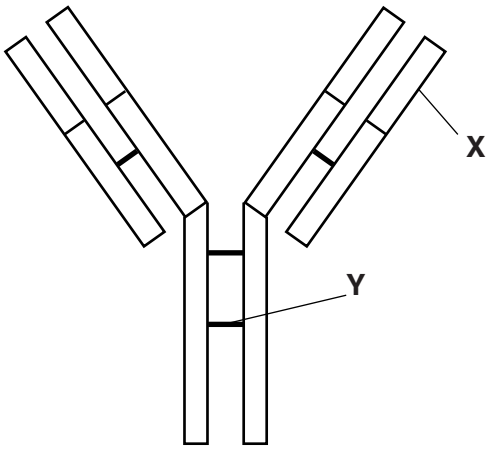


Fig. 1.1

(a) (i) Name the part labelled **X**.

..... [1]

(ii) Name the bond labelled **Y**.

..... [1]

(iii) The antibody molecule in Fig. 1.1 has quaternary structure.

Explain the meaning of the term *quaternary structure* as applied to proteins.

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..... [1]

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(b) When a pathogen enters the body, a primary immune response occurs. This response includes the production of antibodies.

For Examiner's Use

Describe the stages in the immune response that lead to antibody being produced against a specific antigen.

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..... [4]

(c) Vaccination was used in the eradication of smallpox.

Explain, in terms of antigens, why it has not been possible to do the same for malaria.

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..... [2]

[Total: 9]

For Examiner's Use

2 **(a)** Bacteria in root nodules of leguminous plants carry out nitrogen fixation.

Describe how nitrogen that is available to these bacteria can eventually become part of animal protein.

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..... [5]

(b) Fig. 2.1 shows the base sequence of a DNA triplet code used to produce mRNA. Fill in the corresponding tRNA anticodon in the space provided.

DNA triplet	**T A C**
tRNA anticodon	

[1]

Fig. 2.1

(c) More mRNA molecules than tRNA molecules are synthesised in cells.

Suggest a reason for this.

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..... [1]

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(d) Describe the role of ribosomes in protein synthesis.

For Examiner's Use

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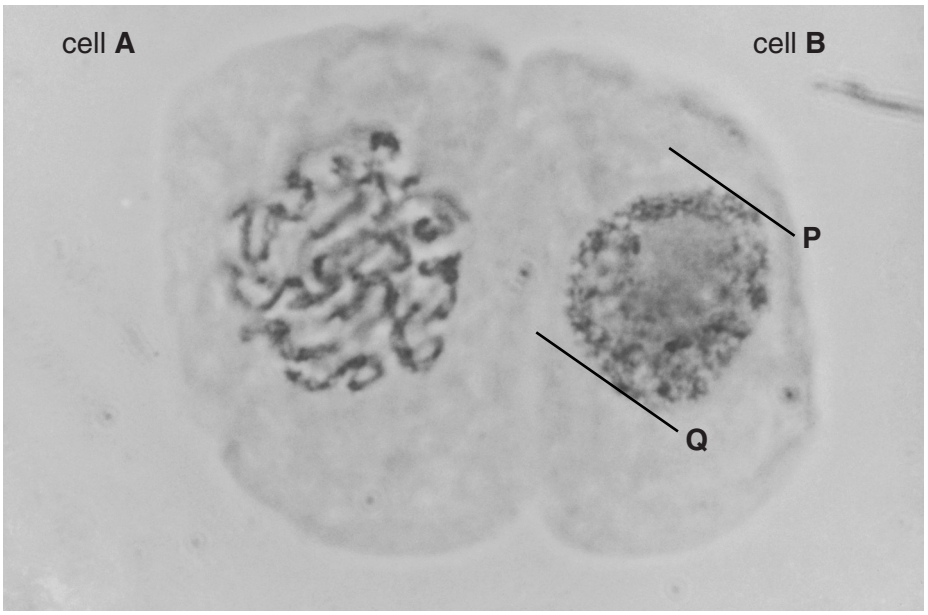
.....

..... [3]

[Total: 10]

3 Fig. 3.1 is a photomicrograph of two animal cells, **A** and **B**, at different stages of the mitotic cell cycle.

For Examiner's Use



magnification ×5000

Fig. 3.1

(a) (i) For each cell, state the name of the stage of the cell cycle shown in Fig. 3.1.

cell **A** .....

cell **B** .....
[2]

(ii) Describe the events that occur during the stage of the cell cycle named for cell **A** in **(a)(i)**.

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..... [4]

(b) The magnification of Fig. 3.1 is ×5000.

Calculate the diameter of the nucleus of cell **B** between lines **P** and **Q**.

Show your working and give your answer to the nearest micrometre (μm).

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answer ..... μm [2]

(c) State the advantages of light microscopy, rather than electron microscopy, for studies of the cell cycle.

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..... [3]

[Total: 11]

4 Fig. 4.1 is a diagram of a section through a mammalian heart.

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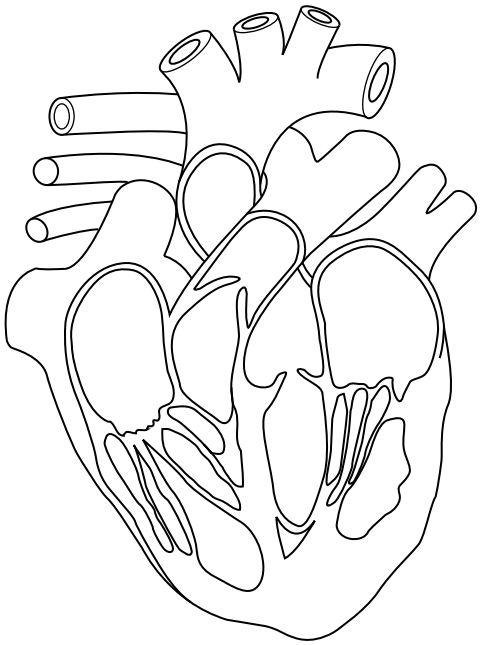


Fig. 4.1

(a) Use a label line and the appropriate letter to label each of the following on Fig. 4.1:

W right atrium

X tricuspid valve

Y aorta.

[3]

(b) Starting from the left ventricle, describe the route taken by the blood as it travels to the lungs.

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..... [3]

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(c) Describe **and** explain how the structure of the human **gas exchange surface** is adapted for maximum efficiency.

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..... [4]

[Total: 10]

5 **(a)** Describe the structure of a cellulose molecule **and** explain how cellulose is a suitable material for the cell walls of plants.

For Examiner's Use

description

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explanation

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.....

..... [4]

Animals do not have the ability to produce enzymes to digest cellulose. Most herbivores have bacteria in their digestive systems that can digest cellulose.

Fig. 5.1 shows the results of a study on 24 different herbivores. The percentage of cell wall material that was digested by each animal was determined. The time taken for the plant material to pass through the digestive system, the retention time, was also recorded.

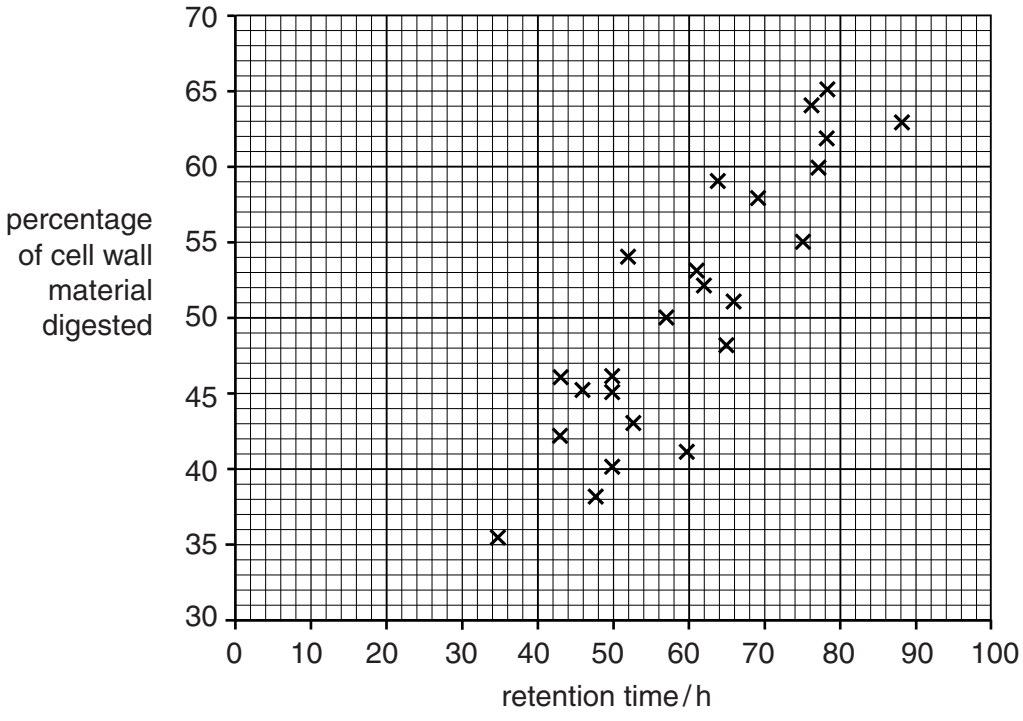


Fig. 5.1

(b) (i) With reference to Fig. 5.1, describe the results of this study.

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..... [3]

(ii) Explain, in terms of energy flow in ecosystems, the importance of the results in Fig. 5.1.

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..... [2]

(c) Digested material in animals is absorbed using both facilitated diffusion and active transport.

State two similarities **and** two differences between facilitated diffusion and active transport.

similarities:

1. .....

2. .....

differences:

1. .....

2. .....

[4]

[Total: 13]

Question 6 starts on page 12

6 Fig. 6.1 is a photomicrograph of phloem sieve tubes from a plant stem.

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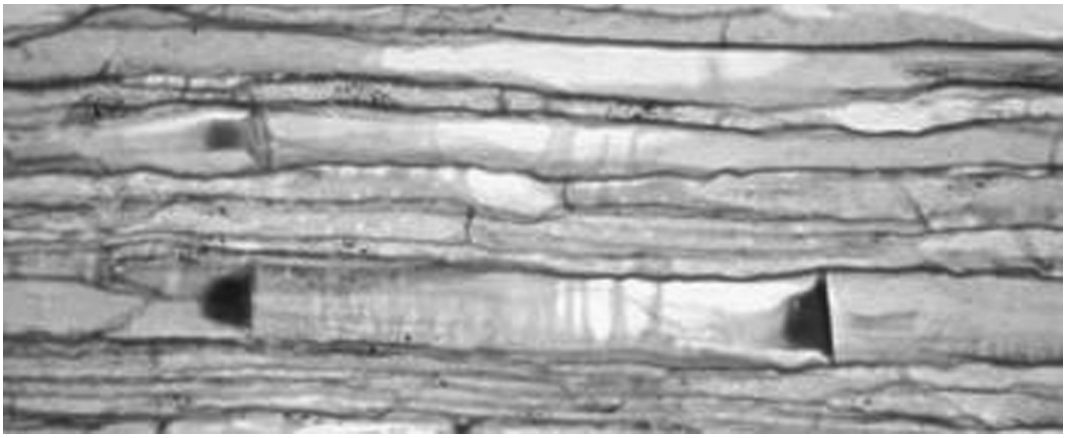


Fig. 6.1

(a) State two features, **visible in Fig. 6.1**, which distinguish sieve tubes from xylem vessels.

1. .....

2. .....
[2]

(b) Explain briefly how sucrose is **moved**, or translocated, **through** sieve tubes.

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..... [2]

(c) Some enzymes are found in phloem tissue.
Describe how enzymes catalyse reactions.

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..... [3]
[Total: 7]

Copyright Acknowledgements:

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