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BIOLOGY **9700/21**

Paper 2 Structured Questions AS **May/June 2016**

1 hour 15 minutes

Candidates answer on the Question Paper.

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Answer **all** questions.

Electronic calculators may be used.
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[Turn over

Answer **all** the questions.

1 Table 1.1 shows features of three infectious diseases: malaria, tuberculosis (TB) and cholera.

Complete Table 1.1.

Table 1.1

feature	malaria	tuberculosis	cholera
name of pathogen	……..… *falciparum*	*Mycobacterium tuberculosis*	……..… ……..…
type of organism	……..…	bacterium	……..…
method of transmission	……..… ……..… ……..…	……..… ……..… ……..…	drinking water and food contaminated with human faeces

[6]

[Total: 6]

2 Macrophages synthesise intracellular enzymes.

Fig. 2.1 is a summary diagram of events that occur in a macrophage.

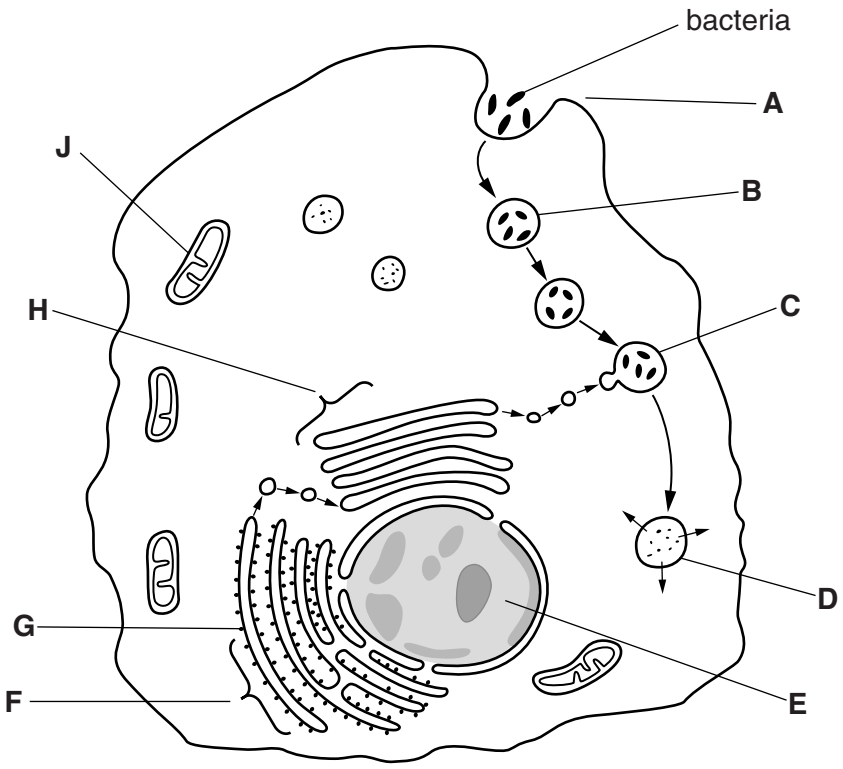


Fig. 2.1

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(a) (i) Name the process at **A**.

.....[1]

(ii) Name the stages of protein synthesis that occur at **E** and at **F**.

E .....

F .....[2]

(iii) Name organelles **B**, **G**, **H** and **J**.

B .....

G .....

H .....

J .....[4]

(b) Describe what happens to the bacteria between **C** and **D**.

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.....[3]

(c) Macrophages are antigen presenting cells (APCs). Antigens from pathogens such as the bacteria shown in Fig. 2.1 are presented to helper T-lymphocytes as shown in Fig. 2.2.

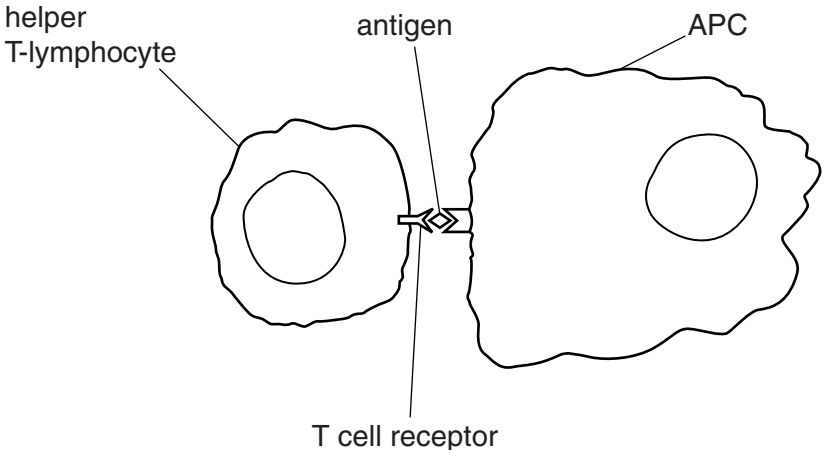


Fig. 2.2

Very few helper T-lymphocytes respond to the presence of APCs by binding in the way shown in Fig. 2.2.

Suggest why this is so.

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.....[2]

[Total: 12]

3 A student studied a transverse section of the trachea of a small mammal. The student drew a plan diagram of the section as shown in Fig. 3.1.

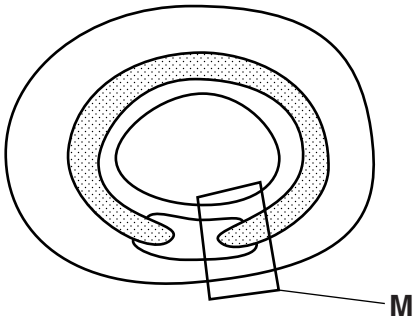


Fig. 3.1

Fig. 3.2 is a photomicrograph of the area labelled **M** in Fig. 3.1.



Fig. 3.2

(a) Name:

(i) the type of epithelium at **N**

.....[1]

(ii) the structures at **O**

.....[1]

(iii) the tissue at **P**.

.....[1]

(b) Smooth muscle in the trachea and in the bronchi relaxes during strenuous exercise.

Suggest the advantages of relaxing this smooth muscle during periods of strenuous exercise.

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.....[2]

(c) The walls of the trachea and bronchi contain elastic fibres.

Elastic fibres are made of bundles of the fibrous protein elastin.

- Each molecule of elastin is a single polypeptide.
- The primary structure contains a large proportion of the amino acid glycine.
- Glycine has a hydrophobic R group.
- Glycine does not occur at regular intervals in the polypeptide.
- The polypeptide forms random coils that change shape as the elastic fibres are stretched and recoil.
- Elastin molecules are joined to each other by many covalent bonds to form a cross-linked network.

Describe two ways in which the structure of a collagen molecule **differs** from the structure of an elastin molecule described above.

1 .....

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2 .....

.....[2]

[Total: 7]

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4 **(a)** Transpiration is often described as 'an inevitable consequence of gas exchange in leaves'.

Explain what is meant by this description.

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.....[3]

(b) Explain how hydrogen bonding is involved in the movement of water in the xylem.

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.....[3]

Southern beech trees of the genus *Nothofagus* grow in forests in the South Island of New Zealand. Fig. 4.1 shows a small part of a forest.

Most of the trees in the forests form a thick canopy of leaves. These are known as canopy trees. The tallest trees are known as emergent trees. Some trees do not reach the canopy and are known as suppressed trees.

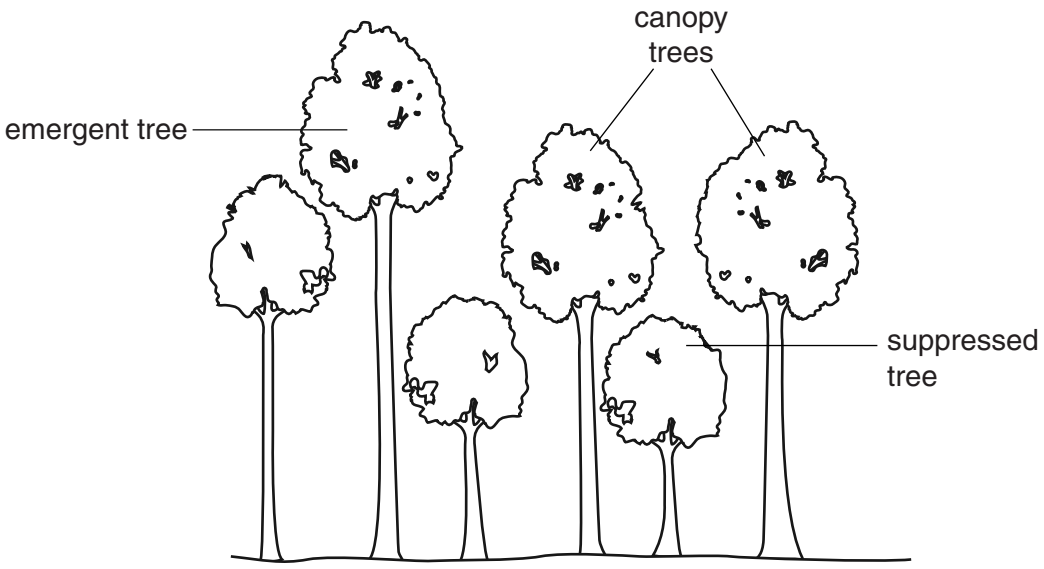
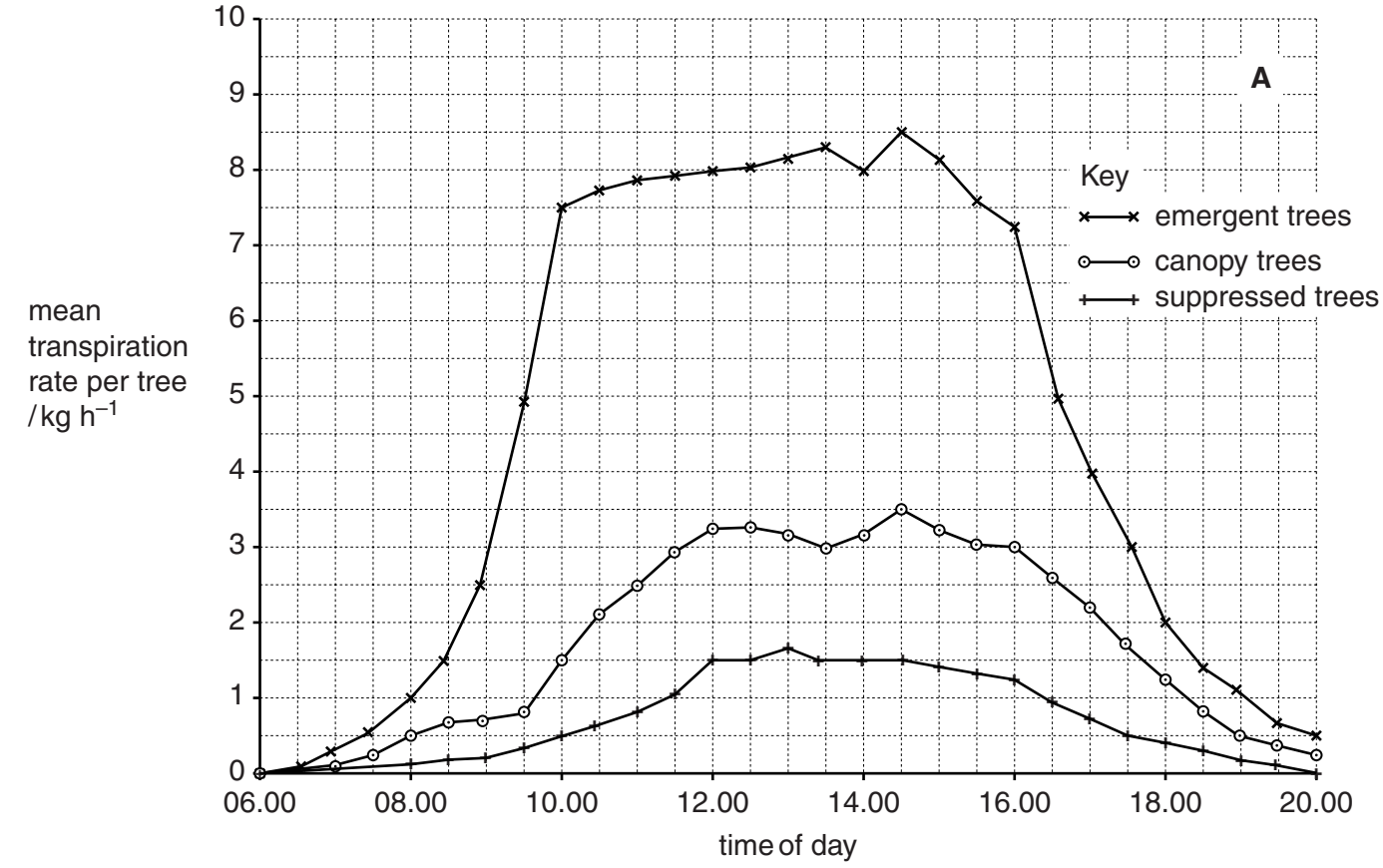


Fig. 4.1

Researchers determined the rates of transpiration of emergent, canopy and suppressed trees in a forest over a 14 hour period from 06.00 until 20.00 on one day in the summer. The results are shown in Fig. 4.2A. They also recorded changes in light intensity above the canopy over the same time period as shown in Fig. 4.2B.



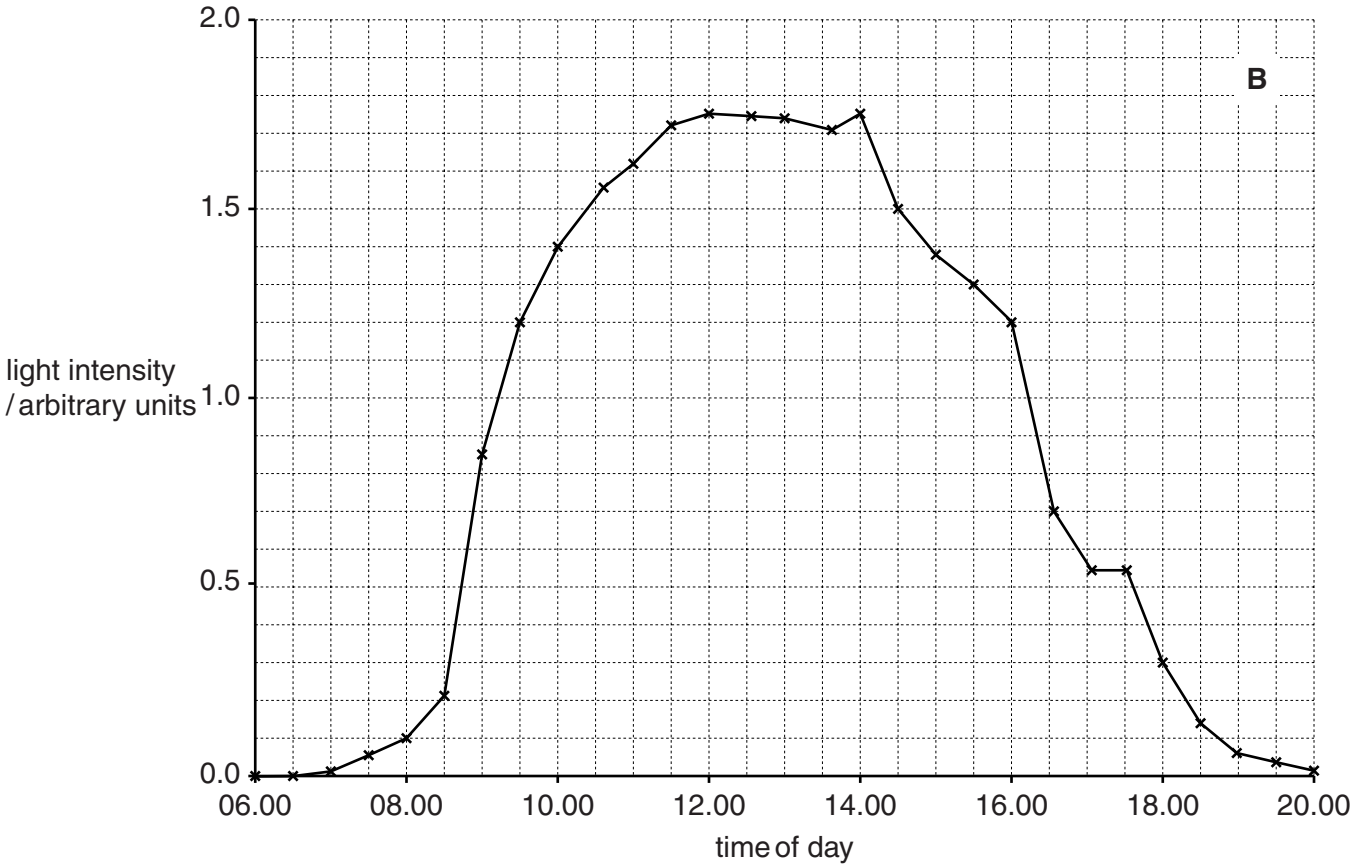


Fig. 4.2

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(c) Use Fig. 4.2A to compare the transpiration rates of the emergent, canopy and suppressed trees in the forest over 14 hours.

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.....[4]

(d) The factors that affect transpiration rate vary considerably at different places inside forests.

Use the information in Fig. 4.1 and Fig. 4.2 to suggest reasons for the difference in the transpiration rates of the emergent and suppressed trees.

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.....[4]

[Total: 14]

5 **(a)** Fig. 5.1 is a diagram of part of an animal cell in a stage of mitosis.

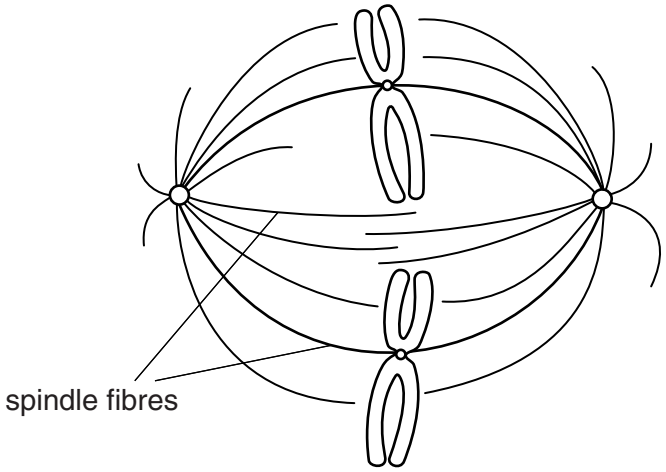


Fig. 5.1

(i) Draw a diagram in the space below to show the stage of mitosis that follows the stage in Fig. 5.1.

[3]

(ii) Describe the roles of the spindle fibres during mitosis.

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.....[2]

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Bone marrow contains many stem cells. Some of these stem cells are responsible for the replacement of red blood cells.
During the production of red blood cells a series of changes occur to the cell structure.

Fig. 5.2 shows the production of a red blood cell from one of these stem cells.

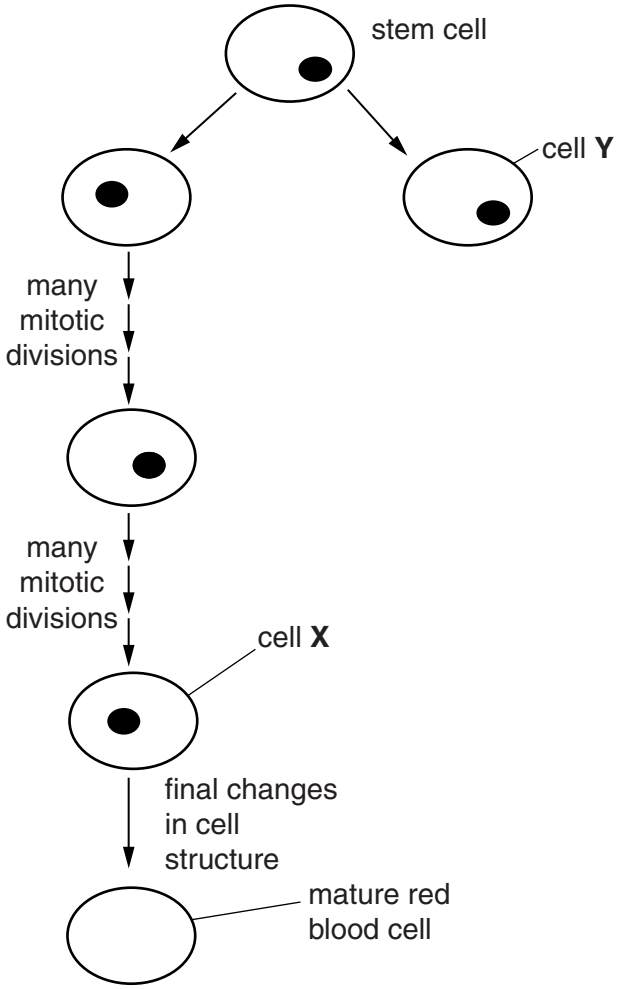


Fig. 5.2

(b) (i) Outline the changes that occur as cell **X** becomes a mature red blood cell.

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.....[3]

(ii) Suggest what may happen to cell **Y**.

.....[1]

(c) People who travel to high altitude become acclimatised to the conditions.

Athletes often train at high altitude before competing at sea level.

A group of male and female athletes who trained at sea level moved to high altitude for further training. Sports scientists analysed blood samples taken from the athletes to measure any changes in the concentration of haemoglobin in the blood and changes in the haematocrit.

Haematocrit is the volume of red blood cells expressed as a percentage of the total volume of a sample of blood.

The results are shown in Table 5.1.

Table 5.1

feature of the blood	at sea level	after 19 days at high altitude	percentage increase
mean concentration of haemoglobin in the blood / g 100 cm^{-3}	13.3	15.1	.....
mean haematocrit	41.0	42.5	3.7

(i) Complete Table 5.1 by calculating the percentage increase in haemoglobin concentration. [1]

(ii) Explain why it is necessary for the athletes to increase the concentration of haemoglobin in their blood when acclimatising to high altitude.

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.....[4]

[Total: 14]

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6 Fig. 6.1 shows an incomplete diagram of the fluid mosaic model of membrane structure. The diagram shows the cell surface membrane of a eukaryotic cell.

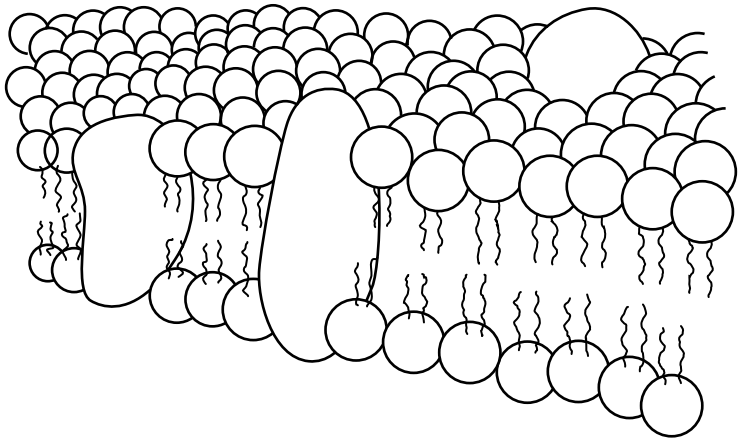


Fig. 6.1

(a) State what is meant by the term fluid mosaic.

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.....[2]

(b) State the thickness of a cell surface membrane.

.....[1]

(c) List four features of cell surface membranes of eukaryotic cells that are **not** visible in Fig. 6.1.

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2 .....

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3 .....

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4 .....

.....[4]

[Total: 7]

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1 hour 15 minutes

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Answer **all** the questions.

1 Statements **A** to **E** are about the structure and functioning of enzymes.

State the correct term to match each of the statements **A** to **E**.

A The energy level, lowered by enzyme action, that needs to be overcome by reactants in order for products to be formed.

.....

B The mechanism of enzyme action that relies on the active site being partially flexible and changing shape in order to bind the substrate.

.....

C The term to describe a protein, such as an enzyme, with a tertiary or quaternary structure that results in an approximately spherical shape.

.....

D The term for enzymes that function outside cells.

.....

E The concentration of substrate that enables an enzyme to achieve half the maximum rate of reaction.

.....

[5]

[Total: 5]

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2 Marram grass, *Ammophila arenaria*, is an important plant of sand dunes. Leaves of marram grass are well adapted to reduce water loss by transpiration.

Fig. 2.1 is a photomicrograph of a section though the leaf of marram grass.

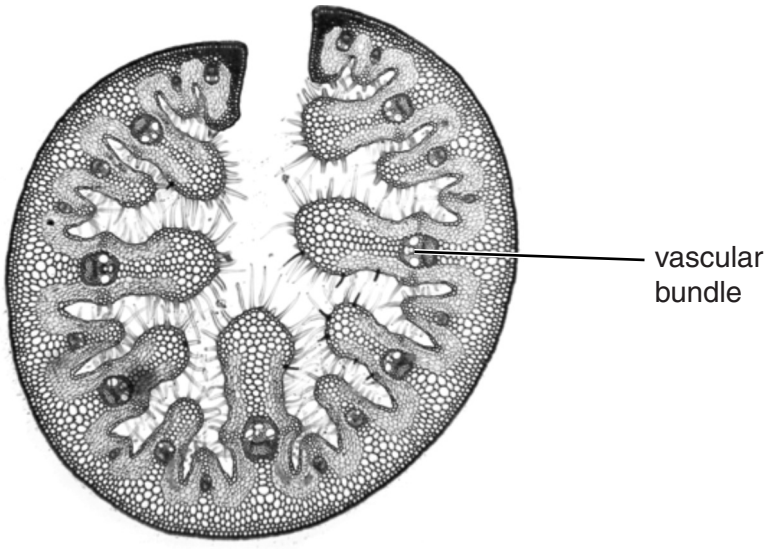


Fig. 2.1

(a) Examples of adaptations to reduce water loss by transpiration include a thick cuticle and no stomata on the outer surface, and stomata in pits on the inner surface.

(i) State **one** other adaptation, visible in Fig. 2.1, which reduces water loss by transpiration.

.....[1]

(ii) Explain how this adaptation reduces water loss.

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.....[2]

(b) State the term used to describe a plant type that has adaptations to reduce water loss by transpiration.

.....[1]

[Total: 4]

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[Turn over

3 Globally, measles is an important disease that mainly affects children. Many deaths from measles occur in children under five years of age.

Table 3.1 shows the population of six countries in Africa in 2009 and the number of cases of measles per 100 000 people for the four years 2009 to 2012.
All six countries are classified as low-income countries.

Table 3.1

country	population in 2009	number of cases per 100 000 people			
		2009	2010	2011	2012
Central African Republic	4 266 000	0.26	0.05	15.31	3.12
Chad	11 371 000	1.45	1.66	71.60	0.96
Eritrea	5 558 000	1.48	0.89	0.81	3.16
Ethiopia	84 838 000	1.39	4.86	3.64	4.74
Gambia	1 628 000	0.00	0.12	0.00	0.00
Niger	15 303 000	5.23	2.34	4.67	1.59

(a) (i) The actual number of cases of measles in Chad in 2009 was 165 and in Eritrea was 82.

Calculate the actual number of cases of measles in Ethiopia in 2009.
Show your working.

[2]

(ii) Use the data for Chad, Eritrea and Ethopia to explain the advantages of showing the data in Table 3.1 as number of cases of measles per 100 000 people rather than the actual number of cases.

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.....[3]

Question 3 continues on page 6

Fig. 3.1 shows the percentage of children vaccinated against measles over a ten year period from 2003 to 2012.

- The percentage vaccinated represents children under one year of age who have been given at least one dose of the vaccine against measles in the given year.
- The data are for the six African countries shown in Table 3.1.

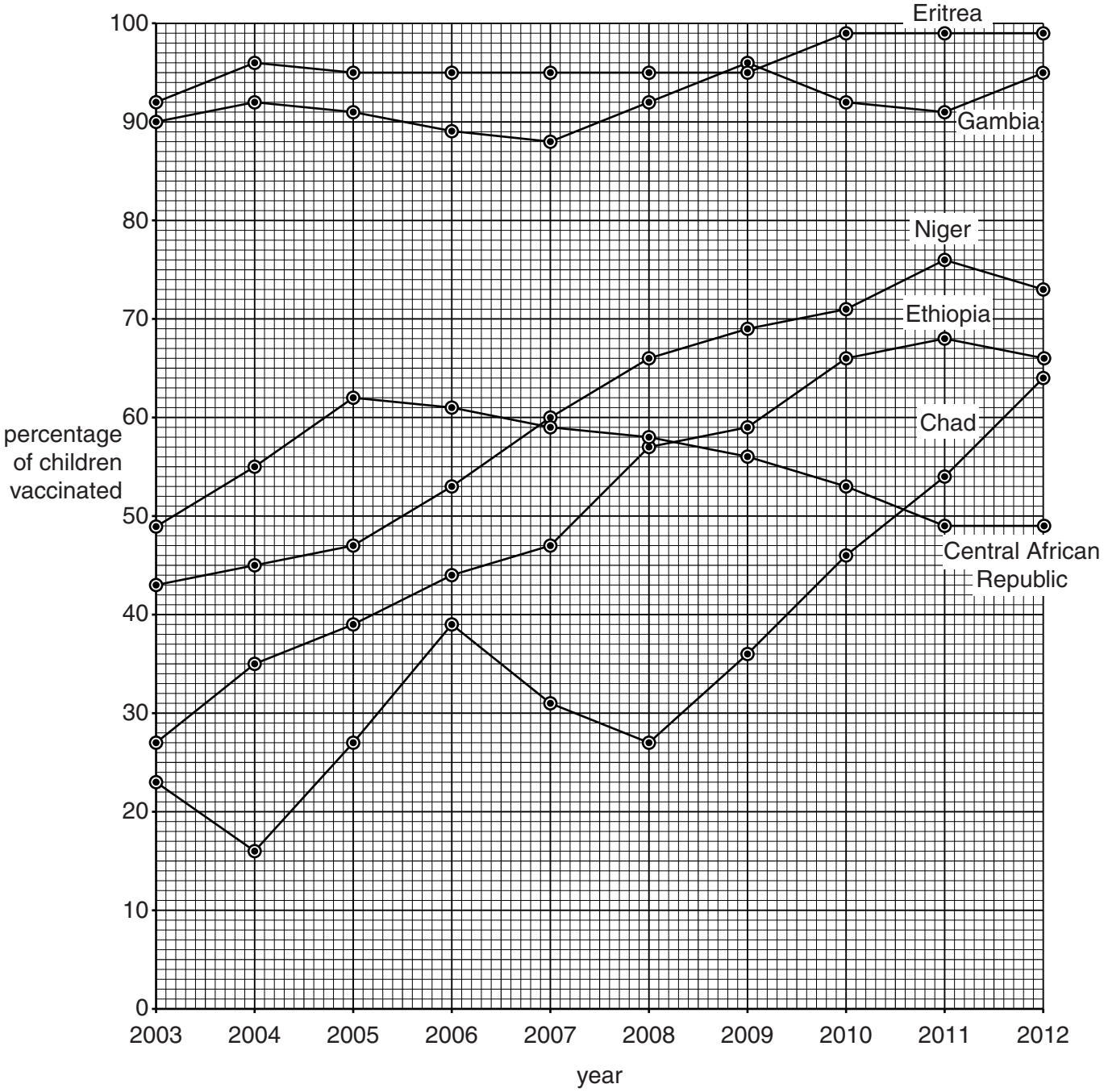


Fig. 3.1

(b) Vaccination is known to protect populations against infectious diseases.

Some of the data in Table 3.1 (on page 4) and Fig. 3.1 (on page 6) support this statement.

Describe the data that support this statement **and** comment on the data that do **not** support this statement.

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.....[4]

(c) The successful eradication of smallpox involved an intensive global vaccination programme. It is hoped that the same can be achieved with measles.

Outline **two** features, apart from cost, of the smallpox eradication programme that may have made it easier to eradicate than measles.

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.....[2]

(d) State precisely the type of immunity gained by receiving a measles vaccine.

.....[1]

(e) Planning the prevention and control of measles using a vaccination programme means that financial costs must be considered.

State two examples of these costs.

1 .....

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2 .....

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.....[2]

[Total: 14]

4 Fig. 4.1 is a simplified diagram of the circulatory system of a mammal. Some of the lymph system is also shown.

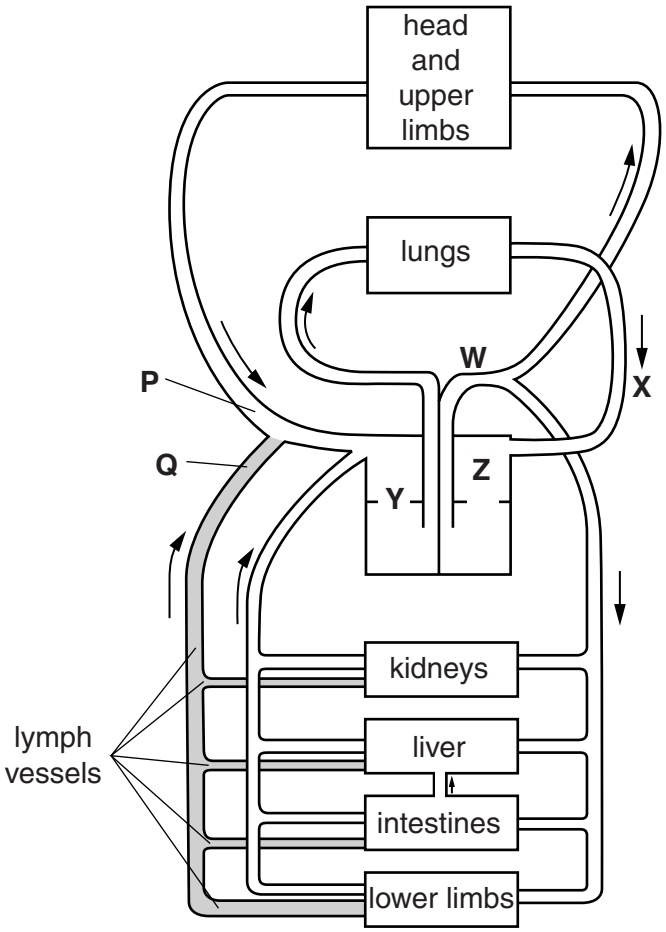


Fig. 4.1

(a) The type of circulatory system shown in Fig. 4.1 is a closed double circulation.

Explain what is meant by a *closed double circulation*.

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.....[2]

(b) With reference to Fig. 4.1, name:

blood vessel **W** .....

blood vessel **X** .....

valve **Y** .....

heart chamber **Z** ..... [4]

(c) State the component present in the blood at location **P** that is **not** present in the lymph at location **Q** in Fig. 4.1.

.....[1]

(d) As blood passes through the capillary network in the lungs, gas exchange occurs.

Describe the process of gas exchange between the alveolus and the blood.

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.....[4]

(e) As blood passes through the small intestine, small soluble products of digestion such as glucose are absorbed into the capillaries to be transported to the liver.

Fig. 4.2 is a transmission electron micrograph of intestinal epithelial cells.

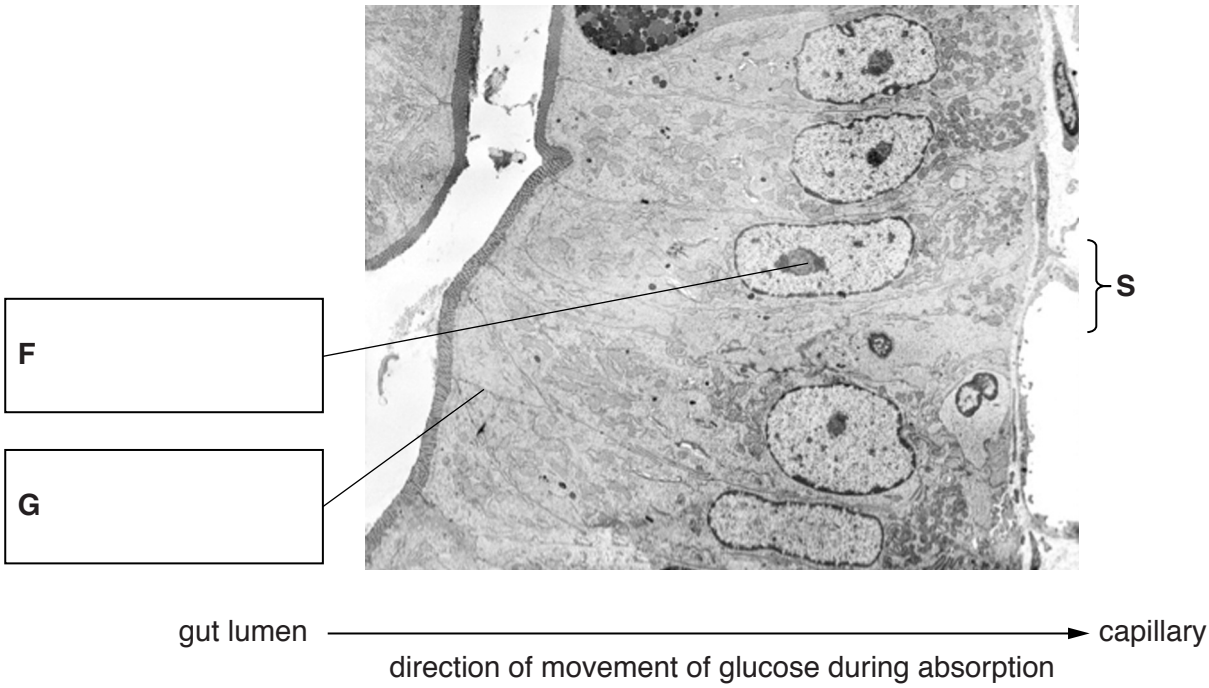


Fig 4.2

(i) Write the name of cell structures **F** and **G** in the boxes provided on Fig. 4.2. [2]

(ii) At the surface labelled **S**, movement of glucose molecules out of the intestinal epithelial cell occurs by facilitated diffusion.

Outline the features of facilitated diffusion of glucose molecules.

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.....[3]

[Total: 16]

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Question 5 starts on page 12

5 Fig. 5.1 shows plant cells in stages of mitosis.



Fig. 5.1

(a) Individual chromosomes cannot be seen in the cell at the start of prophase. Changes to the chromatin occur so that by late prophase chromosomes are clearly visible.

(i) Outline what occurs during early prophase so that chromosomes become visible in late prophase.

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.....[1]

(ii) Describe the structure of the chromosome in late prophase.

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.....[3]

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(b) State **two** differences between the chromosome at metaphase and the chromosome at late anaphase.

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.....[2]

(c) One of the functions of a plant hormone known as cytokinin is to act as a cell signalling molecule and promote cytokinesis.

Suggest how cytokinin acts as a cell signalling molecule.

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.....[3]

[Total: 9]

6 One of the enzymes involved in glycogen synthesis is glycogen synthase. The monomer of the glycogen polymer is α-glucose.

(a) (i) Draw the ring form of α-glucose in the space provided.

[2]

(ii) Glycogen synthase catalyses the formation of a covalent bond between two α-glucose molecules during glycogen synthesis.

Name the type of bond formed.

.....[1]

(iii) Glycogen branching enzyme is another enzyme that is required for glycogen synthesis.

Suggest why glycogen branching enzyme is needed in addition to glycogen synthase.

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.....[1]

(b) The gene coding for glycogen synthase in muscle cells is known as *GYS1*.

(i) Explain what is meant by a *gene*.

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.....[2]

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(ii) There are a number of known mutations for *GYS1*.

Outline how a mutation in *GYS1* can lead to the formation of an altered polypeptide where one amino acid is replaced by a different amino acid.

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.....[3]

(c) Table 6.1 shows three functions of cell structures that are involved in the synthesis of glycogen synthase.

Complete Table 6.1 by naming the cell structure that carries out the function listed.

Table 6.1

function	name of cell structure
assembles ribosomes for polypeptide synthesis	
synthesises ATP to provide a supply of energy for transcription of *GYS1*	
folds and modifies synthesised polypeptide to produce functioning glycogen synthase	

[3]

[Total: 12]

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BIOLOGY **9700/23**

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Answer **all** the questions.

1 Fig. 1.1 is a photomicrograph of epithelial cells in the bronchus.

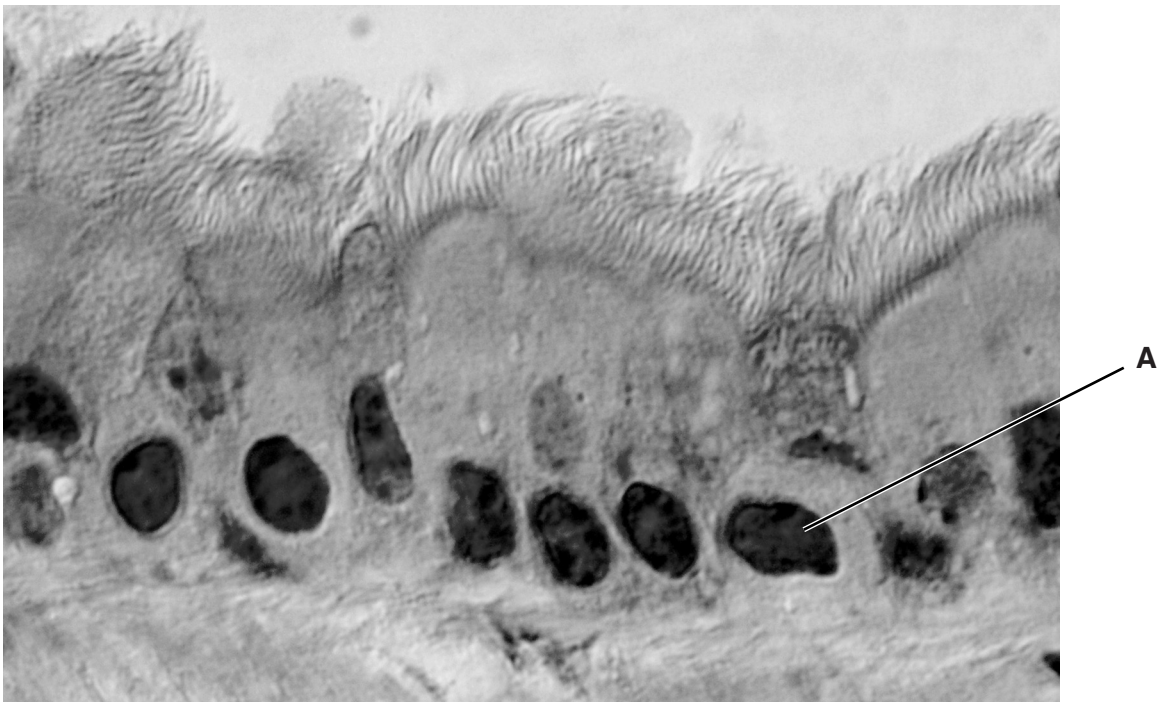


Fig. 1.1

(a) (i) Write a letter **X** on Fig. 1.1 to show the lumen of the bronchus. [1]

(ii) Name the structure in Fig. 1.1 labelled **A**.

.....[1]

(iii) State **one** feature of the cells, **visible in Fig. 1.1**, which indicates that these are **not** epithelial cells from the alveolus.

.....[1]

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(b) Epithelial cells are replaced when they are damaged.

(i) Name the type of cell division used to replace damaged epithelial cells.

.....[1]

(ii) The cells shown in Fig. 1.1 are from a non-smoker.

Smoking causes damage to the epithelial cells of the lungs.

Describe the appearance of the lining of the bronchus in a long-term smoker.

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.....[3]

[Total: 7]

2 Trypsin is a protease enzyme found in the digestive system.

Fig. 2.1 shows how the substrate concentration affects the rate of reaction of trypsin.

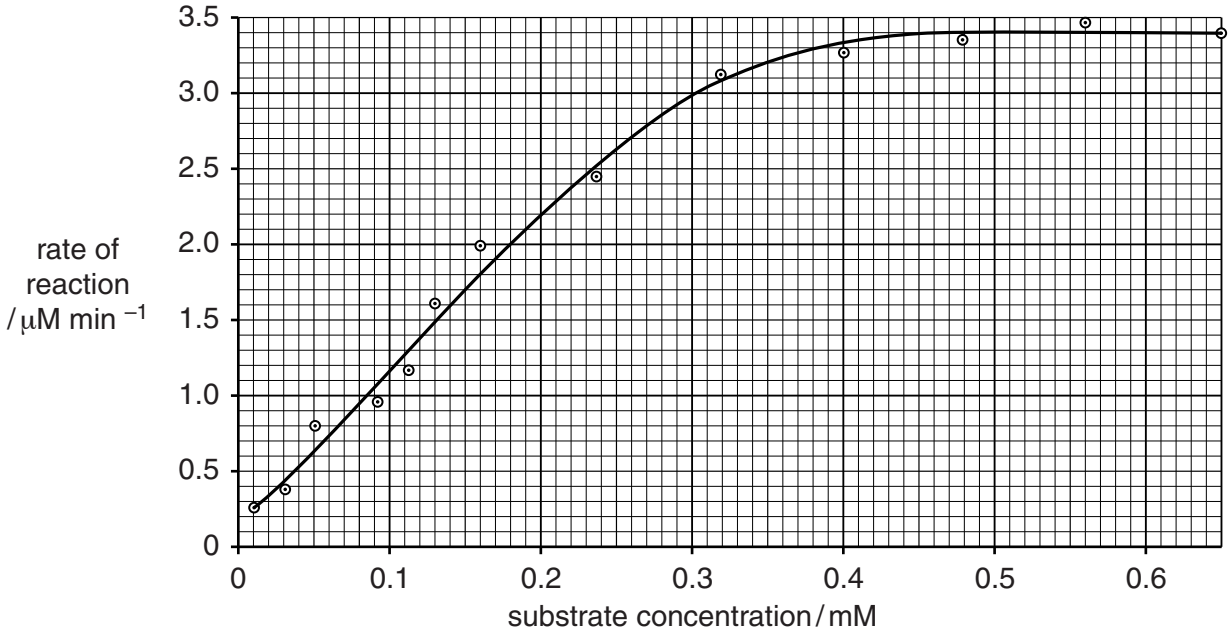


Fig. 2.1

(a) Use Fig. 2.1 to:

(i) determine V_{max} for trypsin

.....[1]

(ii) calculate K_m for trypsin.

Show your working.

.....[2]

(b) Describe **and** explain the shape of the curve in Fig. 2.1.

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.....[4]

(c) Trypsin is composed of one polypeptide chain of 223 amino acids.

The active site of trypsin contains three amino acids which catalyse a hydrolysis reaction. These three amino acids occupy the following positions in the primary structure of trypsin:

- histidine, position 57
- aspartate, position 102
- serine, position 195.

(i) In the functioning enzyme, these three amino acids are close together in the active site.

Explain how the structure of the protein makes this possible.

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.....[3]

(ii) When trypsin acts on a substrate, another substance is required as a reactant.

Name this other substance.

.....[1]

[Total: 11]

3 Rheumatoid arthritis (RA) is a disease of the joints in the human body.

(a) RA is classed as an auto-immune disease where the immune system treats some self antigens as non-self.

Explain what is meant by the term *non-self antigens*.

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.....[3]

(b) The symptoms of RA include inflammation of the joints which causes pain and difficulty in movement of the joint.

The inflammation is triggered by a chemical known as TNF-α, produced by macrophages.

One approach to the treatment of RA is by the use of monoclonal antibody against TNF-α.

Fig. 3.1 is a diagram of an antibody molecule.

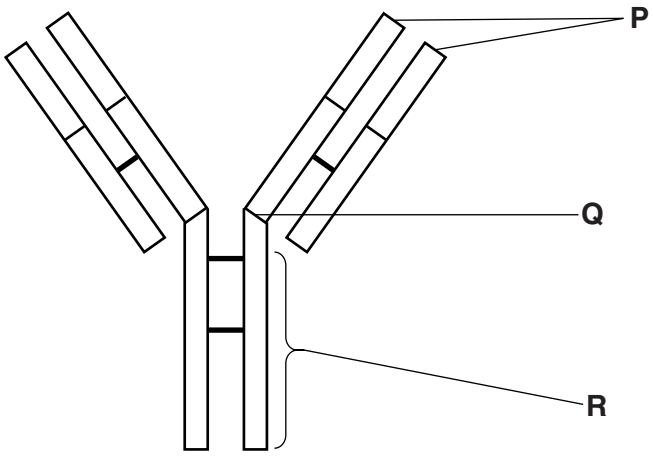


Fig. 3.1

(i) Name the parts of the antibody molecule labelled **P**, **Q** and **R**.

P .....

Q .....

R .....

[3]

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(ii) Name the type of bonds that hold the polypeptide chains together in the antibody structure.

.....[1]

(c) (i) Outline how monoclonal antibody against TNF-α is produced.

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.....[3]

(ii) Suggest how monoclonal antibody against TNF-α can reduce the symptoms of RA.

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.....[2]

[Total: 12]

4 Fig. 4.1 is an electron micrograph showing a section through the stem of Asian rice, *Oryza sativa*.

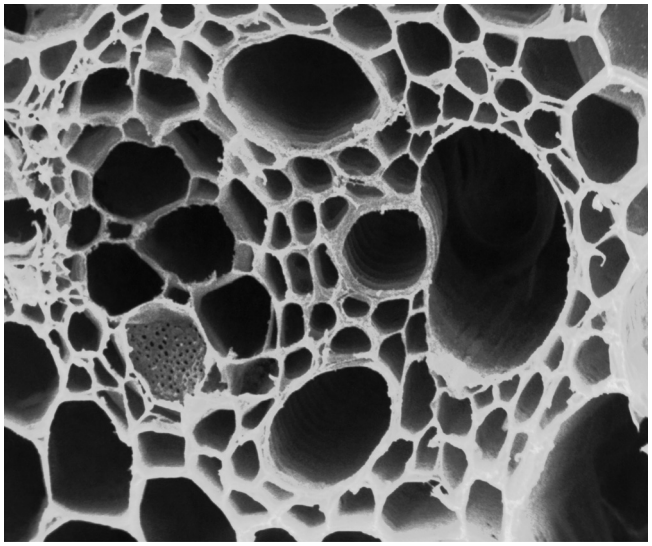


Fig. 4.1

(a) Draw a label line and label on Fig. 4.1 to show a phloem sieve tube. [1]

(b) Describe the function of phloem sieve tubes.

.....

.....

.....[2]

(c) In the root tip, some of the cells produced by mitosis differentiate into xylem vessel elements. During this differentiation, the structure of the cell wall changes.

Explain how the structure of the walls of xylem vessel elements are adapted to their functions.

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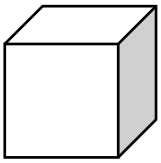
.....[3]

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(d) Organisms can be modelled as simple shapes for the calculation of surface area to volume ratios.

(i) Calculate the surface area to volume ratio of an animal modelled as a cube of side length 0.1 m.

Show your working.



surface area ..... m^2

volume ..... m^3

surface area to volume ratio .....
[3]

(ii) The surface area to volume ratio decreases as animals increase in size.

Use this fact to suggest why multicellular animals require transport systems.

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.....

.....[2]

[Total: 11]

5 Tuberculosis (TB) is an infectious disease caused by the bacterium *Mycobacterium tuberculosis*.

(a) Describe how TB is transmitted.

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.....[2]

(b) Streptomycin was the first antibiotic used to treat TB.

During the first few years after the introduction of streptomycin treatment, an increasing number of *M. tuberculosis* bacteria developed resistance to streptomycin.

Outline how this happened.

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.....[4]

(c) The antibiotic rifampicin was introduced as an alternative to streptomycin.

Rifampicin acts by inhibiting the enzyme RNA polymerase.

RNA polymerase is the enzyme used in transcription.

(i) Explain what is meant by transcription.

.....

.....

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.....[2]

(ii) *M. tuberculosis* and humans both use RNA polymerase for transcription.

Suggest why rifampicin does **not** affect transcription in human cells.

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.....[1]

(d) Other drugs such as isoniazid are also used in the treatment of TB.

Some bacteria are now resistant to more than one of these drugs. These bacteria are known as multi-drug resistant (MDR) bacteria.

Outline the steps that can be taken to reduce the impact of drug resistance in bacteria.

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.....[3]

(e) Explain why antibiotics can be used to treat bacterial infections and not viral infections.

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.....[2]

[Total: 14]

6 Fig. 6.1 is a diagram of a section through a mammalian heart.

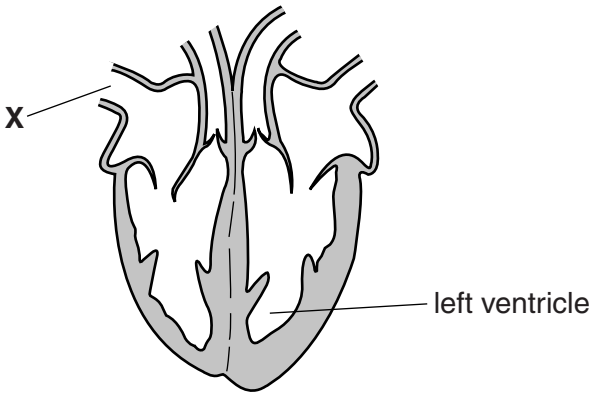


Fig. 6.1

(a) Name the blood vessel labelled **X**.

.....[1]

(b) Explain the difference in thickness between the muscle walls of the left and right ventricles.

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.....[3]

(c) Name the structure in the heart that acts as the pacemaker to initiate the cardiac cycle.

.....[1]

[Total: 5]

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