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

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1081139412

BIOLOGY **9700/21**

Paper 2 Structured Questions AS **May/June 2012**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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1 Name as precisely as you can the structure described in each of the following statements.

For Examiner's Use

(a) The blood vessel that transports deoxygenated blood from the heart.

.....[1]

(b) The cell that ingests and digests cell debris and bacteria in the lungs.

.....[1]

(c) The cell that secretes antibodies.

.....[1]

(d) The epithelial cell that secretes mucus in the trachea.

.....[1]

(e) The tissue that prevents the collapse of the trachea during inhalation.

.....[1]

[Total: 5]

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[Turn over

2 Fig. 2.1 shows a drawing made from an electron micrograph of two adjacent cells in a leaf.

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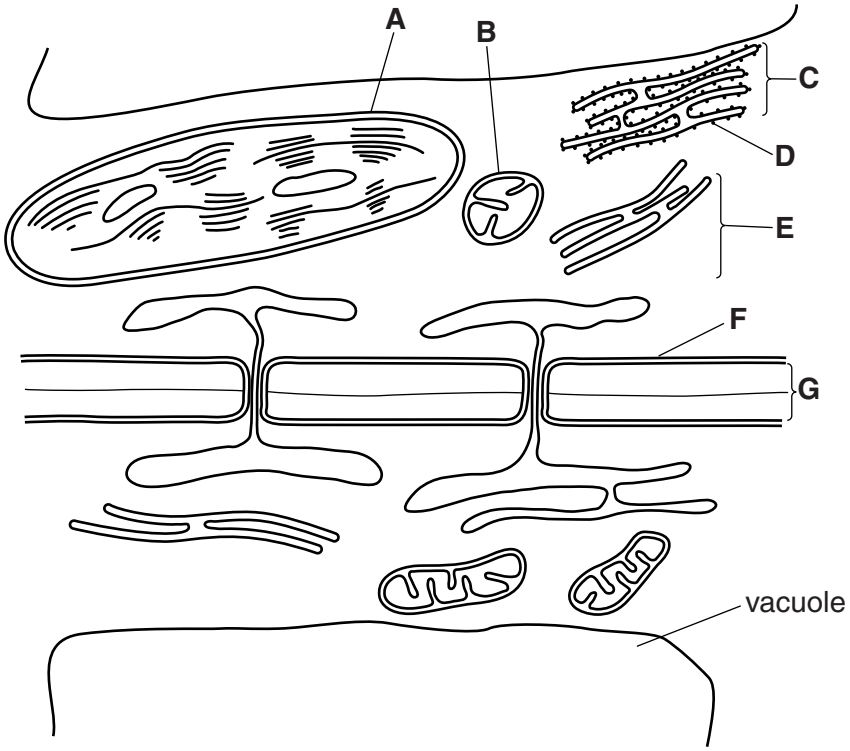


Fig. 2.1

(a) Structures **A** and **B** are both visible using the light microscope, but the internal detail of these organelles shown in Fig. 2.1 is only visible using the electron microscope.

Explain why the internal details of structures **A** and **B** are only visible when using the electron microscope and not when using the light microscope.

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.....[3]

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(b) Name in full the structures labelled **C**, **D** and **E**.

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C .....

D .....

E ..... [3]

(c) State **one** role of vacuoles in plant cells.

..... [1]

(d) Structures **F** and **G** have very different permeability properties.

Explain how the composition of structures **F** and **G** determines the permeability properties of these structures.

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..... [4]

(e) Fig. 2.1 shows two plasmodesmata connecting the adjacent cells.

Describe the roles of plasmodesmata in transport in plants.

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..... [3]

[Total: 14]

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[Turn over

3 Haemoglobinopathies are inherited conditions linked to the structure and function of haemoglobin. Sickle cell anaemia is one of these conditions in which the transport and delivery of oxygen to tissues is less than normal.

For Examiner's Use

An investigation was carried out to discover the effect of sickle cell anaemia on the ability of blood to carry oxygen. Blood samples were taken from two people:

- person **L** without sickle cell anaemia
- person **M** with sickle cell anaemia.

The percentage saturation of haemoglobin with oxygen was determined over a range of partial pressures of oxygen.

Fig. 3.1 shows oxygen haemoglobin dissociation curves for the two blood samples.

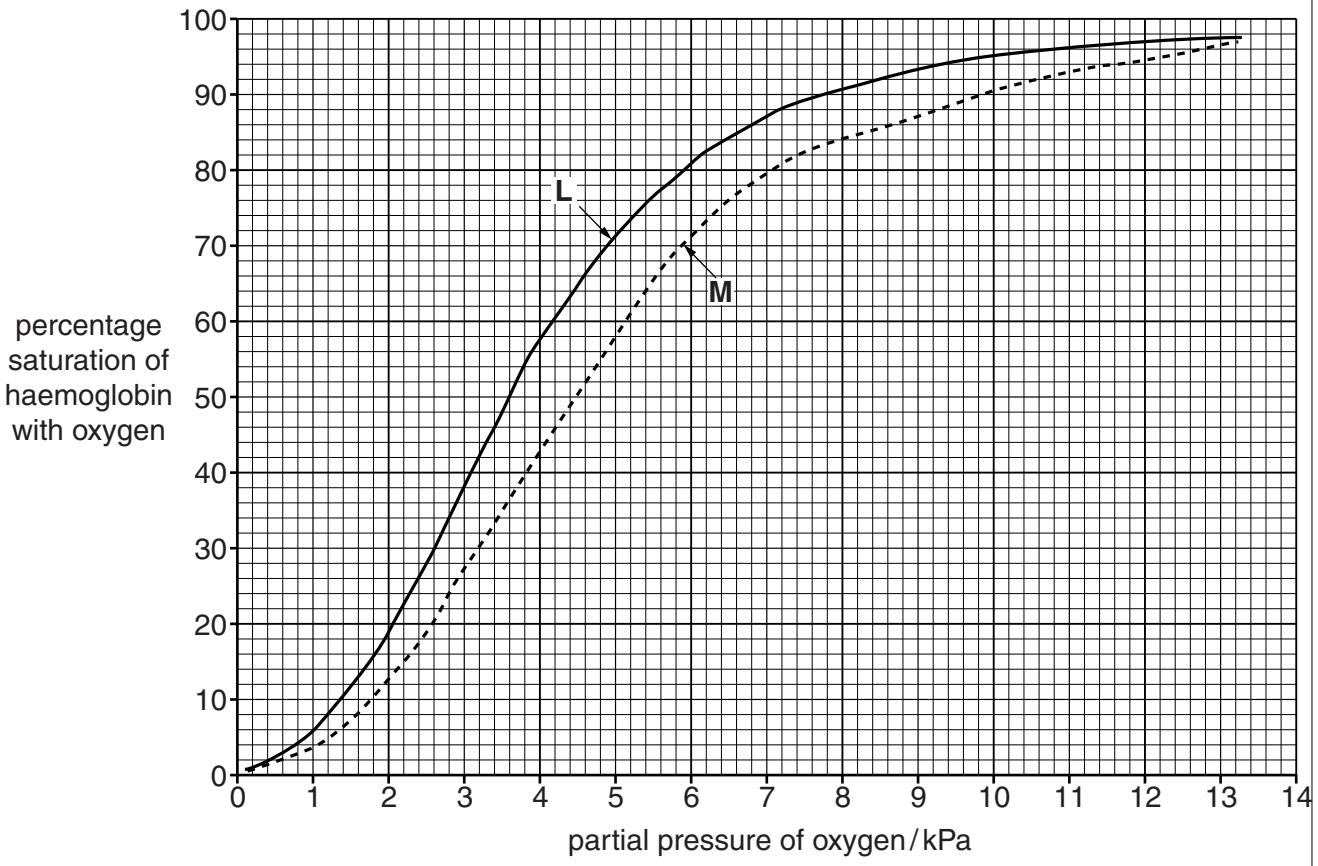


Fig. 3.1

(a) P50 is the partial pressure of oxygen at which haemoglobin is 50% saturated with oxygen. It is taken as a measurement of the affinity of haemoglobin for oxygen.

(i) State the P50 for the two blood samples, **L** and **M**.

L .....

M .....[1]

For Examiner's Use

(ii) With reference to Fig. 3.1, describe how the dissociation curve for person **M differs** from the dissociation curve for person **L**.

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..... [3]

(b) Explain the advantage of the position of the dissociation curve for people with sickle cell anaemia.

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..... [3]

(c) The partial pressure of oxygen in the lungs at sea level is about 13.5 kPa. At an altitude of 3000 metres the partial pressure of oxygen in the lungs is about 7.5 kPa.

When people move from sea level to high altitude they become adapted to the low partial pressure of oxygen.

Describe **and** explain how humans become adapted to the low partial pressure of oxygen at high altitude.

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..... [4]

(d) Vaccination is used to control the spread of diseases, such as measles.

Explain why vaccination cannot be used to prevent sickle cell anaemia.

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.....[2]

[Total: 13]

For Examiner's Use

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Question 4 starts on page 10

4 Penicillin is an antibiotic that interferes with the synthesis of cell walls in bacteria. Even before penicillin became widely available in the 1940s, the enzyme penicillinase which breaks down penicillin had been isolated. This enzyme is now found in many bacteria and gives them resistance to penicillin.

For Examiner's Use

Fig. 4.1 is a ribbon model of the structure of the enzyme penicillinase. The arrow indicates the active site of the enzyme.



Fig. 4.1

(a) Explain why the shape of the active site of an enzyme, such as penicillinase, is important.

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.....[3]

(b) With reference to Fig. 4.1, identify the aspects of protein structure that are shown and those that are **not** shown.

For Examiner's Use

aspects of protein structure shown

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aspects of protein structure not shown

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.....[3]

Fig. 4.2 shows the changes in energy during the progress of an uncatalysed reaction.

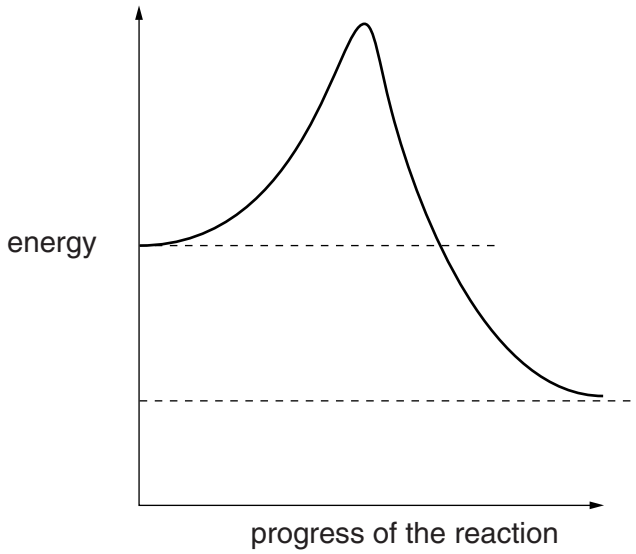


Fig. 4.2

(c) **(i)** Draw on Fig. 4.2 a curve to show changes in energy during the progress of the same reaction when catalysed by an enzyme. [2]

(ii) State the term given to the energy level that must be overcome before a reaction can progress.

.....[1]

(d) Antibiotic resistance is a serious worldwide problem.

For Examiner's Use

Suggest how antibiotics can be used effectively to avoid the development of widespread resistance in bacteria.

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.....[2]

[Total: 11]

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Question 5 starts on page 14

5 The slime mould, *Dictyostelium discoideum*, is a eukaryote and a decomposer of protein-rich material.

For Examiner's Use

Fig. 5.1 shows the life cycle of *D. discoideum*.

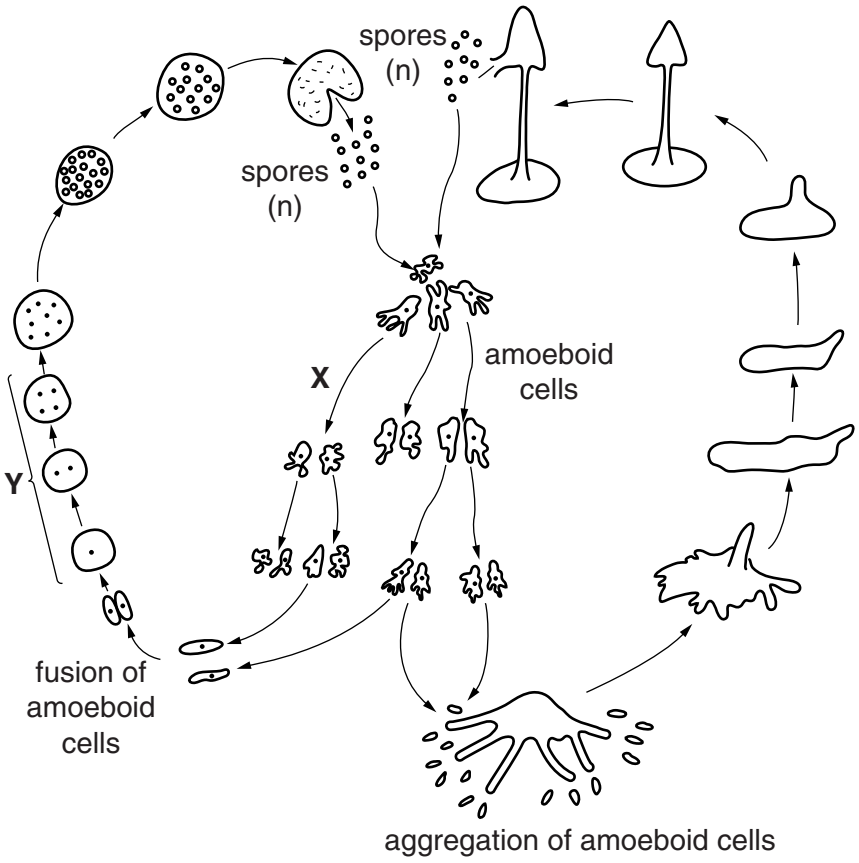


Fig. 5.1

(a) State the type of nuclear division that occurs at **X** and at **Y**.

X .....

Y .....[1]

(b) State what is meant by the term *reduction division* **and** explain why this division is necessary in a life cycle, such as that shown in Fig. 5.1.

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.....[2]

(c) The amoeboid cells of *D. discoideum* feed on protein-rich material and break it down to form ammonium ions (NH_4^+). The cell membranes of *D. discoideum* have transporter proteins that are responsible for the excretion of ammonium ions.

For Examiner's Use

Describe what happens to the ammonium ions excreted by *D. discoideum* into the soil.

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.....[3]

(d) Suggest why a transporter protein is required for the removal of ammonium ions from *D. discoideum*.

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.....[2]

[Total: 8]

6 Fig. 6.1 shows part of a DNA molecule.

For Examiner's Use

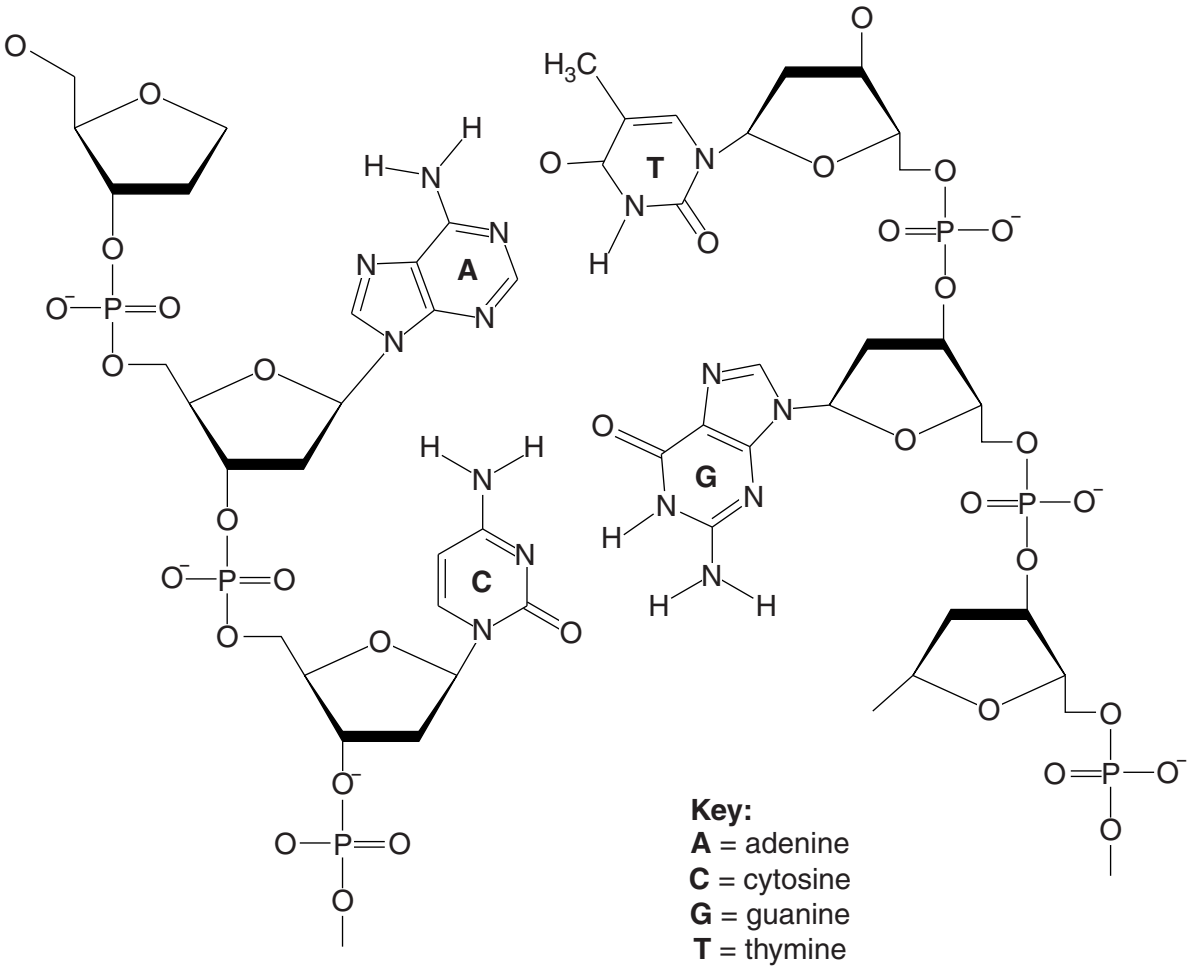


Fig. 6.1

(a) (i) Complete Fig. 6.1 by drawing on the hydrogen bonds between the two base pairs shown. [2]

(ii) State the importance of hydrogen bonding in DNA structure.

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.....[2]

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In the 1950s, Erwin Chargaff determined the relative quantities of the four bases in DNA in different organisms. His results provided important evidence for the model of DNA proposed by James Watson and Francis Crick in 1953. Some of Chargaff's data is shown in Table 6.1.

For Examiner's Use

Table 6.1

organism	percentage of adenine	percentage of thymine	percentage of guanine	percentage of cytosine
Escherichia coli (bacterium)	24.7	23.6	26.0	25.7
a yeast	31.3	32.9	18.7	17.1
wheat	27.3	27.1	22.7	22.8
octopus	33.2	31.6	17.6	17.6
sea urchin	32.8	32.1	17.7	17.3
chicken	28.0	28.4	22.0	21.6
human	29.3	30.0	20.7	20.0

(b) With reference to Fig. 6.1, explain how the data in Table 6.1 helps to confirm the arrangement of bases in DNA.

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.....[3]

(c) Table 6.2 shows Chargaff's data for a virus.

For Examiner's Use

Table 6.2

organism	percentage of adenine	percentage of thymine	percentage of guanine	percentage of cytosine
a virus	24.0	31.2	23.3	21.5

(i) State how the result for the virus differs from the results for all the organisms given in Table 6.1.

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.....[1]

(ii) Suggest why the results for the virus are different from all the other organisms.

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.....[1]

[Total: 9]

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BIOLOGY **9700/22**

Paper 2 Structured Questions AS **May/June 2012**

1 hour 15 minutes

Candidates answer on the Question Paper.

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1 One role of the cell surface membrane is to control the entry and exit of substances.

For Examiner's Use

(a) Complete Table 1.1 to show the transport mechanisms across cell surface membranes and examples of materials transported.

Table 1.1

transport mechanism across cell surface membrane	example of material transported across membrane
active transport	sodium ions
	oxygen molecules
	bacteria
exocytosis	mucin (for mucus)
facilitated diffusion	
osmosis	

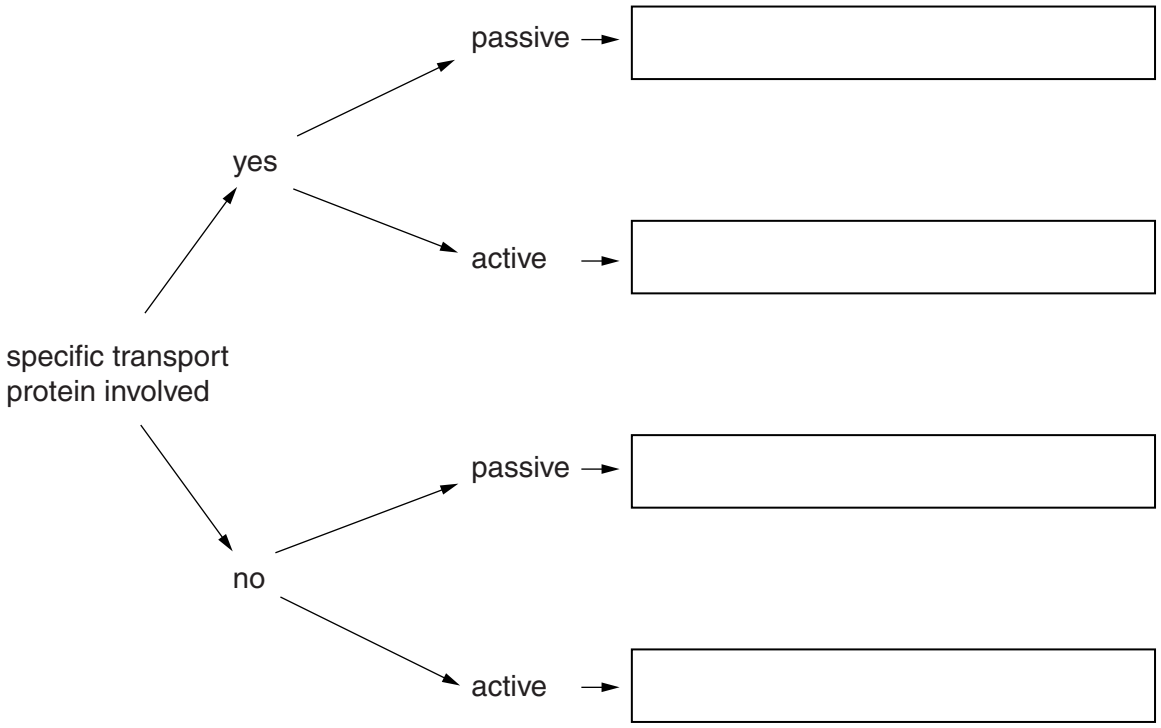
[2]

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(b) Each transport mechanism across cell surface membranes has a characteristic set of features.

For Examiner's Use

In **each** of the boxes below, state **one** example of a transport mechanism that matches the pathway shown.



[4]

[Total: 6]

2 Fig. 2.1 is a transmission electron micrograph of a plasma cell. Plasma cells are antibody-secreting cells that are formed from B-lymphocytes.

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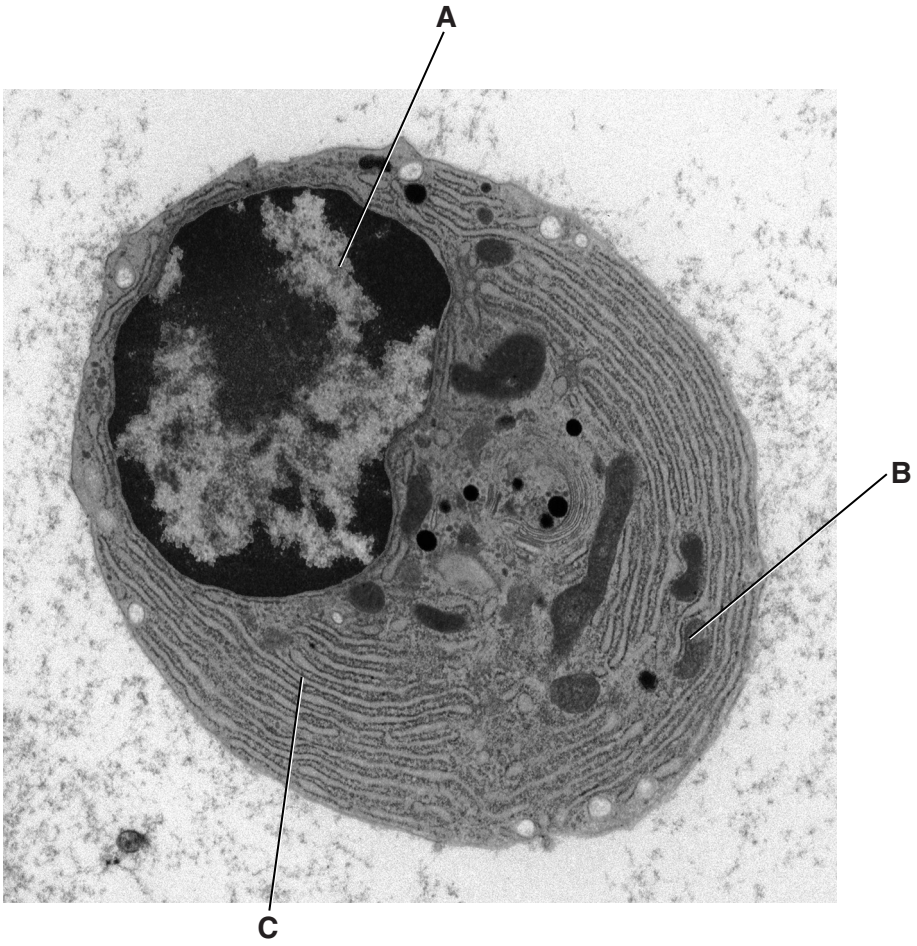


Fig. 2.1

(a) Complete Table 2.1 to:

- name in full, structures **A**, **B** and **C**
- outline how each structure functions to contribute to the **specific role of the plasma cell**.

Table 2.1

structure	name of structure	function of structure within plasma cell
A		
B		
C		

[6]

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(b) An activated B-lymphocyte divides repeatedly by mitosis to produce many identical plasma cells.

For Examiner's Use

(i) Explain why it is important that many identical plasma cells are produced.

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..... [3]

(ii) B-lymphocytes have centrioles and a spindle that can be observed during mitosis.

Describe and explain how the behaviour of the centrioles and spindle of a cell dividing by mitosis is associated with the behaviour of the chromosomes.

You may use the space below for labelled diagrams.

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..... [4]

[Total: 13]

For Examiner's Use

3 **(a)** With reference to the structure of a leaf, explain the difference between evaporation and transpiration.

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.....[4]

(b) Apple, *Pyrus malus*, sour cherry, *Prunus cerasus,* and peach, *Prunus persica*, are dicotyledonous trees that are of importance to commercial growers for the fruit that they produce.

A student chose a small area of land where all three species of fruit tree were growing. Leaf samples were removed and, using a microscope, the mean number of stomata per square millimetre was estimated for each species.

The rate of transpiration of each species was then measured on each of three separate occasions. The student performed the investigation outside where the trees were located and recorded the weather conditions on each day.

The mean transpiration rate was calculated per unit area of leaf.

The results are shown in Table 3.1.

Table 3.1

fruit tree	mean number of stomata / mm^{-2}	mean transpiration rate / $cm^3 h^{-1}$		
		hot dry day	warm dry day	warm rainy day
apple	266	0.19	0.35	0.21
sour cherry	284	0.09	0.28	0.25
peach	190	0.03	0.08	0.07

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(i) With reference to Table 3.1, describe **and** explain the results of the investigation.

For Examiner's Use

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.....[4]

(ii) The mean transpiration rate of each species was calculated over a 24 hour period.

Describe how the transpiration rate during the night would differ from the transpiration rate during the day.

Explain your answer.

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.....[3]

(iii) Suggest which of the three species of fruit tree has been described as 'drought-resistant' and would be economical to grow in areas where water is scarce.

..... [1]

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[Turn over

(c) Many fruits are thought to have beneficial health effects. Sour cherries and peaches may contribute to improved health for tobacco smokers.

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Read the following statements. For each, explain how the fruit contributes to protecting smokers from smoking-related diseases.

(i) Glutathione is a protein known to be involved in the repair of damaged DNA. Regularly eating sour cherries increases the level of glutathione in the body.

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.....[2]

(ii) A diet rich in peaches can help reduce inflammation of the bronchi and bronchioles.

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..... [2]

[Total: 16]

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4 DNA and RNA are important biological molecules that are involved in the production of polypeptides.

(a) Fig. 4.1 shows two nucleotides joined by a covalent bond.

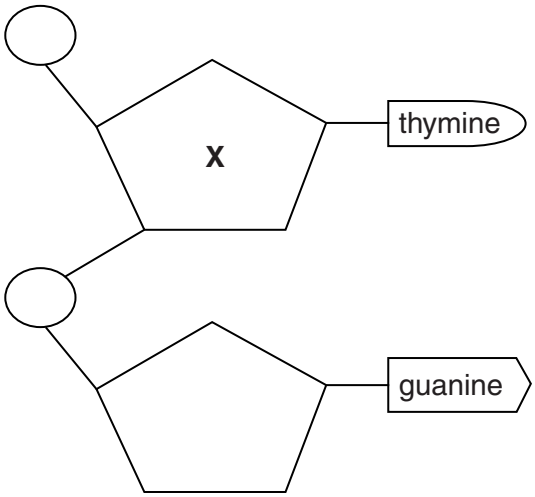


Fig. 4.1

(i) Fig. 4.1 represents part of a DNA molecule, **not** part of an RNA molecule.

Explain why.

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.....

..... [1]

(ii) Name the covalent bond between the two nucleotides.

..... [1]

(iii) Name component **X**.

.....

..... [1]

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(b) Outline the role of transfer RNA (tRNA) in the production of a polypeptide.

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..... [2]

(c) Describe how a peptide bond is formed between two amino acids during polypeptide production.

You may use the space below to help with your answer.

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..... [3]

[Total: 8]

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[Turn over

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5 **(a)** State the name of the organism that causes cholera.

..... [1]

(b) NQR is an important respiratory enzyme located in the cell surface membrane of the bacterium that causes cholera.

A student suggested that an inhibitor of the enzyme NQR could be used as a drug in the prevention and control of cholera.

Suggest and explain how this inhibitor would function.

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..... [3]

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(c) Table 5.1 shows the statistics for cholera reported to the World Health Organization (WHO) in four regions of the world in 2008.

For Examiner's Use

Table 5.1

region	number of cases	number of deaths	fatality rate/%
Africa	179 323	5 074	2.83
Asia	10 778	69	0.64
Europe	22	0	0.00
North America	7	0	0.00
Total	190 130	5 143	

(i) Calculate the total cholera fatality rate for 2008.

Show your working.

answer ..... % [2]

(ii) Apart from differences in total population size in each of the regions, suggest explanations for the differences shown in Table 5.1.

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.....[4]

[Total: 10]

6 Microorganisms play an important role in the cycling of nitrogen in ecosystems.

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Fig. 6.1 is a diagram of a nitrogen cycle.

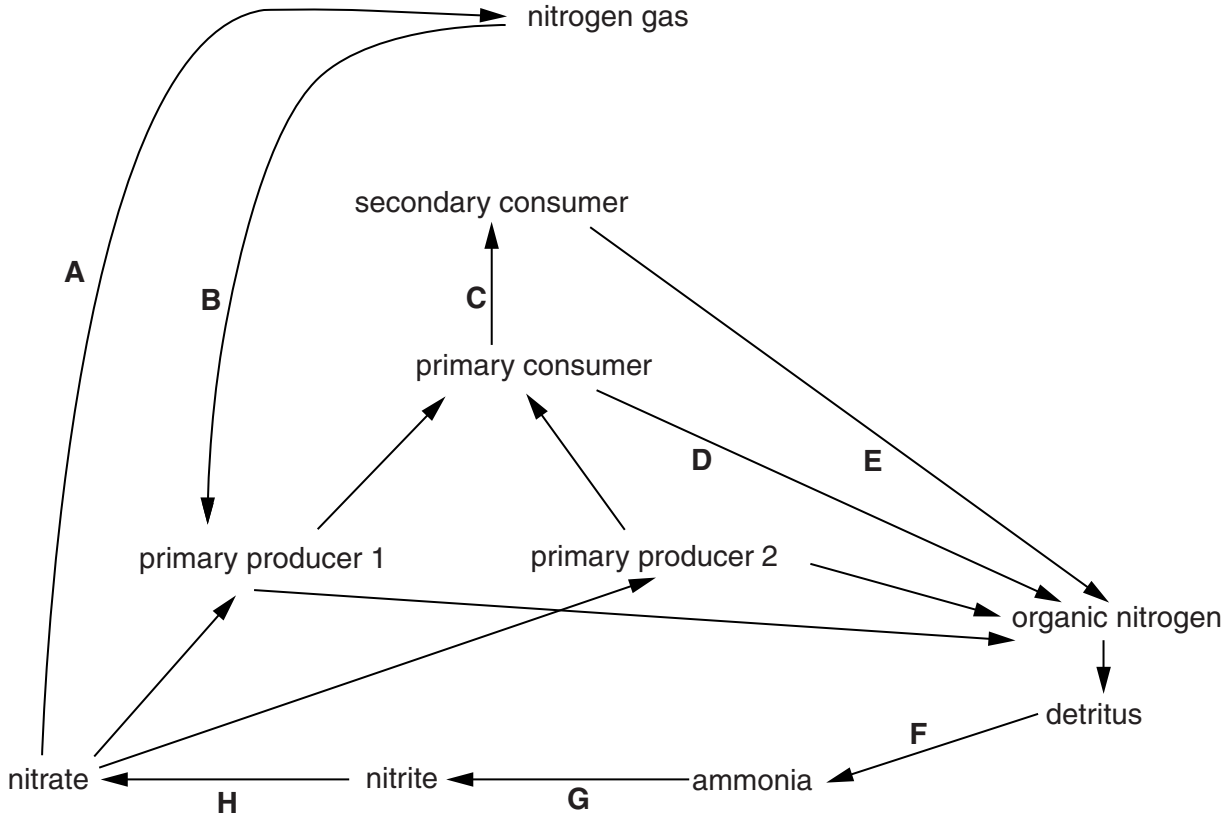


Fig. 6.1

(a) Read the information below about four different species of soil bacteria. In the box provided, write the appropriate letter that matches each microorganism to its corresponding stage in the nitrogen cycle in Fig. 6.1.

- *Nitrosomonas europaea* is an ammonia-oxidising bacterium.
- *Bacillus cereus* is a denitrifying bacterium.
- *Azospirillum lipoferum* lives in the roots of some cereals and grasses and supplies fixed nitrogen to plants.
- *Streptomyces coelicolor* is a bacterium that secretes powerful hydrolases to break down compounds such as proteins and cellulose.

[4]

(b) Some fungi form beneficial associations with plant roots. They enable the plant to increase the uptake of nutrients, such as phosphates, which are not readily available to the plants from the soil.

For Examiner's Use

Suggest how increasing phosphate ion uptake will lead to increased plant growth.

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.....[3]

[Total: 7]

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Question 2 Fig. 2.1 © STEVE GSCHMEISSNER / SCIENCE PHOTO LIBRARY
Question 5 Table 5.1 © *Cholera*; Weekly Epidemiological Record; WHO Geneva; www.who.int/wer; 2009.

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5197508294

BIOLOGY **9700/23**

Paper 2 Structured Questions AS **May/June 2012**

1 hour 15 minutes

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1 Fig. 1.1 is an electron micrograph of a cross section through a blood vessel.

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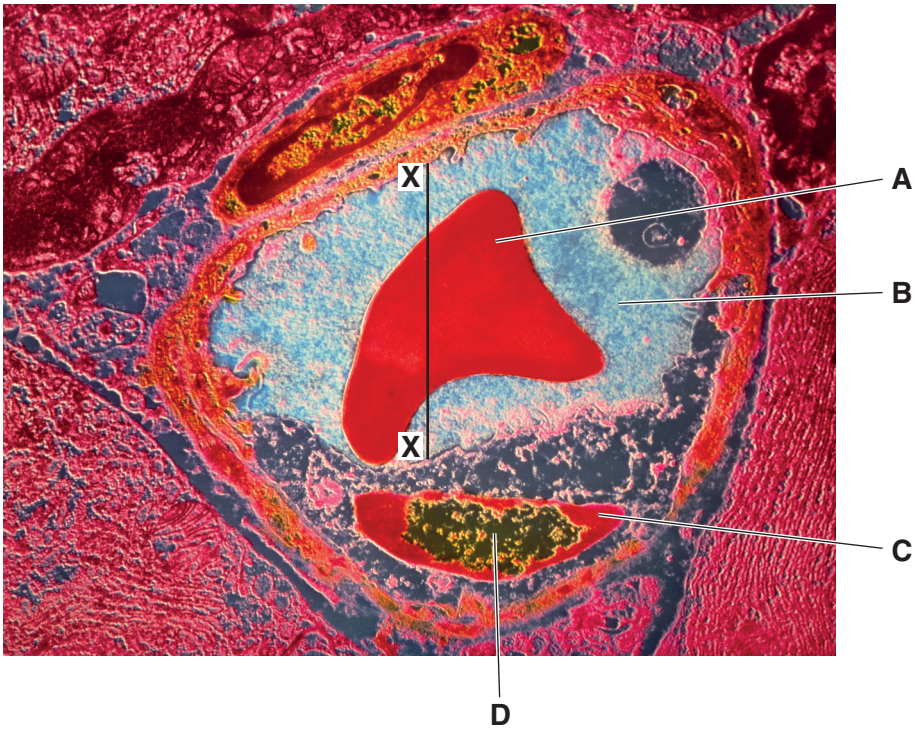


Fig. 1.1

(a) Name the type of blood vessel shown in Fig. 1.1 and describe one **visible** feature which is characteristic of this type of vessel.

type of vessel.....

characteristic feature .....

.....[2]

(b) Name:

(i) structure **A** .....

(ii) the main component of substance **B**. .....
[2]

(iii) Cell **C** in Fig. 1.1 is an endothelial cell.

Name structure **D**.

.....[1]

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(c) The magnification of Fig. 1.1 is × 6000.

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Calculate the diameter of the lumen along the line **X**–**X**.

Show your working and give your answer in micrometres (μm) to the nearest whole number.

answer ..... μm [2]

[Total: 7]

2 Fig. 2.1 shows an apparatus used to measure the rate of water uptake by leafy parts of plants.

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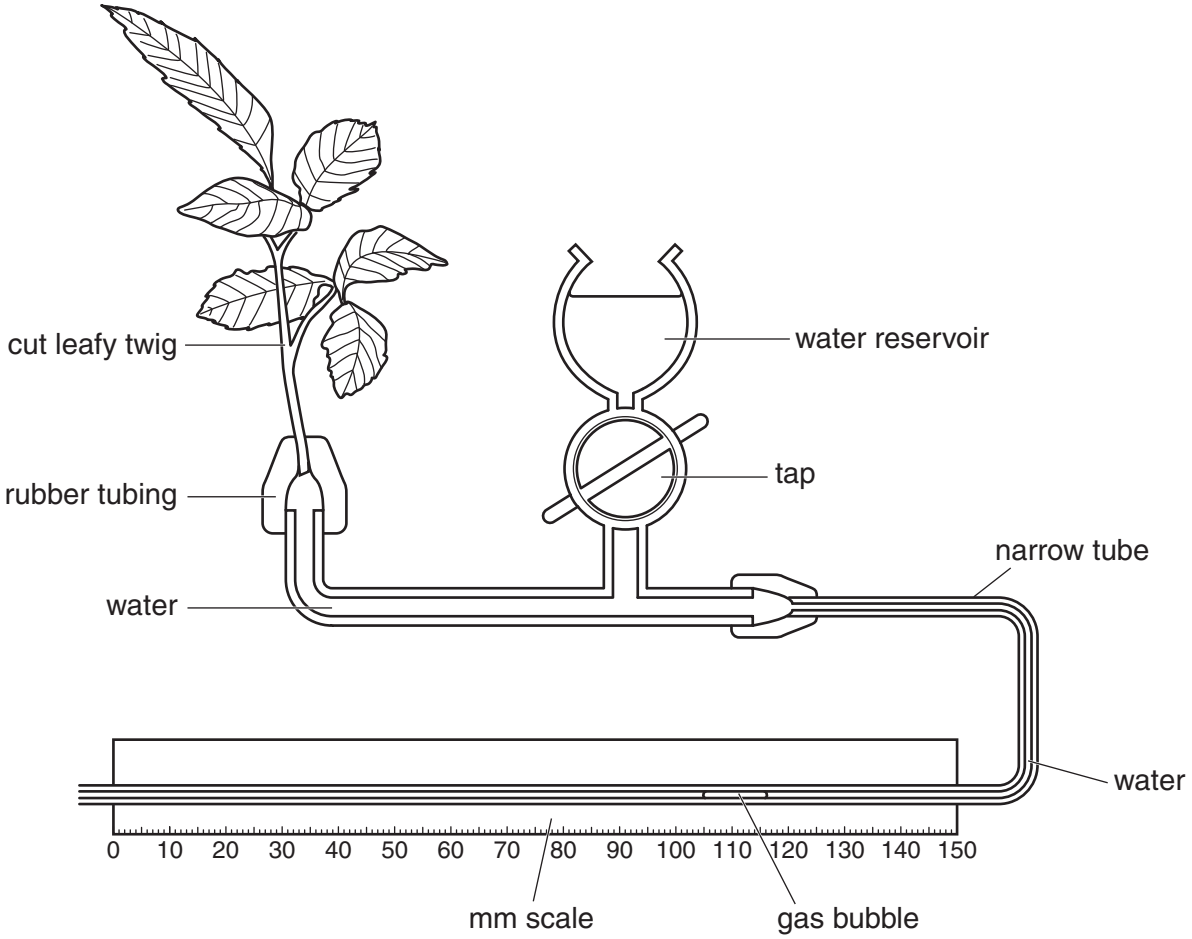


Fig. 2.1

(a) State the name of this apparatus.

.....[1]

(b) Explain why the rate of water uptake by the leafy part of the plant shown in Fig. 2.1 will **not** be the same as the rate of transpiration.

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.....[2]

For Examiner's Use

(c) Using the apparatus as shown in Fig. 2.1, the rate of water uptake at 25 °C was found to be greater than at 20 °C.

(i) Explain the effect of increasing the temperature on the rate of water uptake.

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.....[3]

(ii) State two environmental conditions, **other than temperature**, which will affect the rate of water uptake of a leafy twig as shown in Fig. 2.1.

1. .....

2. .....[2]

(d) Transpiration is sometimes described as an 'inevitable consequence of gas exchange' in plants.

Explain this statement.

.....

.....

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.....

.....

.....[3]

[Total: 11]

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[Turn over

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3 Cholera is a disease caused by the bacterium *Vibrio cholerae*. The disease symptoms are caused by a toxin, produced by the bacterium, interacting with proteins in the cell surface membranes of epithelial cells in the human intestine.

The cholera toxin is a protein and is composed of two subunits, **A** and **B**. Subunit **A** is made from one polypeptide and subunit **B** is made from five identical polypeptides.

Fig. 3.1 shows the structure of the cholera toxin.

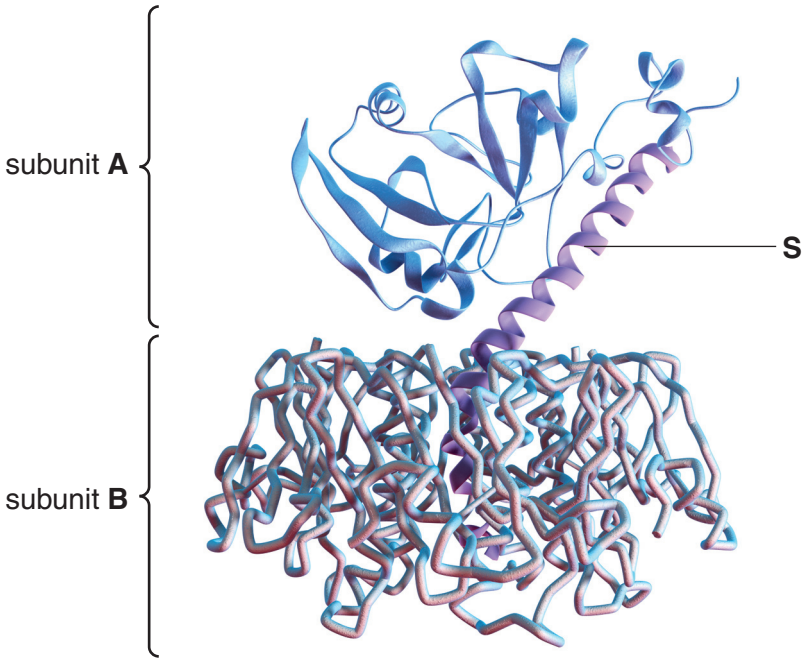


Fig. 3.1

(a) Name:

(i) the level of structure that is only shown by a protein that has more than one polypeptide chain

.....[1]

(ii) the part labelled **S**.

.....[1]

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The cholera toxin interacts with ion channels in the epithelial membranes, resulting in watery diarrhoea.

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These channels open, allowing ions to move from the epithelial cells into the lumen of the intestine.

(b) (i) Name the process by which the ions move in this case.

.....[1]

(ii) Due to the movement of ions into the lumen, water moves from the epithelial cells into the lumen.

Name the process by which water moves and explain why it moves into the lumen.

name .....

explanation .....

.....

.....

.....[3]

Large outbreaks of cholera are often associated with natural disasters. For example, following an earthquake in Pakistan in 2005, an estimated 20 000 cholera cases were reported in the vicinity, compared to approximately 1000 cases in the rest of the country.

(c) (i) Describe the mode of transmission of cholera.

.....

.....

.....

.....

.....[2]

(ii) Explain how natural disasters can sometimes result in transmission to more individuals.

.....

.....

.....

.....[2]

[Total: 10]

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[Turn over

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4 The two strands of a DNA molecule are held together by hydrogen bonds between complementary base pairs.

(a) Explain why the hydrogen bonding between the two strands of DNA is important for it to carry out its functions.

.....

.....

.....

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.....

..... [4]

Switching genes on and off allows proteins to be synthesised only when required.

Processes **P** and **Q** occur when a gene is switched on, as shown in Fig. 4.1.

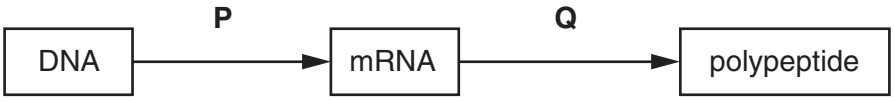


Fig. 4.1

(b) Name processes **P** and **Q**.

P .....

Q ..... [1]

DNA is a very stable molecule. This means that it is not broken down either chemically or by enzymes during the normal life of the cell.

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In contrast, mRNA is described as being highly labile. This means that most mRNA molecules are broken down in the cytoplasm within a few hours of their release from the nucleus.

(c) Suggest the significance of:

(i) DNA being very stable

.....

.....

.....[2]

(ii) mRNA being highly labile.

.....

.....

.....[2]

[Total: 9]

5 Malaria is a disease caused by the parasite, *Plasmodium*. The parasite has a complex life-cycle, part of which involves development within the gut of the female mosquito which is responsible for the transmission of the disease.

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Fig. 5.1 shows part of the life-cycle of the malarial parasite.

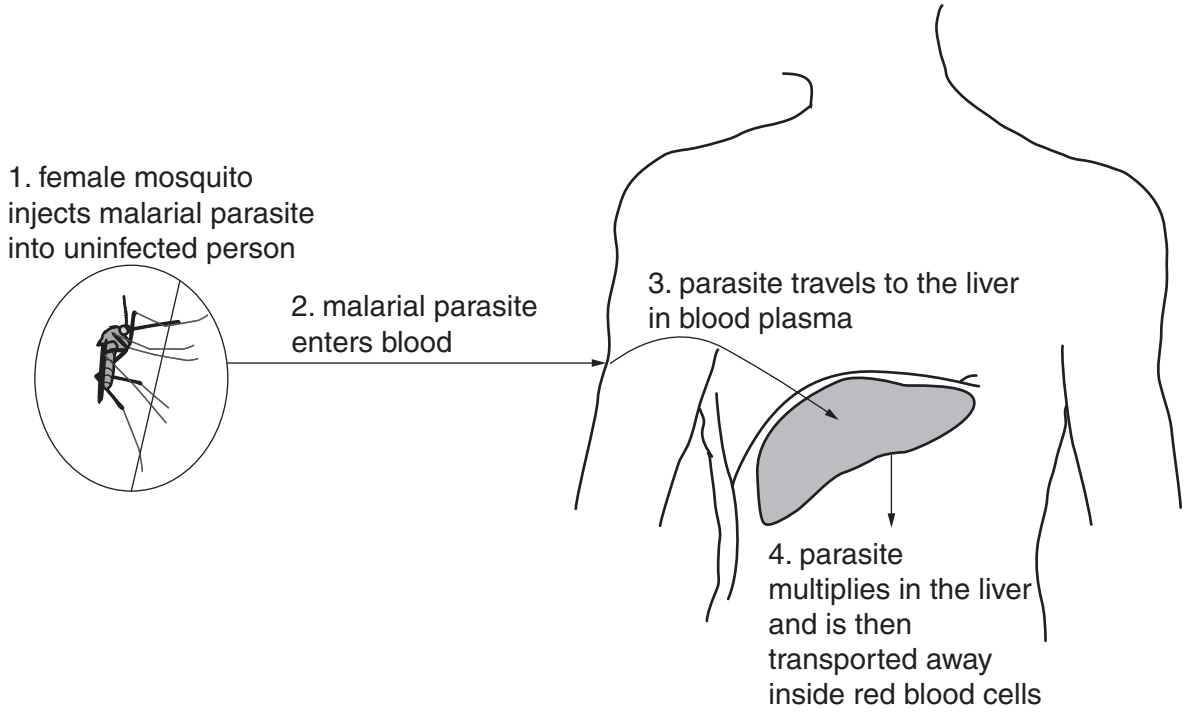


Fig. 5.1

Research has been directed towards the development of a malarial vaccine. Much of this research relies on the fact that *Plasmodium* has different forms in its life cycle.

During trials of a malarial vaccine, the parasites were killed using radioactivity and then injected into volunteers. This method provided some protection against malaria.

(a) Explain why the parasites were killed using radioactivity and not by using high temperatures.

.....

.....

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.....

.....[3]

(b) With reference to Fig. 5.1, explain why the researchers decided to use the form of the parasite which is injected by mosquitoes and not the form which leaves the liver.

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.....[3]

(c) The volunteers who were injected with the killed parasites produced antibodies, which provided some protection against the disease.

Outline the events that occur following injection of the parasites, which lead to the production of antibodies.

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.....[5]

[Total: 11]

6 Read the following passage.

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> Catfish are a commercially important species of freshwater fish used as a human food source. In the wild, catfish are found in all types of large freshwater habitats, such as rivers, lakes and reservoirs. In North America, they are often maintained in catfish ponds, which are artificially constructed habitats. Each pond functions as a self-sustaining ecosystem with its own community of organisms. Catfish feed on living and dead fish, amphibians, insects and even dead mammals found on the bottom of the pond. Different species of phytoplankton are always present in these ponds. They are small organisms found suspended in the water and they are essential for the growth of all the other pond organisms.

(a) With reference to the passage:

(i) state the meaning of the terms *habitat* and *community*

habitat

.....

.....

.....

community

.....

.....

.....[4]

(ii) name the producer in the pond ecosystem

.....[1]

(iii) describe the features of producers.

.....

.....

.....

.....

.....[3]

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(b) Studies on the energy efficiency of raising catfish in ponds have shown that only 15–20% of the energy taken in by the catfish population in their food is used to increase their total biomass.

(i) Explain why only some of the energy taken in by the catfish is used to increase biomass.

.....

.....

.....

.....

.....

.....[3]

(ii) In the wild, only about 10% of the energy taken in by the catfish in their food is used to increase biomass.

Suggest why this percentage is lower in the wild than in the pond.

.....

.....

.....[1]

[Total: 12]

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