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General Certificate of Education
Advanced Subsidiary Level and Advanced Level

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BIOLOGY **9700/21**

Paper 2 Structured Questions AS **October/November 2010**

1 hour 15 minutes

Candidates answer on the Question Paper.

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Total	

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1 **(a)** Complete the passage with the most appropriate term.

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Within each ecosystem there is a ..... of organisms that interact with each other and with their environment. Each species fills a particular ..... within the ecosystem. Feeding relationships in food webs are an example of the interactions species have with each other. In old field ecosystems in North America, producers, such as blue grass, provide energy for grazing animals. These animals form the .... in the food chain. [3]

(b) Very little of the energy consumed by grazing animals is available to carnivores.

State two reasons why this is so.

1. .....

.....

2. .....

.....[2]

[Total: 5]

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2 **(a)** Table 2.1 shows some of the structures in different parts of the gas exchange system.

Complete Table 2.1 by indicating with a tick (✓) if the structure is present in each part of the gas exchange system or a cross (✗) if it is not.

Table 2.1

structure	trachea	bronchus	bronchiole	alveolus
ciliated epithelium				
goblet cells				
cartilage				
smooth muscle				

[4]

(b) An exercise physiologist investigated aspects of breathing in an athlete.

The minute volume is the volume of air breathed in during one minute.

The data recorded is in Table 2.2.

Table 2.2

vital capacity / dm^3	breathing rate at rest / breaths min^{-1}	minute volume / dm^3
5.8	11	5.5

(i) Explain how the physiologist would determine the vital capacity of the athlete.

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.....[2]

(ii) Calculate the athlete's tidal volume.

Answer = ...[1]

(c) Fig. 2.1 shows a cross section of a coronary artery partially blocked by plaque causing atherosclerosis.

For Examiner's Use

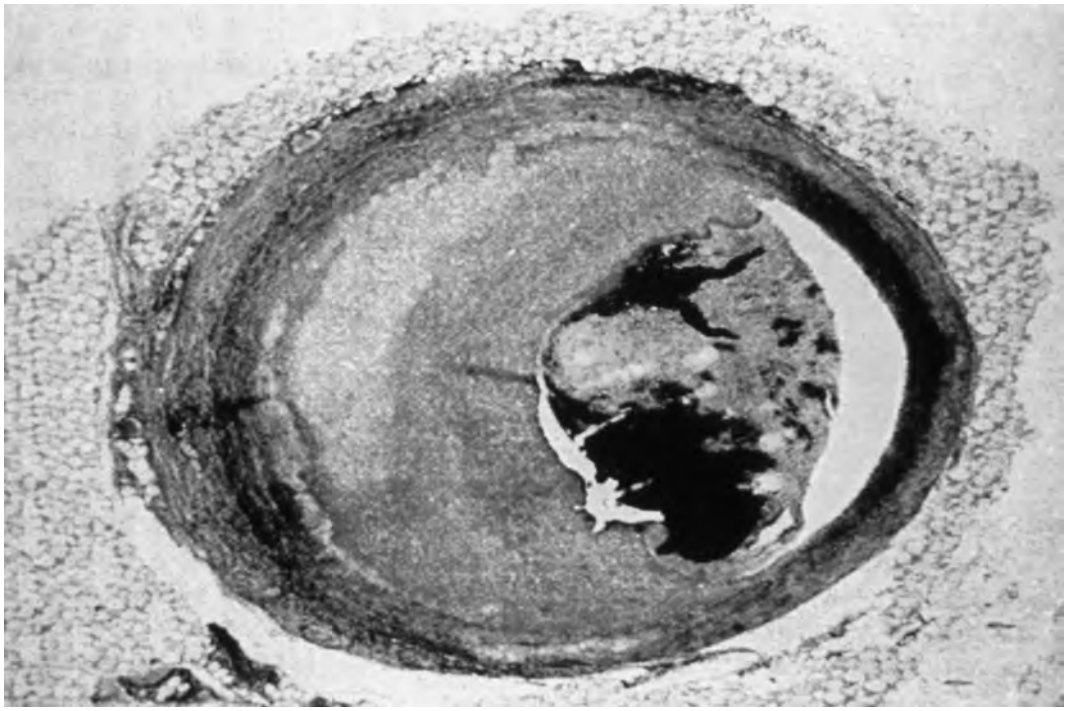


Fig. 2.1

Explain why atherosclerosis in coronary arteries may limit the ability of people to take vigorous exercise.

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.....[3]

(d) Describe the effects of nicotine and carbon monoxide in cigarette smoke on the cardiovascular system.

For Examiner's Use

nicotine .....

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carbon monoxide .....

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.....[3]

[Total: 13]

3 Red blood cells are suspended in plasma which has a concentration equivalent to that of 0.9% sodium chloride (NaCl) solution.

For Examiner's Use

A student investigated what happens to red blood cells when placed into sodium chloride solutions of different concentration.

A small drop of blood was added to 10 cm^3 of each sodium chloride solution. Samples were taken from each mixture and observed under the microscope. The number of red blood cells remaining in each sample was calculated as a percentage of the number in the 0.9% solution. The results are shown in Fig. 3.1.

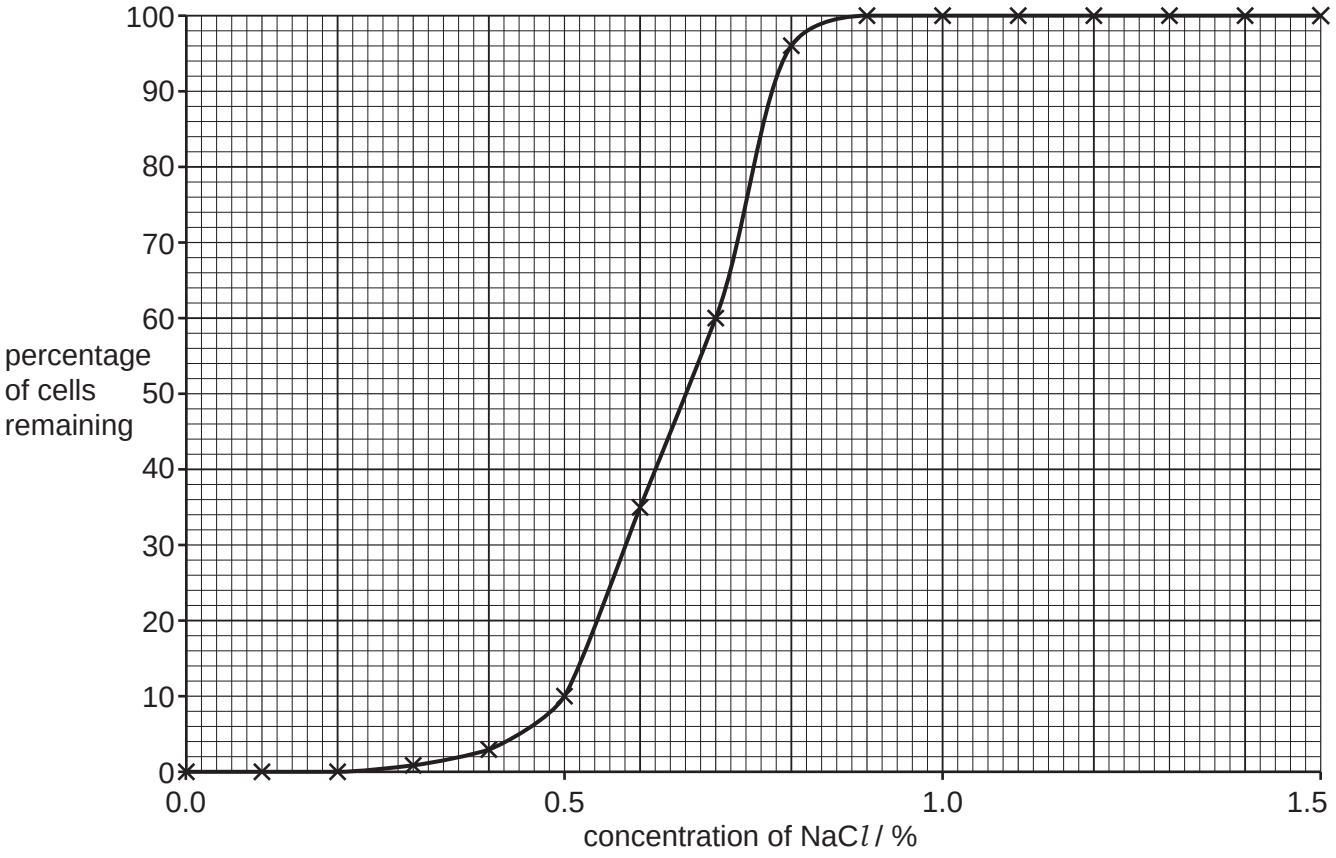


Fig. 3.1

(a) With reference to Fig. 3.1, describe the student's results.

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..... [3]

The student also measured the cell volumes of the red blood cells in three of the sodium chloride solutions. The results are shown in Table 3.1.

For Examiner's Use

Table 3.1

concentration of sodium chloride /%	mean red cell volume / μm^3
0.7	120
0.9	90
1.5	65

Fig. 3.2 shows the appearance of some red blood cells removed from the 1.5% sodium chloride solution.

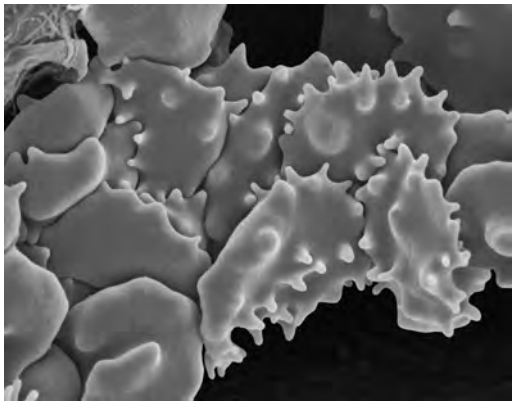


Fig. 3.2

(b) Explain the results shown in Fig. 3.1, Table 3.1 and Fig. 3.2, in terms of **water potential**.

0% NaCl solution .....

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0.7% NaCl solution .....

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1.5% NaCl solution .....

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.....[6]

Red blood cells each contain about 240 million molecules of haemoglobin that transport oxygen and carbon dioxide.

For Examiner's Use

(c) Describe the role of haemoglobin in the **transport** of oxygen and carbon dioxide.

oxygen .....

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.....

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carbon dioxide .....

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.....[4]

(d) The haematocrit is the proportion of the blood that is composed of red blood cells. Samples of blood were taken from an athlete who lived at sea level since birth and moved to live and train at an altitude of 5000 m for three weeks. The haematocrit and the number of red blood cells per mm^3 were determined before moving to high altitude and after three weeks at that altitude. The results are shown in Table 3.2.

Table 3.2

altitude	haematocrit	number of red blood cells × 10^6 per mm^3
sea level	0.45	6.1
5000 m (after three weeks)	0.53	7.3

(i) Calculate the percentage increase in the number of red blood cells per mm^3 after three weeks at 5000 m. Show your working.

Answer = ... % [2]

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(ii) Explain why the haematocrit increases at altitude.

For Examiner's Use

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.....[3]

[Total: 18]

4 Cholera bacteria release the enzyme neuraminidase which alters some of the surface proteins on the membranes of epithelial cells in the small intestine.

For Examiner's Use

These surface molecules become receptors for the toxin, choleragen, released by cholera bacteria. The toxin stimulates the cells to secrete large quantities of chloride ions into the lumen of the small intestine. Sodium ions and water follow the loss of chloride ions.

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

.....[1]

(ii) Suggest how chloride ions are moved from the epithelial cells into the lumen of the small intestine.

.....

.....[1]

(iii) Explain how cholera bacteria are transmitted from one person to another.

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.....[3]

A potential vaccine for choleragen was trialled on volunteers. Fig. 4.1 shows the concentration of antibodies against choleragen in the blood of a volunteer who received a first injection at week 0, followed by a booster injection at week 15.

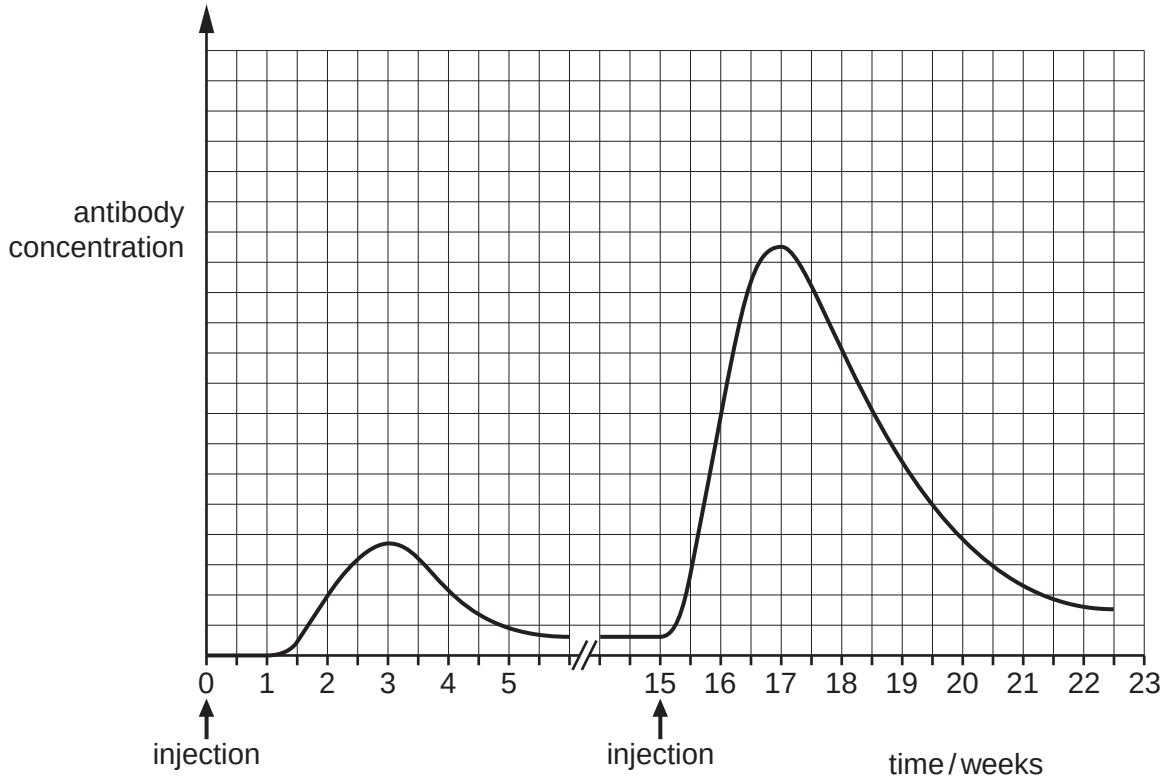


Fig. 4.1

(b) Using the information in Fig. 4.1, explain the differences between the responses to the first injection and the booster injection.

For Examiner's Use

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.....[4]

(c) Discuss the problems involved in preventing the spread of cholera.

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.....[4]

[Total: 13]

For Examiner's Use

5 **(a)** Cellulose is a polysaccharide.

Fig. 5.1 shows three sub-units from a molecule of cellulose.

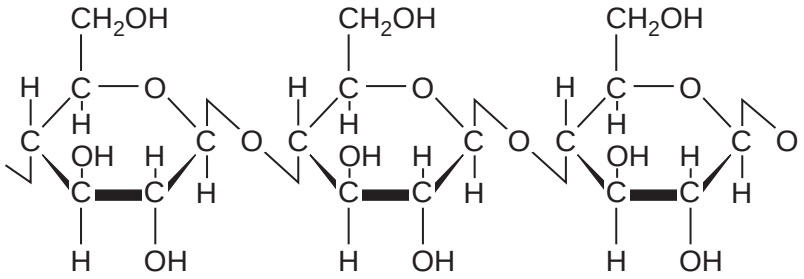


Fig. 5.1

(i) Name the sub-unit molecule of cellulose.

.....[1]

(ii) Name the bonds that attach the sub-unit molecules together within cellulose.

.....[1]

(b) Cellulose has high mechanical strength which makes it suitable for the cell walls of plants.

Explain how cellulose has such a high mechanical strength making it suitable for the cell walls of plants.

.....

.....

.....

.....[2]

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Plant cell walls consist of cellulose that is embedded in a matrix of compounds, such as pectins and proteins.

For Examiner's Use

Cell wall material is synthesised inside the cell and transported to the cell surface membrane as shown in the drawing made from an electron micrograph in Fig. 5.2.

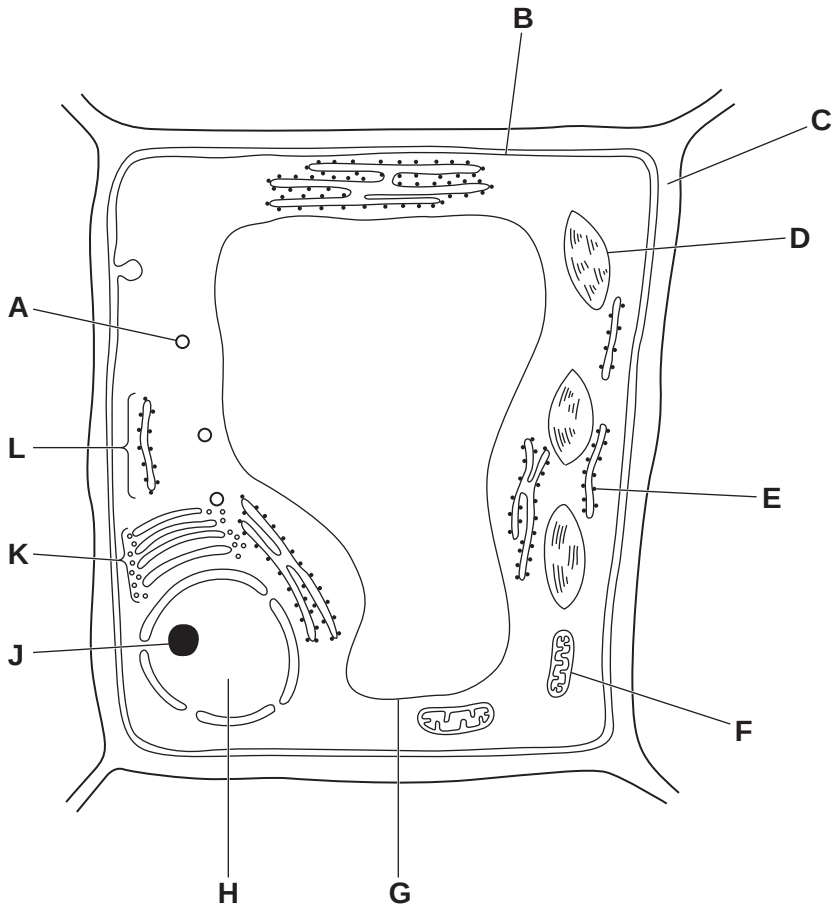


Fig. 5.2

(c) Locate the parts of the cell labelled in Fig. 5.2 which apply to each of the following statements. You must only give one letter in each case. You may use each letter once, more than once or not at all. The first answer has been completed for you.

statement	letter from Fig. 5.2
organelle that contains DNA	**H**
transports cell wall material to the cell surface membrane	
site of transcription	
site of ribosome synthesis	
site of photosynthesis	

[4]

(d) Enzymes known as expansins are found in the matrix of cell walls to help the growth of cells.

For Examiner's Use

Use the information in Fig. 5.2 to describe how proteins made by the ribosomes reach the matrix of the cell wall.

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.....[3]

[Total: 11]

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Fig. 3.2 Steve Gschmeissner / Science Photo Library

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BIOLOGY **9700/22**

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Answer **all** the questions.

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1 Protein production involves a complex sequence of events and a number of cell structures.

(a) The first column in Table 1.1 shows some of the events that occur in the production of a protein in a cell and its eventual release from the cell.

Table 1.1

event	sequence of events (numbers)	cell location (letters)
exocytosis		
protein modification		
secretory vesicle formation		
transcription		
translation		

(i) In Table 1.1, write the sequence in which the events occur, using **1** as the **first** process in the sequence. [2]

(ii) From the list **A** to **F** below, choose **one** cell location for each event and write the letter in Table 1.1. Each letter may be used once, more than once, or not at all.

A Golgi apparatus
B lysosome
C nucleus
D rough endoplasmic reticulum
E smooth endoplasmic reticulum
F plasma (cell surface) membrane [3]

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(b) Describe the process of *exocytosis*.

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..... [3]

(c) One example of protein modification is the removal of the first amino acid, methionine, from a newly formed polypeptide chain to make a functioning protein.

(i) The DNA nucleotide sequence that specifies the amino acid methionine is TAC.

State the mRNA nucleotide sequence that is complementary to the DNA sequence for methionine.

..... [1]

(ii) Suggest **two** other ways in which the polypeptide chain is modified to produce the functioning protein.

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..... [2]

[Total: 11]

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[Turn over

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2 Malaria is an infectious disease that is considered by the World Health Organization to be a disease of worldwide importance.

(a) Explain what is meant by the term *infectious*.

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..... [2]

(b) Name **one** species of organism that causes malaria.

..... [1]

(c) Explain the significance of the following statements in the control of malaria.

(i) The female *Anopheles* mosquito has been more closely studied with regard to malaria than the male *Anopheles* mosquito.

.....

..... [1]

(ii) The infective stages of the malarial organism are present in anti-coagulant produced by the mosquito.

.....

..... [1]

(iii) After circulating in the blood for a short time, the pathogen enters liver cells of the newly infected person and then enters red blood cells.

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..... [2]

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(d) Discuss the factors that determine the distribution of malaria worldwide.

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..... [4]

[Total: 11]

For Examiner's Use

3 **(a)** Enzymes are globular proteins that catalyse metabolic reactions.

Describe the features of globular proteins.

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..... [3]

(b) Enzymes can be used to remove cell walls from plant and fungal cells. The cells are incubated in a solution that contains a mixture of enzymes.

(i) Suggest an explanation for the fact that a different mixture of enzymes is required to remove the walls of plant cells compared to the walls of fungal cells.

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..... [2]

(ii) Explain why, when plant cells are incubated with enzymes to remove their cell walls, it is important to maintain an optimum pH.

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..... [3]

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(c) A student carried out an investigation into osmosis using red blood cells.

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Red blood cells were placed in sodium chloride (salt) solutions at five different concentrations. For each concentration, a sample was added immediately to a microscope slide and the cells were viewed using a light microscope for a period of time. The observations recorded are shown in Table 3.1.

Table 3.1

concentration of salt solution / %	observation of red blood cells
0.0	swell and burst, numbers decrease
0.4	increase in size
0.9	remain the same size
1.5	decrease in size
3.0	smaller and shrivelled

Explain, in terms of **water potential** and osmosis, the results that the student obtained.

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..... [4]

For Examiner's Use

(d) The student also carried out a similar investigation using plant cells with cell walls removed. These cells were suspended in a 12% mannitol solution so that the water potential inside and outside of the cells was equal.

Fig. 3.1 is a photomicrograph of these cells.

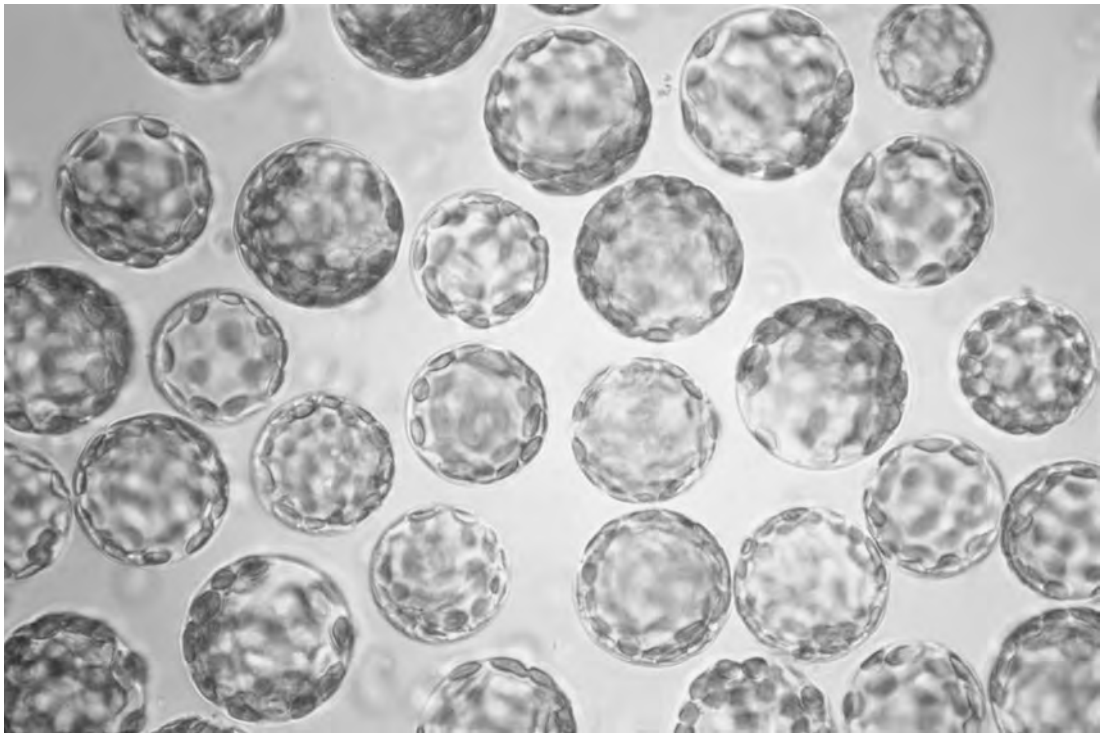


Fig. 3.1

The student removed a sample of these cells. The sample was placed into distilled water and was viewed using a light microscope.

Describe what you would expect the student to observe and explain why this would not occur with normal plant cells.

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..... [2]

[Total: 14]

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4 Fig. 4.1 is an incomplete flow chart showing some of the events of the primary immune response that occur after a person has been given a vaccine.

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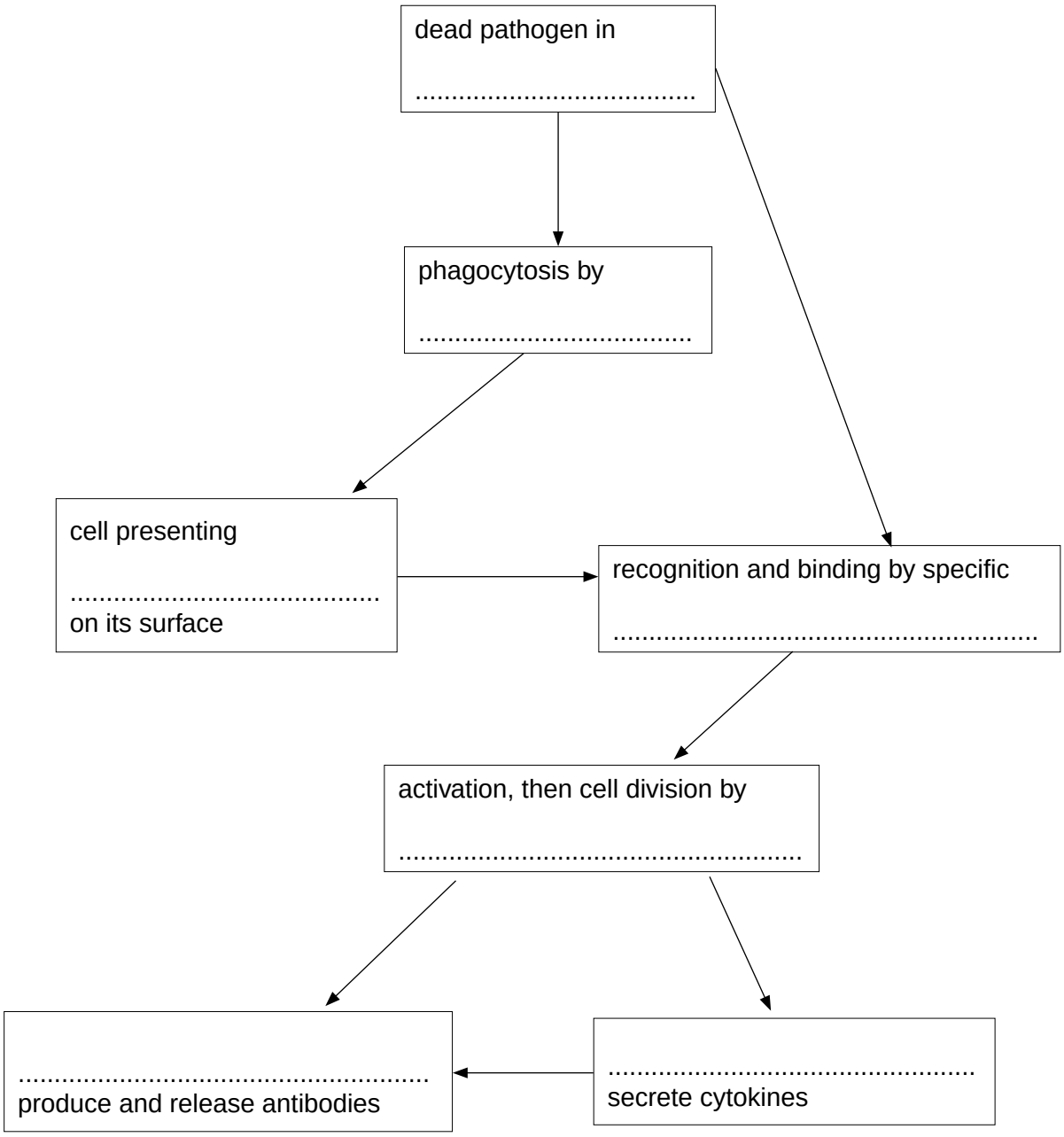


Fig. 4.1

(a) Choose the correct term from the list below to complete Fig. 4.1.

lymphocytes	**antigens**	**mitosis**	**vaccine**
T_h-lymphocytes	**plasma cells**	**macrophages**	

[3]

(b) Explain why the person is unlikely to become ill if they are infected by the same pathogen some months later.

For Examiner's Use

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..... [3]

(c) Some parents decide that their children should not take part in a vaccination schedule.

Suggest how a country-wide vaccination schedule can give protection against infection to **unvaccinated** children.

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..... [2]

[Total: 8]

5 State the term that applies to each of the descriptions **(a)** to **(e)**.

For Examiner's Use

(a) Storage polysaccharide in animals made of chains of 1,4 linked α-glucose with 1,6 linkages forming branches.

..... [1]

(b) A plant that has adaptations to enable it to live in areas where water is in short supply.

..... [1]

(c) Any cell containing one complete set of chromosomes.

..... [1]

(d) The name of the trophic level to which photosynthetic organisms belong.

..... [1]

(e) A process carried out by bacteria that involves the conversion of atmospheric nitrogen into nitrogenous compounds that can be used directly by plants.

..... [1]

[Total: 5]

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6 Fig. 6.1 is a section through lung tissue showing an alveolus and its blood supply.

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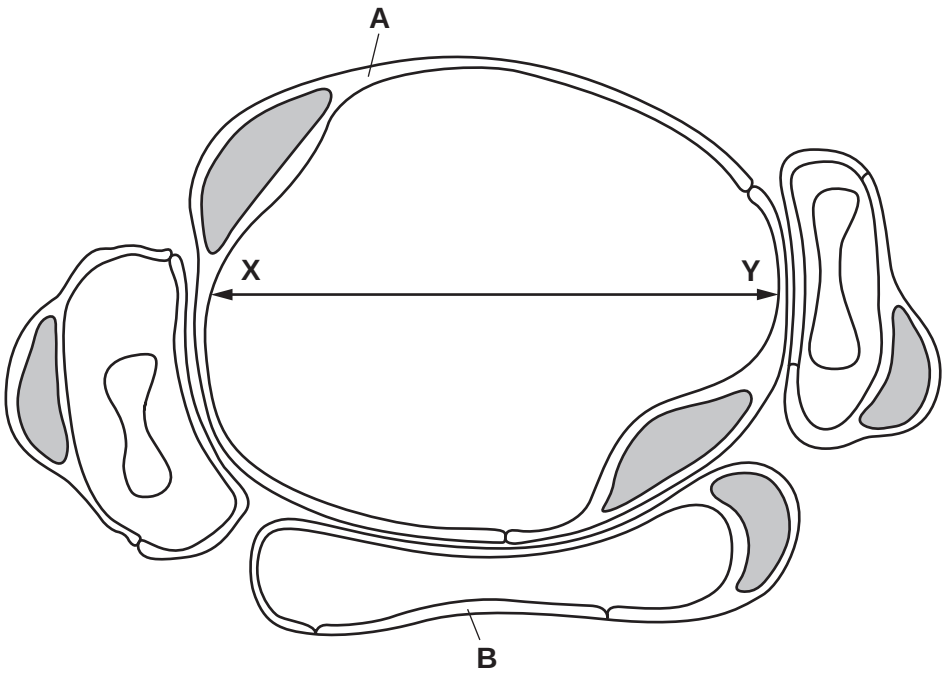


Fig. 6.1

(a) **(i)** Name the type of epithelial cell shown by label lines **A** and **B**.

..... [1]

(ii) Describe how the elastic fibres of the alveoli contribute to the healthy functioning of the lungs.

.....

.....

.....

..... [2]

(b) The actual diameter of the alveolus along the line **X**–**Y** is 220 micrometres (µm). Calculate the magnification of Fig. 6.1.

Show your working and give your answer to the nearest whole number.

answer × ..... [2]

(c) Outline two features of a gas exchange surface **that are shown on Fig. 6.1**.

1. .....

.....

2. .....

..... [2]

(d) Fig. 6.2 is a simplified diagram of the circulatory system of a human, showing gas exchange in the lungs and in respiring tissue. The partial pressures of oxygen (pO_2) and carbon dioxide (pCO_2) at four locations are also shown.

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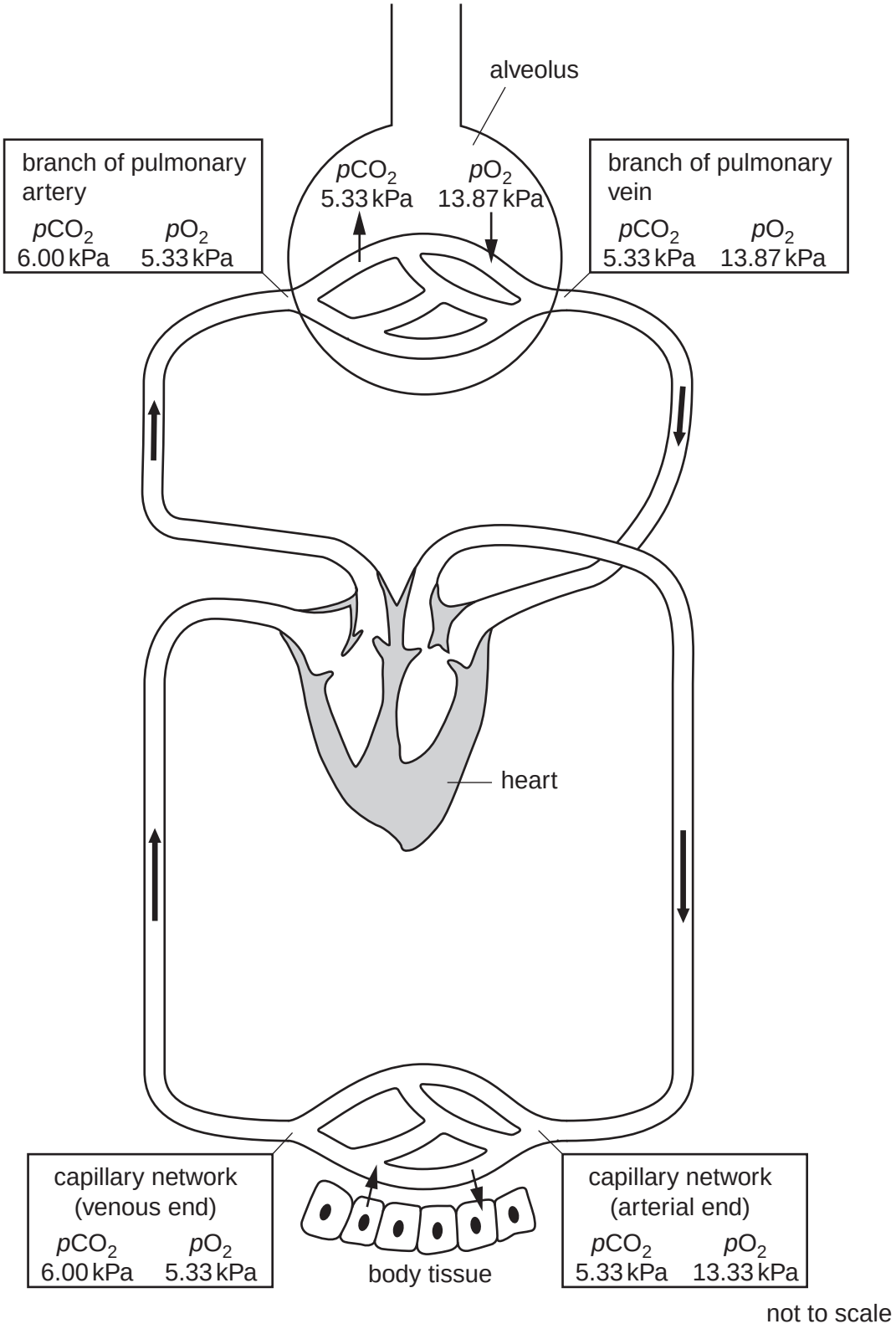


Fig. 6.2

With reference to Fig. 6.2, explain how the differences in *p*O2 and pCO_2 in the alveolus and in blood enable gas exchange in the lungs **and** respiring tissue.

For Examiner's Use

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..... [4]

[Total: 11]

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BIOLOGY **9700/23**

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1 Fig. 1.1 shows a diagram of part of a cell surface membrane.

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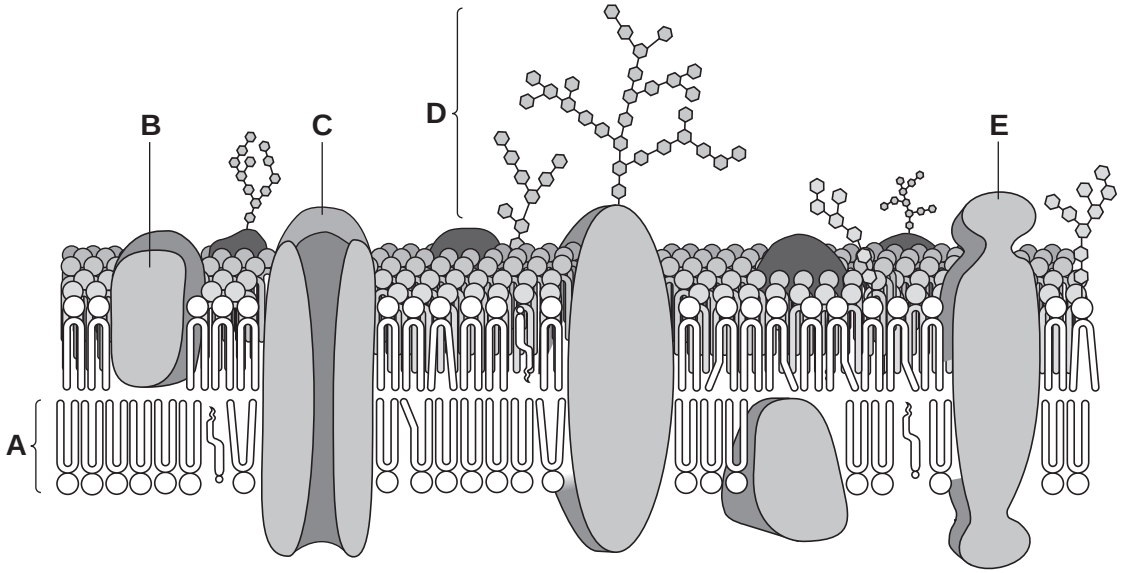


Fig. 1.1

(a) (i) Name molecules **A** and **B**.

A .....

B .....[2]

(ii) Explain how the features of molecules of **A** cause them to form a layer in the membrane as seen in Fig. 1.1.

.....

.....

.....

.....

.....[3]

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(b) State the functions of **C** and **D**.

For Examiner's Use

C .....

.....

D .....

.....[2]

(c) Structure **E** is a protein composed of 588 amino acids.

Calculate the minimum number of nucleotide base pairs required in the gene coding for this protein. Show your working.

Answer = ...[2]

[Total: 9]

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[Turn over

2 Fig. 2.1 shows a world map shaded by country according to the incidence of tuberculosis (TB).

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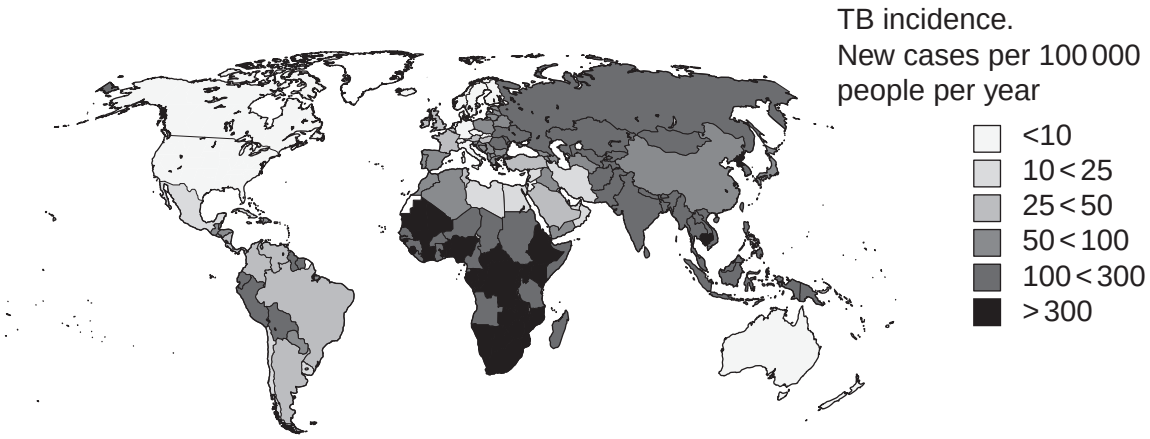


Fig. 2.1

(a) State the name of the pathogenic organism which causes TB and describe its mode of transmission from infected to uninfected people.

name of organism .....

mode of transmission .....

.....

.....[3]

(b) People suffering from TB are treated using antibiotics. Recently, multi-drug resistant TB (MDR-TB) has developed, making the disease more difficult to treat.
Suggest how this drug resistance may have arisen.

.....

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.....[2]

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(c) The World Health Organization (WHO) aims to eradicate TB worldwide by 2050. With reference to Fig. 2.1, discuss the problems to be faced in the eradication of TB.

For Examiner's Use

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.....[5]

[Total: 10]

3 The enzyme sucrase is used by many organisms for the hydrolysis of sucrose. Fig. 3.1 shows a diagram of the enzyme and its substrate.

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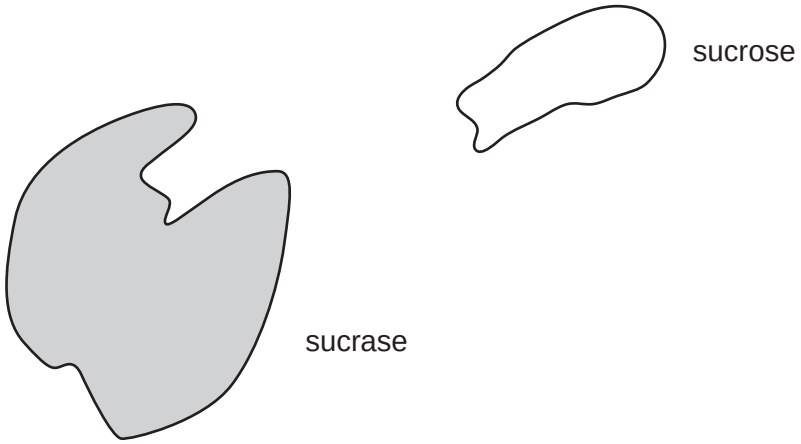


Fig. 3.1

(a) (i) State the names of the products of the hydrolysis of sucrose.

.....[1]

(ii) With reference to Fig. 3.1, describe the mechanism of action of the enzyme in converting the substrate to products.

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.....[4]

(iii) Copper ions (Cu^{2+}) will inhibit the enzyme sucrase.
Suggest which type of inhibition occurs.

.....[1]

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(b) Sucrose is one of the assimilates transported in the phloem sieve tubes of plants from source to sink. Sucrase is found in sinks.

(i) Suggest the role played by sucrase in the process of unloading of sucrose at sinks.

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.....[2]

(ii) Plant sink organs convert excess products of sucrose hydrolysis to storage molecules, such as starch.

Explain why these products of hydrolysis themselves cannot be stored in plant tissue.

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.....[3]

[Total: 11]

For Examiner's Use

4 **(a)** Outline the roles of the T-lymphocytes and B-lymphocytes in a primary immune response.

T-lymphocytes .....

.....

.....

.....

B-lymphocytes .....

.....

.....

.....[4]

Fig. 4.1 shows how the concentration of antibody in blood plasma changes during the response to an antigen which is injected at day 0.

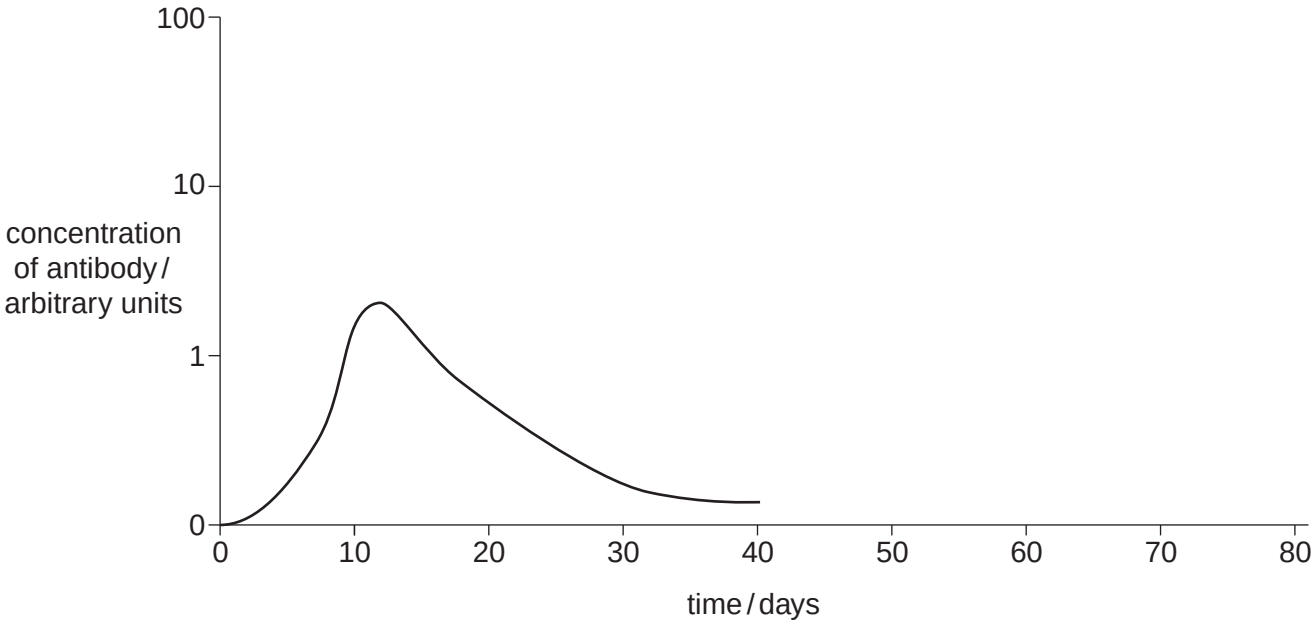


Fig. 4.1

(b) Explain why the concentration of antibody falls as shown in Fig. 4.1.

For Examiner's Use

.....

.....

.....

.....

.....[3]

(c) Draw on Fig. 4.1 how the antibody concentration would change if the **same** antigen entered the blood plasma on day 40. [3]

[Total: 10]

5 **(a)** Describe and explain how the structure of alveoli is adapted for efficient gas exchange.

For Examiner's Use

.....

.....

.....

.....

.....[3]

Fig. 5.1 shows a cross-section of normal human alveoli and Fig. 5.2 shows a cross-section of alveoli from a person suffering from emphysema.

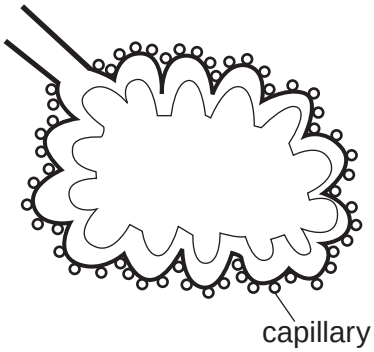


Fig. 5.1

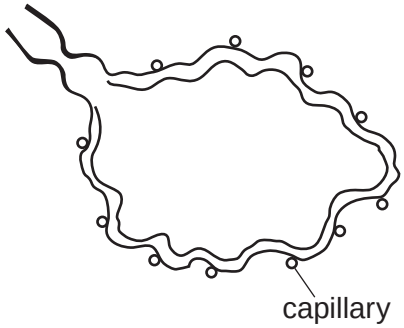


Fig. 5.2

(b) **(i)** State the most common cause of emphysema.

.....[1]

(ii) With reference to changes visible in Fig. 5.1 and Fig. 5.2, state and explain the effect of emphysema on the alveoli and on gas exchange.

.....

.....

.....

.....[2]

(c) State three symptoms of emphysema.

For Examiner's Use

1. .....

.....

2. .....

.....

3. .....

.....[3]

[Total: 9]

6 Fig. 6.1 shows the directions of **nutrient flow** in a soil food web.

For Examiner's Use

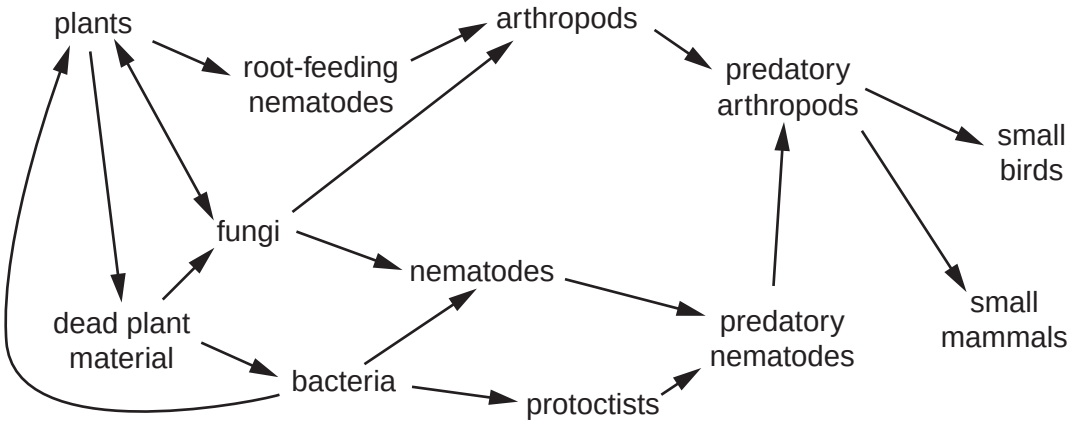


Fig. 6.1

(a) (i) Magnesium is an example of a nutrient required by organisms.
State **one** role of magnesium in organisms.

.....[1]

(ii) State, in terms of **nutrient flow**, the significance of the double-headed arrow between plants and fungi.

.....

.....

.....

.....[2]

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(b) The small birds shown in Fig. 6.1 are preyed upon by larger birds.

For Examiner's Use

(i) State which trophic level these larger birds occupy.

.....[1]

(ii) Some large animals feed on more than one trophic level.
Suggest why this is so.

.....

.....

.....

.....[2]

(c) Communities of organisms, in soil habitats, have been described by biologists as "the driving force for the environment".

(i) Define the terms

community .....

.....

habitat .....

.....[2]

(ii) Suggest what is meant by the term "driving force for the environment".

.....

.....

.....

.....

.....

.....[3]

[Total: 11]

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