ECOLOGY & HUMAN PHYSIOLOGY

QUESTIONS BOOKLET

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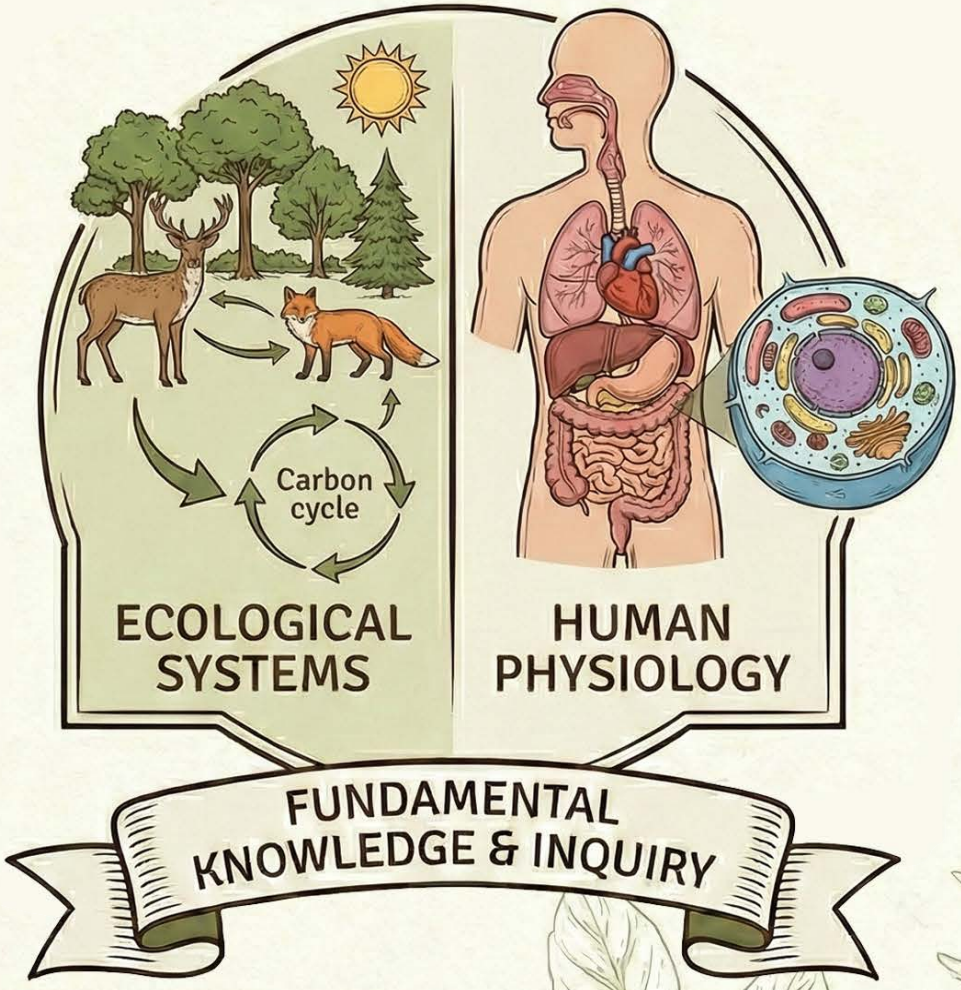
TEAM BIOCARDIA



INDEX

Digestive System

2 **(a)** A person ate a meal containing starch and fat.

Fig. 2.1 shows some events that occurred after ingesting this meal.

P	absorption of nutrients in the villi
Q	assimilation of fatty acids in the liver
R	breakdown of large food particles by the teeth
S	movement of small food particles through the oesophagus
T	secretion of amylase from the salivary glands

Fig. 2.1

Put the events in Fig. 2.1 into the correct sequence. One has been done for you.

R				

[2]

(b) The stomach lining contains cells that secrete proteins.

(i) State the names of **two** cell structures that are involved in making or secreting proteins.

1 .....

2 .....

[2]

(ii) State the name of **one** component of gastric juice **and** describe its functions.

.....

.....

.....

.....

.....

.....

.....

[3]

(iii) There are goblet cells in many parts of the alimentary canal.

State the substance that goblet cells secrete.

..... [1]

(c) Emulsification of fats occurs in the alimentary canal.

(i) Describe the process of emulsification of fats.

.....

.....

.....

.....

..... [2]

(ii) State the name of the organ in the alimentary canal where fats are emulsified.

..... [1]

(iii) State the name of the structure in the villi where digested fats are absorbed.

..... [1]

[Total: 12]

2 Fig. 2.1 is a vertical section of a human molar tooth and surrounding structures.

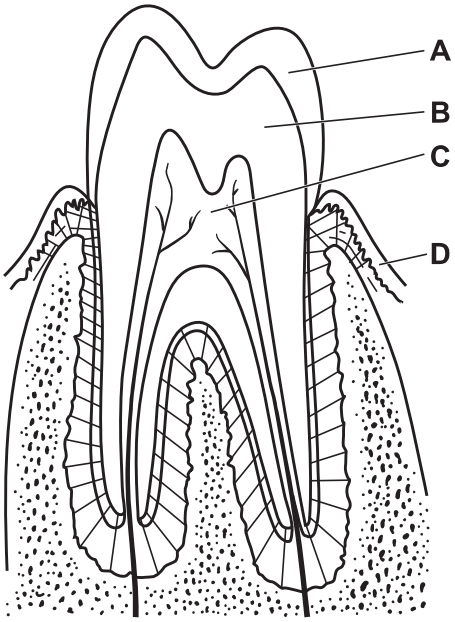


Fig. 2.1

(a) State the names of the parts labelled **A** to **D** on Fig. 2.1.

A .....

B .....

C .....

D .....

[4]

(b) Describe **and** explain the function of molar teeth.

.....

.....

.....

.....

.....

.....

..... [3]

5 Milk is a source of some of the nutrients that are part of a balanced diet.

(a) Calcium and protein are two nutrients found in milk.

Describe the importance of calcium and protein in the diet.

calcium .....

.....

.....

protein .....

.....

.....

[4]

(b) Lactose is found in cows' milk. Some people do not have the enzyme to digest lactose.

State the names of **two** organs, associated with the alimentary canal, that produce enzymes.

1 .....

2 .....

[2]

Digestive System

2

1 **(a)** State **three** uses of energy in the human body.

1 .....

2 .....

3 .....

[3]

(b) Fig. 1.1 shows part of the digestive system of a human.

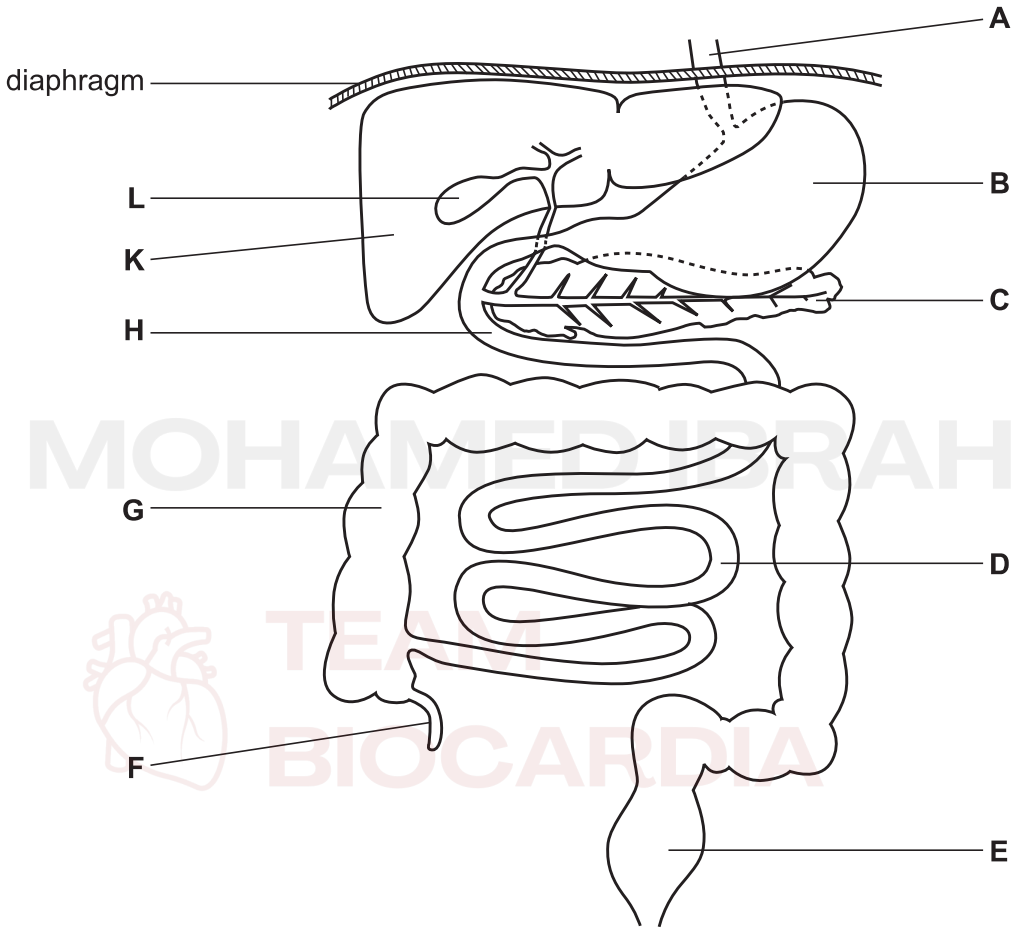


Fig. 1.1

Digestive System

3

Complete Table 1.1. One row has been done for you.

Table 1.1

function	name of structure	letter from Fig. 1.1
pushes food to the stomach	oesophagus	**A**
assimilation of amino acids to produce plasma proteins		
storage of bile		
secretion of insulin		
absorption of fatty acids and glycerol		
secretion of pepsin		
digestion of starch		

[6]

3 **(a)** Dialysis tubing is an artificial membrane, which is similar to the lining of the intestine.

A student investigated the diffusion of glucose through dialysis tubing by using the apparatus shown in Fig. 3.1.

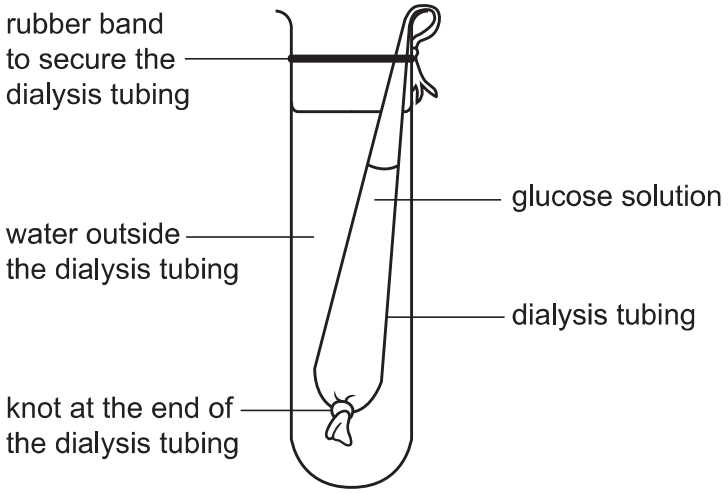


Fig. 3.1

The student took samples of the water outside the dialysis tubing at 5 minute intervals and tested the samples with Benedict's solution.

The results are shown in Table 3.1.

Table 3.1

time / minutes	results of the Benedict's tests on the water outside the dialysis tubing
0	blue
5	green
10	yellow
15	red

(i) Describe and explain the results shown in Table 3.1.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) The student repeated the investigation with a higher concentration of glucose in the dialysis tubing.

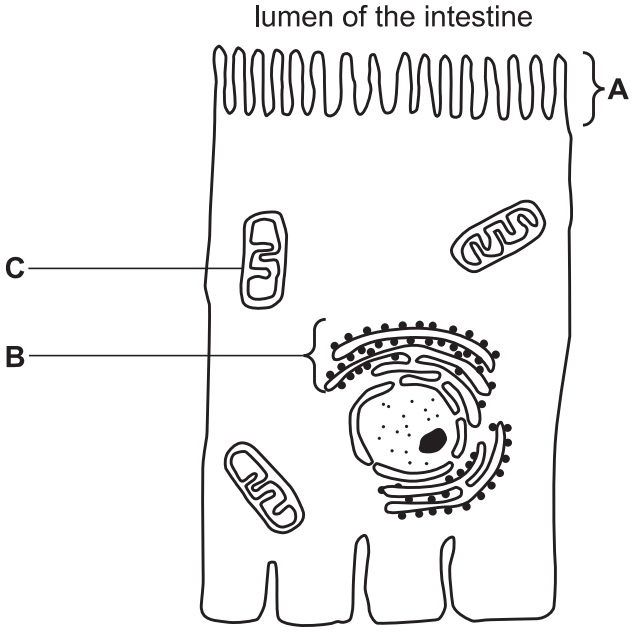
Predict the results that the student would observe.

.....

.....

..... [1]

(b) Fig. 3.2 shows a drawing of a cell from the lining of the small intestine. The lumen is the space inside the intestine where food is digested.



not to scale

Fig. 3.2

State the names of the **three** labelled structures in Fig. 3.2 **and** describe the role of each structure in the intestinal cell.

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.....

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.....

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.....

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.....

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..... [6]

(c) The cholera bacterium can survive in the small intestine and the large intestine. The bacterium releases a toxin that interacts with receptors on the surface of cells.

Fig. 3.3 shows the effect of the toxin. The arrows indicate the direction of movement.

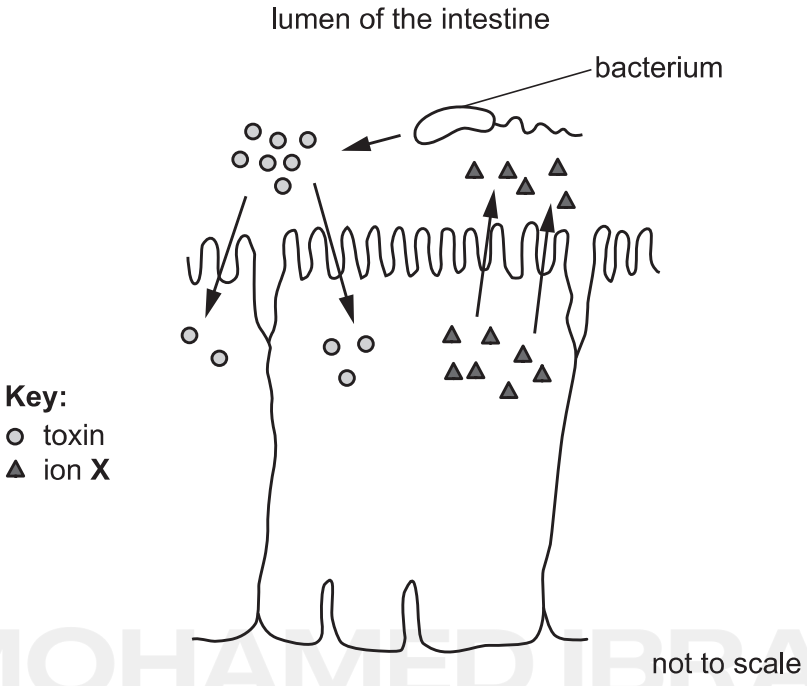

Fig. 3.3

The toxin stimulates the secretion of ion **X** out of the intestinal cell.

(i) State the name of ion **X**.

..... [1]

(ii) Describe the effects on the body of the secretion of ion **X** into the lumen of the intestine.

.....

.....

.....

.....

.....

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.....

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..... [4]

[Total: 15]

3 Carbohydrates are an important component of a balanced diet.

The flow chart in Fig. 3.1 shows some of the processes that happen to carbohydrates in food that is eaten.

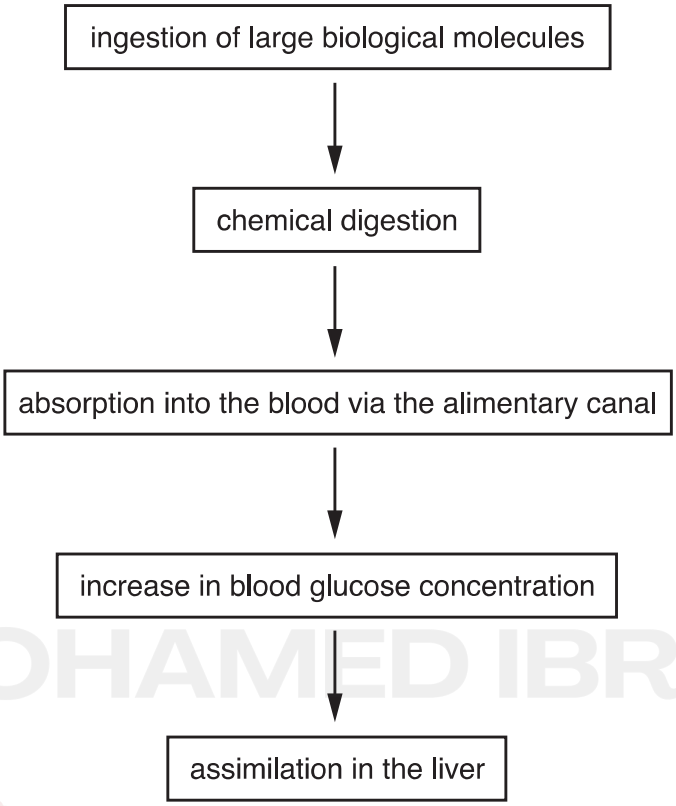

Fig. 3.1

Digestive System

9

(a) Describe what happens to carbohydrates in the human body between ingestion and assimilation in the liver.

Use the information in Fig. 3.1 as a guide.

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..... [8]

(b) Mineral salts are another important component of a balanced diet.

State the importance of calcium ions and iron ions in a balanced diet.

calcium ions .....

.....

.....

iron ions .....

.....

.....

[4]

(d) The volunteers were divided into two groups.

The mass of salt consumed by **both** groups was changed every 4 weeks:
- low salt intake for 4 weeks
- medium salt intake for 4 weeks
- high salt intake for 4 weeks.

In addition, group **2** was given other changes to their diet but group **1** was not.

(i) Suggest **one** component of the diet of group **2**, **other than salt**, that the doctors changed to further reduce the risk of developing CHD.

..... [1]

The systolic blood pressure of the volunteers was measured every 4 weeks.
These results are shown in Fig. 3.2.

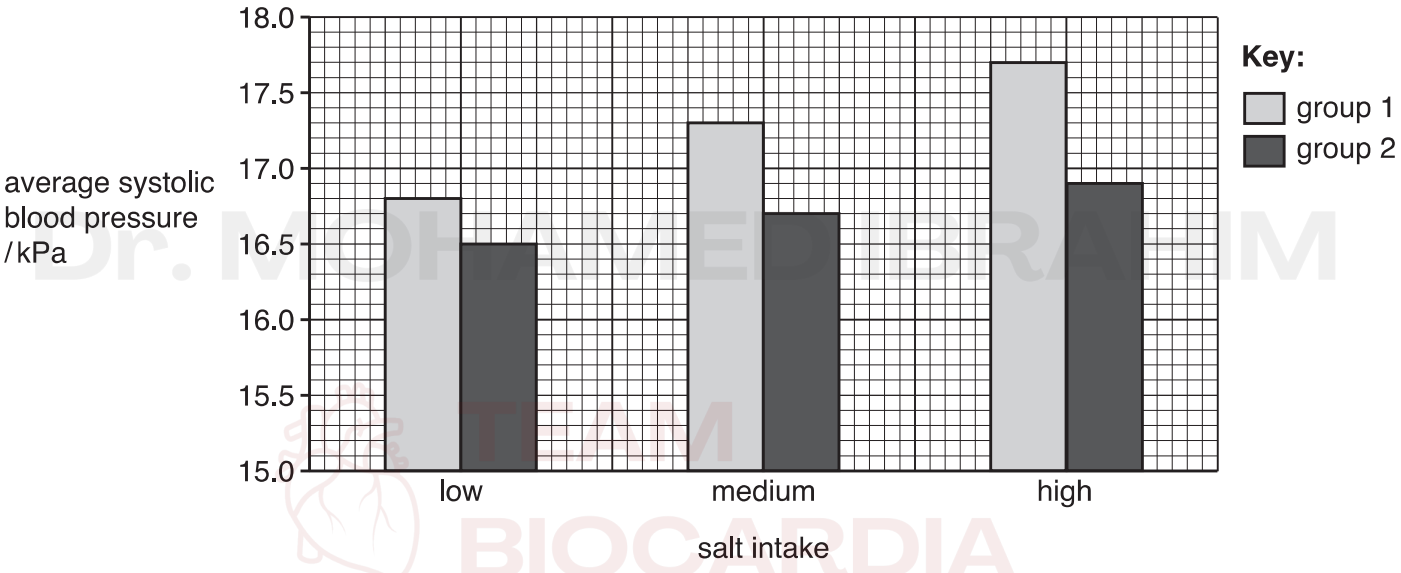

Fig. 3.2

(ii) Calculate the percentage increase in the average systolic blood pressure of the group **1** volunteers when they increased their salt intake from low to high.

low salt intake ..... kPa

high salt intake ..... kPa

Give your answer to the nearest whole number.

Space for working.

..... %
[3]

(iii) The doctors concluded that some diets reduce the risk of CHD.

Give evidence from Fig. 3.2 to support this conclusion.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 23]

3 Cells in the lining of the stomach secrete gastric juice, which contains hydrochloric acid and pepsin.

(a) (i) State **two** roles of hydrochloric acid in the stomach.

1 .....

2 .....
[2]

(ii) Describe the function of pepsin.

.....

.....

.....

..... [2]

(b) Define the term *assimilation*.

.....

.....

.....

..... [2]

(d) The epithelial cells of the small intestine have many microvilli.

State the role of the microvilli.

.....

.....

.....

..... [2]

6 Fig. 6.1 is a photomicrograph of part of a cell from the pancreas that produces enzymes that are released into the small intestine.

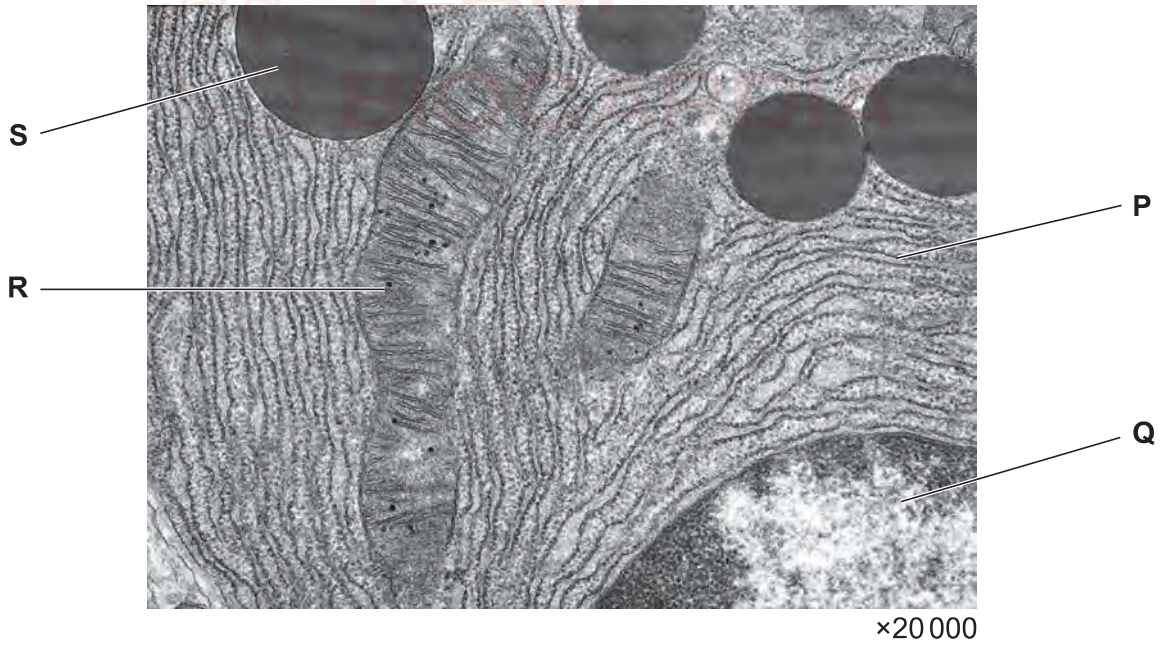

Fig. 6.1

(a) **(i)** Structure **Q** is part of the nucleus of the cell.

State **one** function of a nucleus.

.....

.....

..... [1]

(ii) State the names of the structures labelled **P** and **R** in Fig. 6.1.

P .....

R .....

[2]

(b) The structure labelled **S** transports enzymes to the cell membrane for release into the pancreatic duct. These structures contain molecules of amylase, trypsin and lipase.

Complete the sentences with the most appropriate words.

Enzymes are made of protein and act as ..... because they increase the rate of chemical reactions, but are not changed in those reactions. Amylase speeds up the digestion of ..... to ..... Trypsin continues the chemical digestion of protein begun by the enzyme ..... in the stomach.

The optimum pH for pancreatic enzymes is greater than pH 7. Bile is produced by the ..... and enters the small intestine, where it ..... stomach acid to provide the appropriate pH. Bile also breaks down fat by ..... to increase the surface area for the action of lipase.

[7]

[Total: 10]

(b) Galapagos iguanas feed on seaweed which contains starch and other carbohydrates.

(i) State the name of the enzyme that digests starch.

..... [1]

(ii) State the names of **two** parts of the alimentary canal where starch is digested.

1 .....

2 .....
[2]

(b) The digestive systems of young mammals are not fully developed.

Enzymes such as amylase, maltase and protease are often added to baby food to aid chemical digestion.

(i) Complete Table 6.1 by stating the substrate and product(s) for each enzyme reaction.

Table 6.1

enzyme	substrate	product(s)
amylase		
maltase		
protease		

[3]

(ii) Suggest why the temperature of baby food must be controlled when the enzymes are added.

.....

.....

.....[2]

(iii) State **one** other condition that must also be controlled to optimise enzyme activity.

.....[1]

[Total: 11]

Digestive System

2

1 Two functions of the alimentary canal are mechanical digestion and chemical digestion.

(a) Outline where **and** how mechanical digestion occurs in the alimentary canal.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(b) Enzymes catalyse the reactions of chemical digestion. Table 1.1 gives information about chemical digestion in three parts of the alimentary canal.

Complete Table 1.1.

Table 1.1

part of the alimentary canal	enzyme	substrate	product(s)
mouth		starch	
stomach			peptides
		fat	fatty acids and glycerol

[3]

(b) Explain the importance of chemical digestion.

.....

.....

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.....

.....

.....[2]

(c) Fig. 1.2 shows the human alimentary canal and associated organs.

The functions of some of these parts of the body are given in Table 1.1.

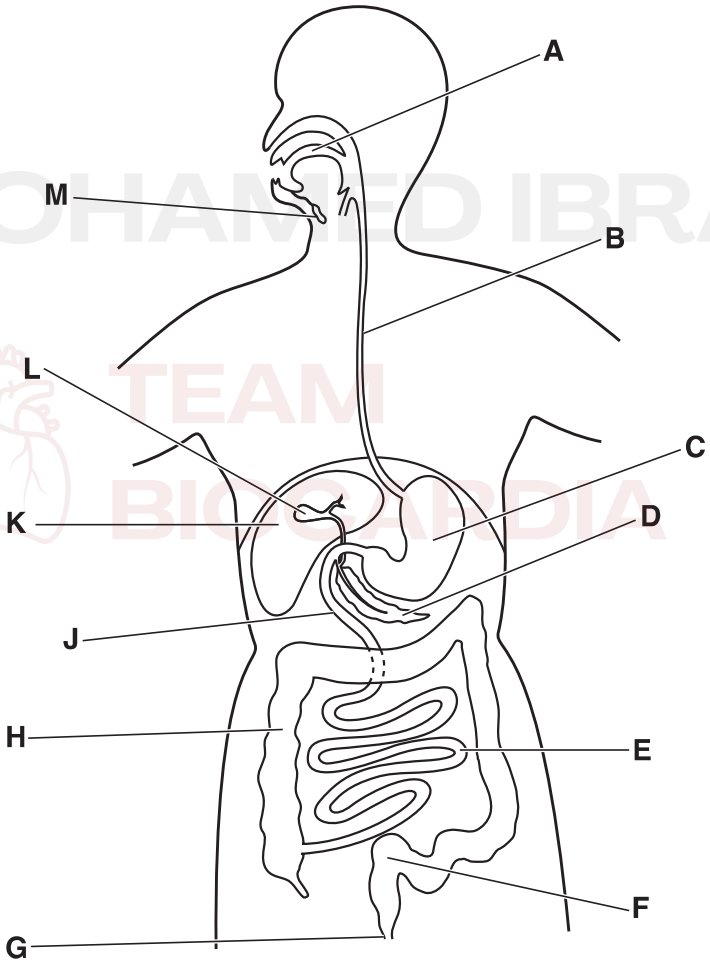


Fig. 1.2

5

Complete Table 1.1. One row has been done for you.

Table 1.1

function	letter from Fig. 1.2	name of structure
site of starch digestion		
reabsorption of water		
secretion of pepsin		
site of maltose digestion		
secretion of bile		
storage of faeces	**F**	rectum
secretion of lipase and trypsin		

[6]

[Total: 12]

6 **(a)** Define the term *chemical digestion*.

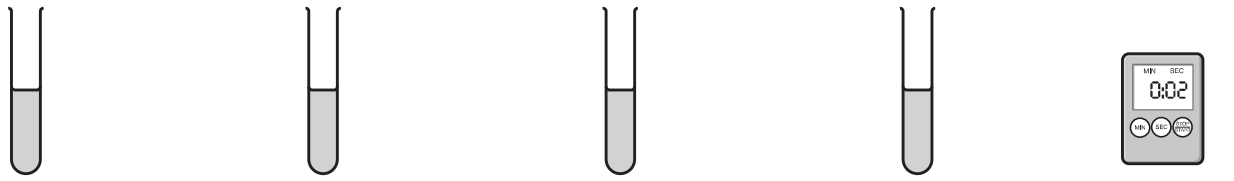
.....

.....

.....[2]

(b) A student investigated the activity of the digestive enzyme pepsin.

Fig. 6.1 shows the apparatus used in the investigation.



test-tube 1
egg white solution and pepsin

test-tube 2
egg white solution, pepsin and hydrochloric acid

test-tube 3
egg white solution, boiled pepsin and hydrochloric acid

test-tube 4
egg white solution and hydrochloric acid

stop-clock

Fig. 6.1

The appearance of the four test-tubes was recorded at 0 and 5 minutes.

The protein in the egg white solution gives the solution a cloudy appearance.

The cloudy appearance clears when the protein in the egg white solution breaks down.

Table 6.1 shows the results.

Table 6.1

test-tube	contents	appearance at 0 mins	appearance after 5 mins
1	egg white solution, pepsin	cloudy	less cloudy
2	egg white solution, pepsin, hydrochloric acid	cloudy	clear
3	egg white solution, boiled pepsin, hydrochloric acid	cloudy	cloudy
4	egg white solution, hydrochloric acid	cloudy	cloudy

(i) Explain the results shown for test-tubes **1**, **2** and **3** in Table 6.1.

.....

.....

.....

.....

.....

.....

.....

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.....

.....

.....[5]

(ii) Explain the purpose of test-tube **4**.

.....

.....

.....

.....

.....[2]

(iii) State the name of the organ in the body that produces pepsin.

.....[1]

(c) Maltase is another digestive enzyme.

Describe the action of maltase **and** state where it acts in the alimentary canal.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 13]

Digestive System

2

1 Fig. 1.1 and Fig. 1.2 show two images of villi.

Fig. 1.1 shows a surface view of many villi viewed through a scanning electron microscope.

Fig. 1.2 shows a section of one villus viewed through a light microscope.

Fig. 1.1

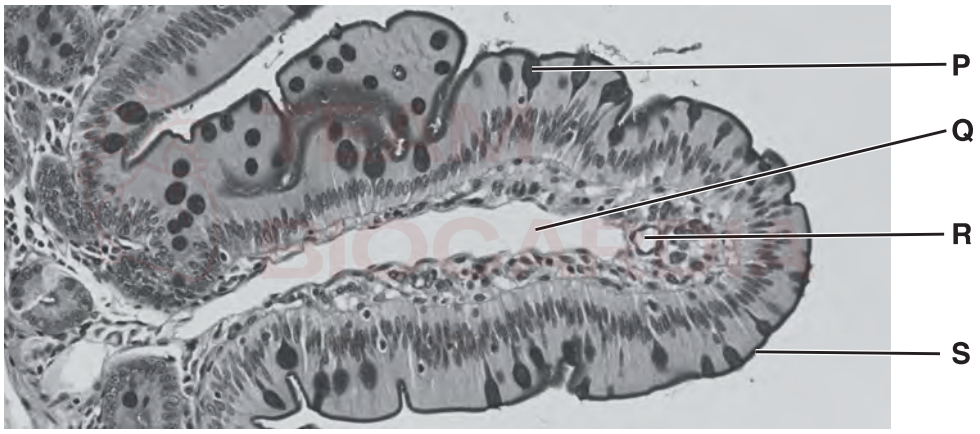

Fig. 1.2

Villi are found in the small intestine.

(a) State the function of villi.

.....

.....[1]

(b) Identify and describe **two** of the labelled components of a villus.

Use the letters in Fig. 1.2 in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(c) Some infections in the small intestine can cause diarrhoea.

(i) Describe the effects of diarrhoea on the body.

.....

.....

.....

.....

.....[2]

(ii) State the treatment for the effects of severe diarrhoea.

.....[1]

(d) **(i)** Blood transports nutrients.

State the component of the blood that transports nutrients.

.....[1]

(ii) The nutrients in the blood can be used to become part of cells.

State the name of this process.

.....[1]

(iii) Amino acids are an example of a type of nutrient transported in the blood.

State **two** examples of larger molecules found in cells that are made from amino acids.

1 .....

2 .....
[2]

[Total: 12]

Digestive System

2

1 Fat is a necessary component of the human diet.

(a) State **three** ways in which the human body uses fat.

1.....

2.....

3.....

[3]

The arrows in Fig. 1.1 show the pathway of fat in part of the alimentary canal.

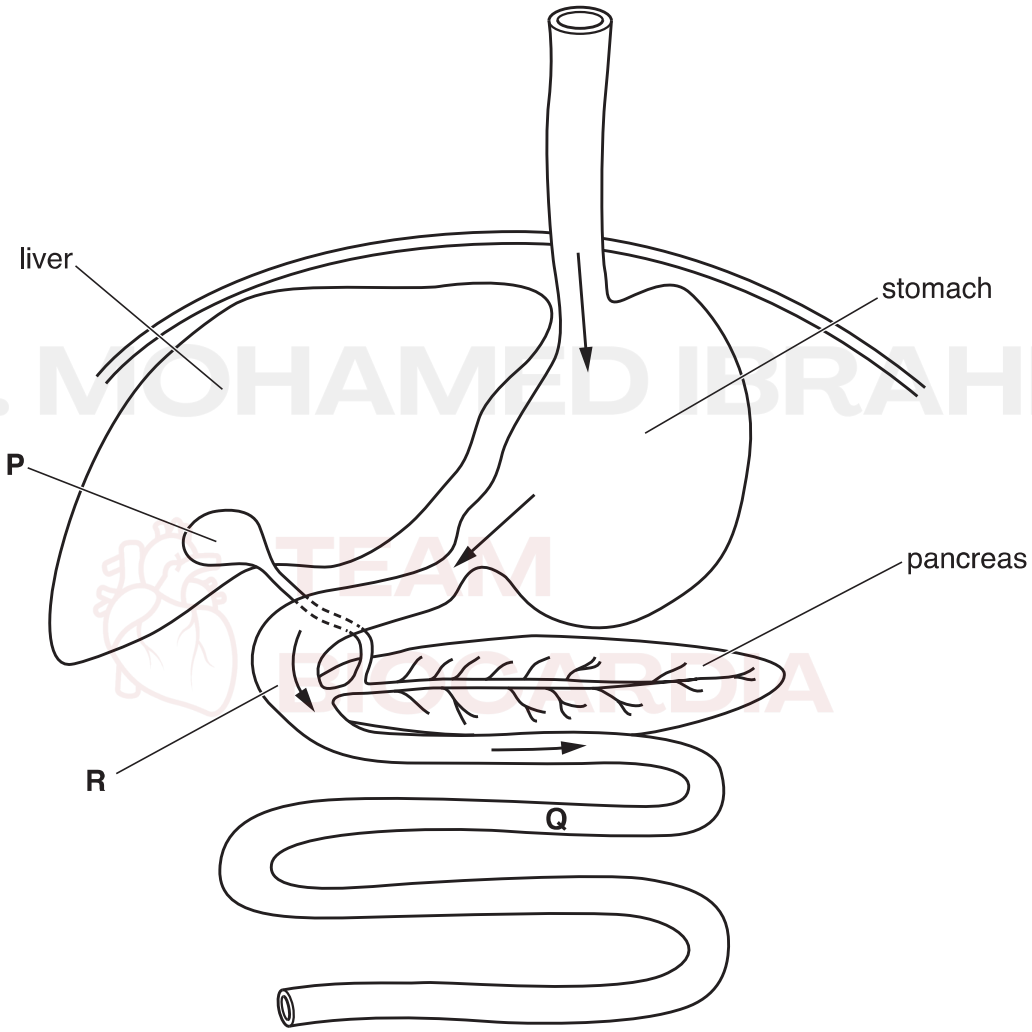

Fig. 1.1

(b) State the name of

(i) the enzyme secreted by the pancreas that digests fat

.....[1]

(ii) the products of chemical digestion of fat

.....[1]

(iii) the liquid that is produced by the liver and stored by organ **P** in Fig. 1.1

.....[1]

(iv) organ **P** in Fig. 1.1.

.....[1]

(c) Explain what happens to ingested fat at **R** in Fig. 1.1 **before** chemical digestion occurs.

.....

.....

.....

.....

.....[2]

(d) Explain how the products of fat digestion are transported from **Q** to the rest of the body.

.....

.....

.....

.....

.....

.....

.....[3]

4

One possible effect of too much fat in the diet is coronary heart disease.

(e) Describe how too much fat in the diet may cause coronary heart disease.

.....

.....

.....

.....

.....

.....

.....[3]

6 **(a)** Table 6.1 shows some of the enzymes, their substrates, products and where they are produced in the digestive system.

Complete Table 6.1.

Table 6.1

enzyme	substrate	product(s)	location of enzyme production
.....	starch	.....	salivary glands
maltase	maltose	.....	.....
.....	.....	amino acids	stomach wall
.....	.....	amino acids	pancreas and small intestinal wall
lipase	fats	.....	.....

[5]

(b) Bile is made in the liver, stored in the gall bladder and passes into the small intestine.

Describe the role of bile in digestion.

.....

.....

.....

.....

.....

.....

.....[3]

(c) After chemical digestion the products of digestion are absorbed.

Define *absorption*.

.....

.....

.....

.....

.....[3]

(e) People that eat a diet that is high in fats are often advised to reduce their intake of fats.

Suggest the health benefits of this change in diet.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 15]

3 The length of the small intestine was measured in four types of mammal.
The results are shown in Table 3.1.

Table 3.1

mammal	length of small intestine / cm	length of small intestine relative to body mass / cm per g
insect-eating bat	19	2.30
domestic cat	104	0.05
rat	98	0.34
human	552	0.01

(a) Use the information in Table 3.1 to compare the length of the small intestine of the four mammals.

.....

.....

.....

.....

.....

.....

.....[3]

(b) Fig. 3.1 is a diagram showing a short length of the small intestine of a mammal.

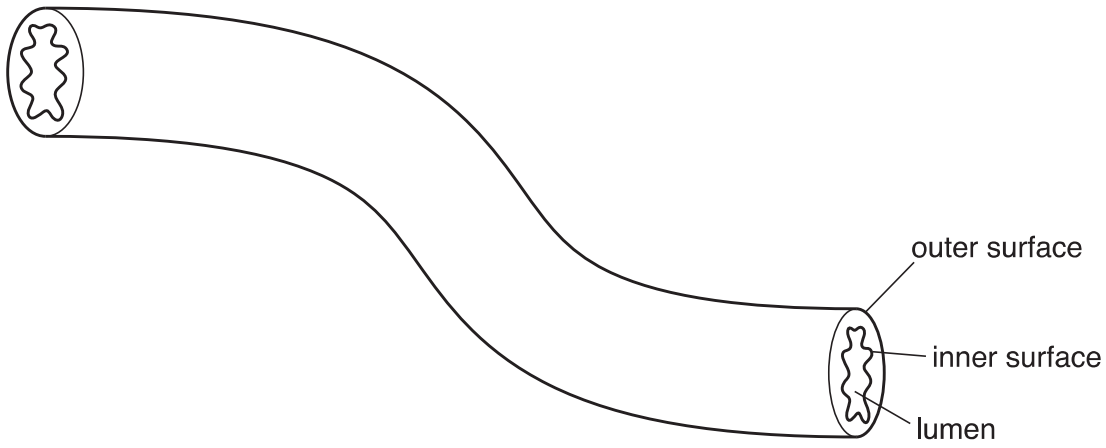

Fig. 3.1

A function of the small intestine is absorption.

Describe how a molecule of glucose passes from the lumen of the small intestine into the blood.

.....

.....

.....

.....

.....

.....

.....[3]

(c) Measurements were taken of the inner and outer surface area of two parts of the small intestine for the four mammals in Table 3.1. The results are shown in Table 3.2.

Table 3.2

mammal	ratio of inner surface area to outer surface area	
	duodenum	ileum
insect-eating bat	283:1	54:1
domestic cat	15:1	12:1
rat	6:1	4:1
human	7:1	3:1

(i) Suggest which mammal has the most villi per centimetre of small intestine.

.....[1]

(ii) The duodenum is more effective than the ileum at absorption. Use the information in Table 3.2 to explain why.

.....

.....

.....

.....

.....[3]

(d) Bile is released into the small intestine from the gall bladder.

Outline the roles of bile.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 14]

3 Pepsin is a protease enzyme found in the alimentary canal.

(a) **(i)** Name the product formed from the digestion of proteins by protease enzymes.

.....[1]

(ii) State the organ in the alimentary canal where pepsin is secreted.

.....[1]

(b) A biologist performed an experiment to find the optimum pH for the activity of pepsin.

The enzyme activity was measured in four test-tubes. Each test-tube contained a 1 cm^3 cube of cooked egg white which contains protein.

Fig. 3.1 shows the four test-tubes.

The biologist measured the time taken for the complete digestion of the cubes of cooked egg white.

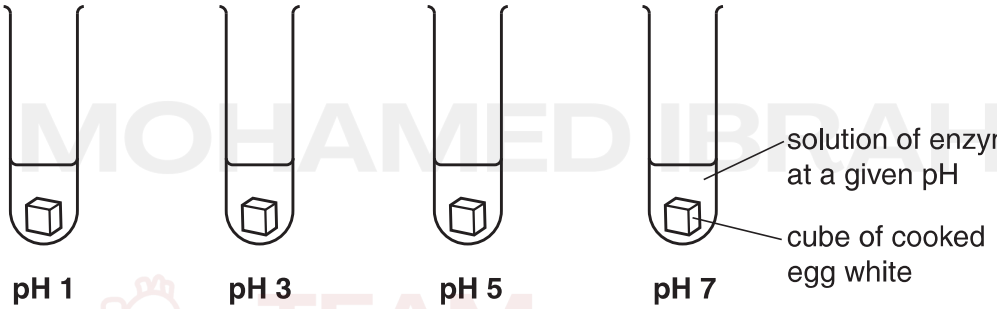

Fig. 3.1

(i) The biologist ensured all the cubes of cooked egg white were exactly the same size.

Suggest why.

.....

.....

.....

.....

.....[2]

(ii) Temperature must be controlled in this experiment.

Describe how temperature could be controlled.

.....

.....[2]

(c) The same experiment was performed with trypsin, another protease enzyme.

Predict the optimum pH for trypsin.

.....[1]

5 Fig. 5.1 shows the different types of human teeth.

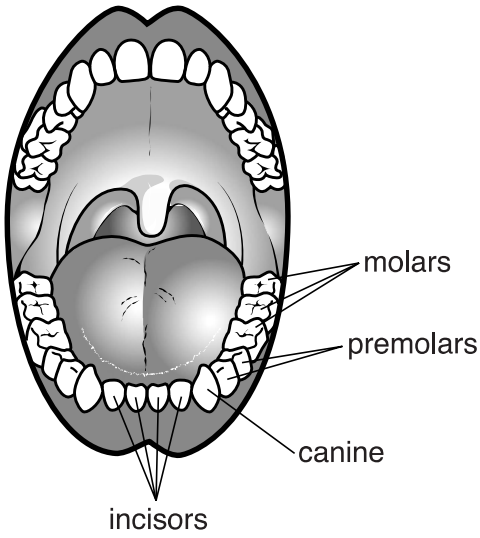

Fig. 5.1

(a) Describe the functions of the canine and molar teeth.

.....

.....

.....

.....

.....[2]

(b) Fig. 5.2 shows the skulls of a tiger and a rabbit.

tiger

rabbit

Fig. 5.2 not to scale

(i) State **two** ways in which the teeth of a tiger differ from the teeth of a rabbit, using evidence from Fig. 5.2.

.....

.....

.....

.....

.....[2]

(ii) Suggest **one** feature **visible** in Fig. 5.2 that indicates the tiger is a carnivore.

.....

.....

.....[1]

(c) Omnivores are animals that eat both animals and plants. Scientists use the number and types of teeth to classify animals as carnivores, herbivores or omnivores.
Table 5.1 shows examples of different types of mammals and their teeth.

Table 5.1

mammal	carnivore, herbivore or omnivore	incisors	canines	premolars	molars	total number of teeth
1	omnivore	12	4	16	12	
2	omnivore	12	4	16	12	44
3	herbivore	12	4	12	12	40
4	herbivore	6	2	12	12	32
5	carnivore	12	4	16	10	42
6	carnivore	12	4	10	8	34
X		12	4	12	8	36

(i) Calculate the number of molars as a percentage of the total number of teeth for mammal 1.
Show your working.
Give your answer to the nearest whole number.

.....%
[2]

(ii) The skull of an unidentified mammal, **X**, is likely to be a carnivore.
Discuss the evidence in Table 5.1 for **and** against classifying mammal **X** as a carnivore.

.....

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.....

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.....

.....

.....

.....

.....[4]

(d) Mechanically digested food travels from the mouth to the stomach. The gastric juice in the stomach contains hydrochloric acid, giving a low pH environment.

Explain why it is important to have a low pH in the stomach.

.....

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.....

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.....

.....

.....[3]

(e) Products of digestion are absorbed through the villi in the small intestine.
Explain how villi are adapted for absorption.

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.....

.....[3]

(f) Coeliac disease is caused by a reaction to a protein called gluten. The villi become damaged causing a reduction in the absorption of nutrients.

Suggest possible effects on the body of a reduction in the absorption of nutrients.

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.....

.....

.....

.....

.....

.....[3]

[Total: 20]

Circulatory System

2 **(a)** Fig. 2.1 shows the transfer of materials between blood and tissues.

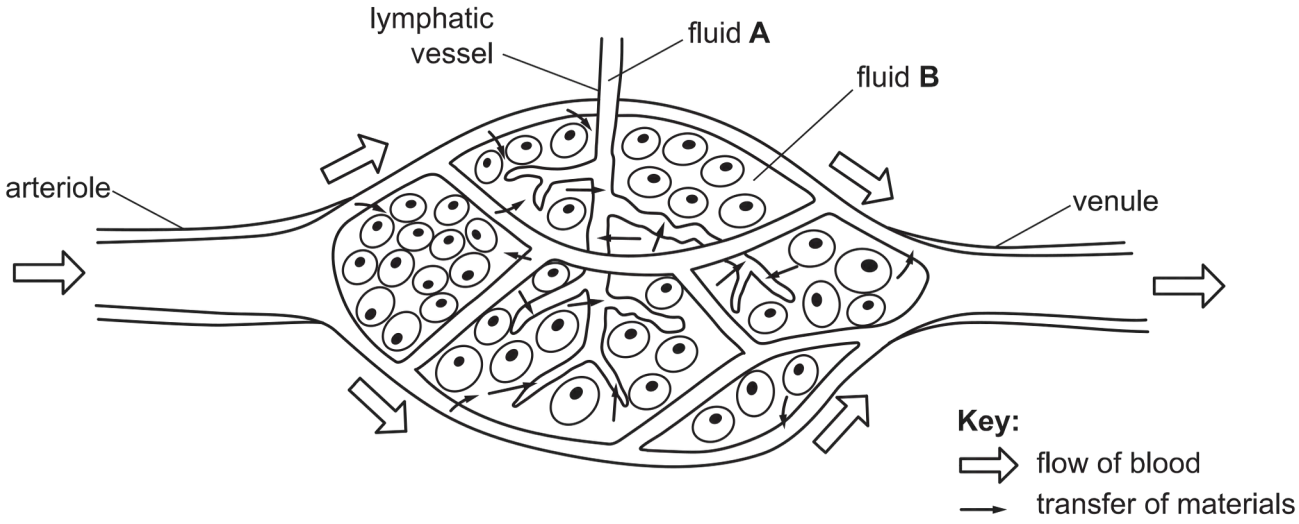

Fig. 2.1

(i) Complete Table 2.1 by:

- stating the names of the fluids
- writing **yes** if the fluid contains red blood cells or **no** if the fluid does **not** contain red blood cells.

Table 2.1

letter on Fig. 2.1	name of the fluid	contains red blood cells
A		
B		

[2]

(ii) State the name of the process by which oxygen is transferred from fluid **B** to the cells.

..... [1]

(iii) Explain why cells need oxygen.

.....

.....

.....

.....

..... [2]

(b) Describe the functions of arterioles in the skin.

.....

.....

.....

.....

.....

.....

..... [3]

(d) Lacteals are part of the lymphatic system.

(i) State where in the body lacteals are found.

..... [1]

(ii) Describe the role of lacteals.

.....

.....

..... [1]

5 Fig. 5.1 shows an angiogram of a heart before and after treatment for coronary heart disease (CHD). An angiogram is an image of the blood flow through the blood vessels of the heart.

before treatment after treatment

Fig. 5.1

(a) The arrow on Fig. 5.1 shows the position of a blockage in a blood vessel.

(i) State the name of the blocked blood vessel.

..... [1]

(ii) The blockage is caused by a blood clot.

Describe how a blood clot forms.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Many health specialists think that the risk of coronary heart disease can be reduced by doing regular exercise.

A long-term study of a large group of women was used to test this hypothesis.
The women were between 35 and 45 years old at the start of the study.
Every two years the same group of women were asked how much they were exercising.

After 28 years the researchers analysed their data:

- They calculated the average time spent exercising per week by each woman.
- They put the women into categories determined by how much exercise they had done.
- For each category, they calculated the number of women who died from coronary heart disease (CHD).

The results are shown in Fig. 5.2.

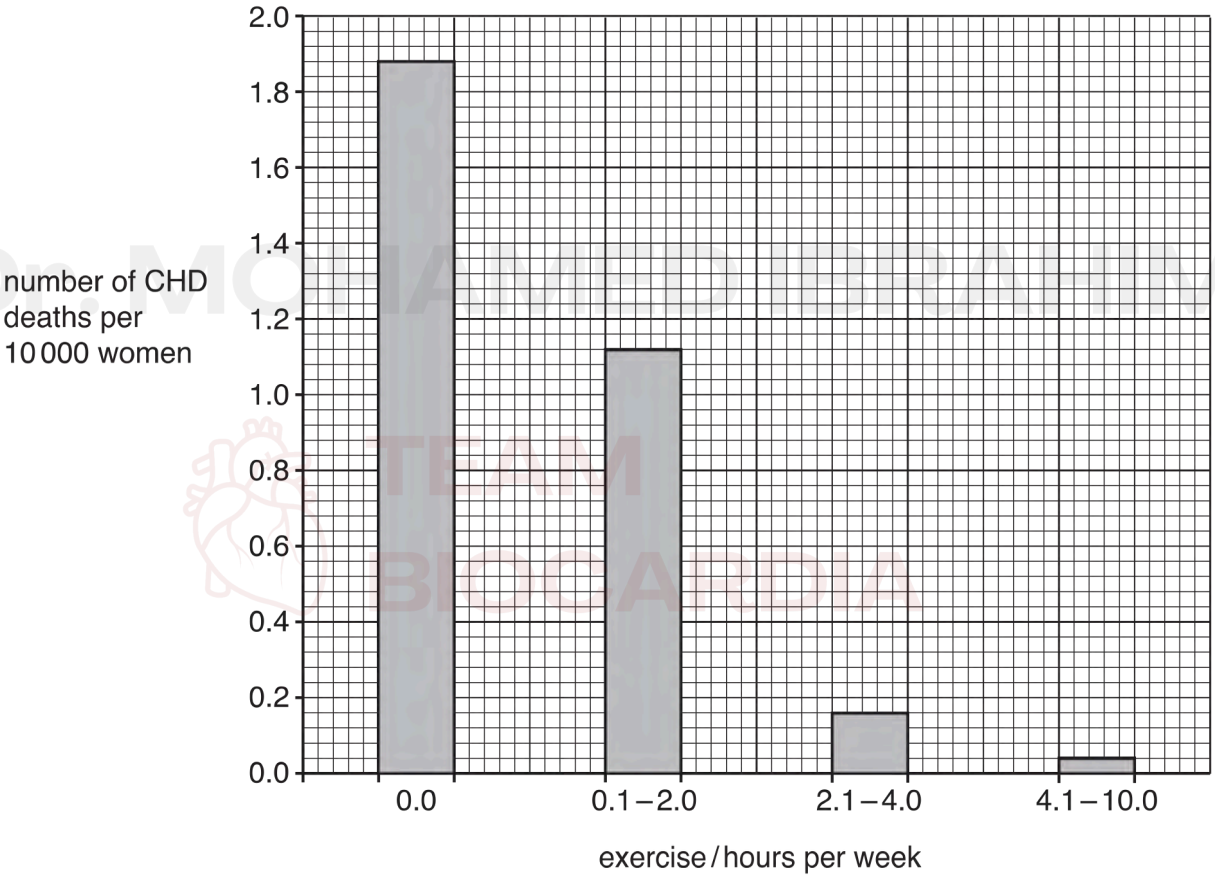

Fig. 5.2

(i) Calculate the percentage **decrease** in the number of CHD deaths per 10 000 women between those who did no exercise and those who exercised for 4.1 to 10.0 hours a week, using the data in Fig. 5.2.

number of CHD deaths per 10 000 women who did no exercise .....

number of CHD deaths per 10 000 women who did 4.1 to 10.0 hours per week of exercise

.....

Give your answer to the nearest whole number.

Space for working.

..... %
[3]

(ii) Health professionals wanted to use the results of this study to encourage the whole population to take more exercise.

Discuss the arguments for and against health professionals using this study in this way.

Use the information about how the study was designed and the results in Fig. 5.2 in your arguments.

.....

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.....

..... [5]

(c) Exercise causes heart rate to increase.

Explain why exercise causes an increase in heart rate.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 16]

6 Fish are an important part of a balanced diet for many people.

(a) Fish are a good source of vitamin D.

State **one** effect of a diet that is deficient in vitamin D.

.....

.....

..... [1]

4 Mammals have a double circulation.

(a) State what is meant by the term *double circulation*.

.....

.....

..... [1]

(b) Table 4.1 shows some information about the functions of the components of blood.

Complete Table 4.1.

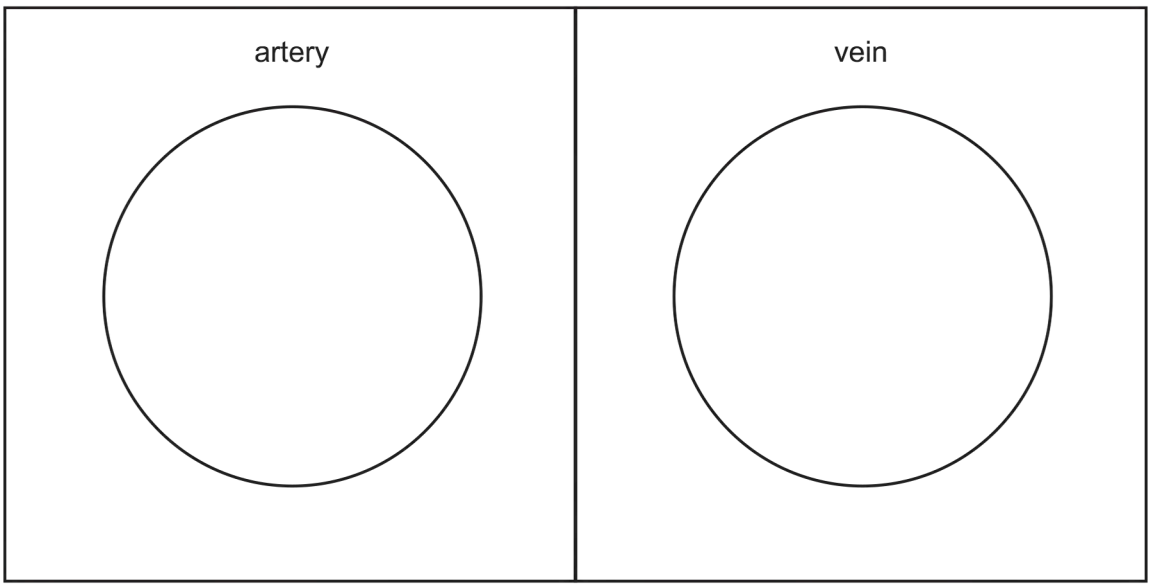
Table 4.1

function	type of cell
production of antibodies	
	phagocyte
promotes blood clotting	
transports oxygen	

[4]

(c) Blood is transported in arteries and veins.

Complete the drawings of the cross-sections of an artery and a vein to show the differences between these two types of blood vessel. Label the lumen in each drawing.



[2]

(d) A diagram of a mammalian heart and associated blood vessels is shown in Fig. 4.1.

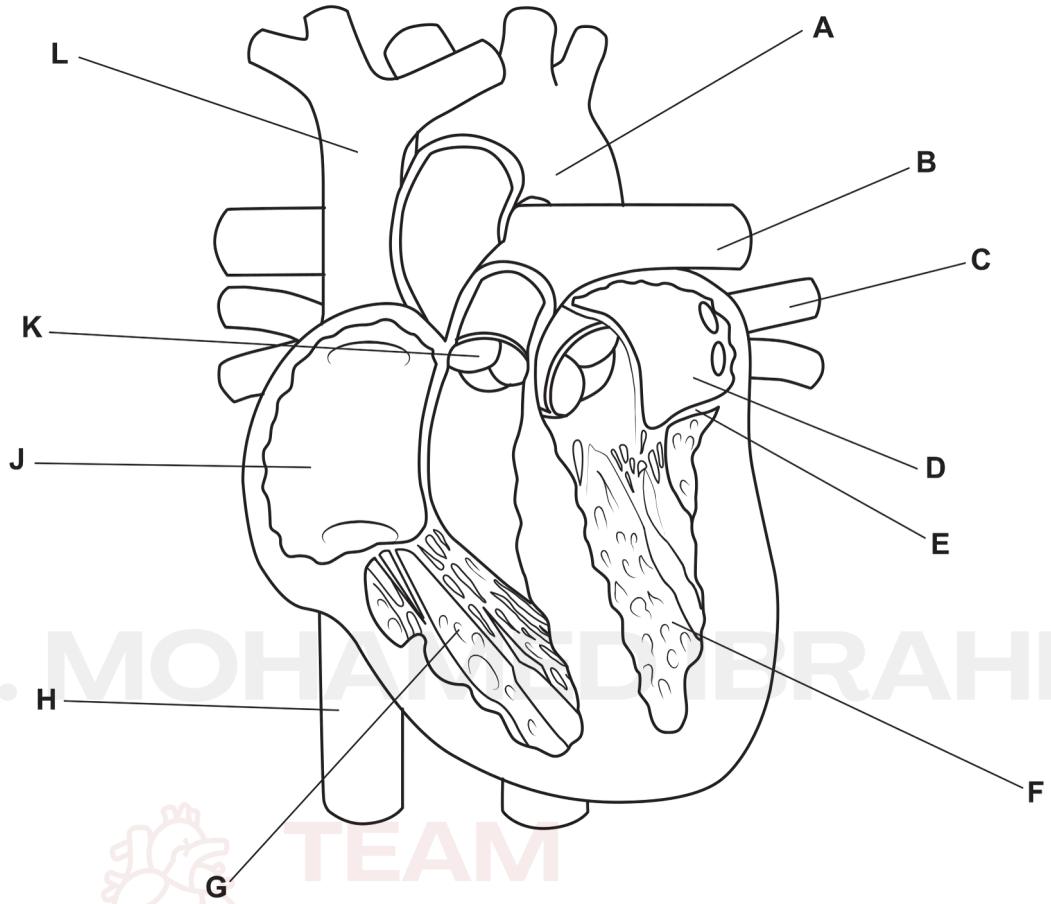


Fig. 4.1

(i) Sketch arrows on Fig. 4.1 to show the pathway taken by deoxygenated blood from the heart towards the lungs. [2]

(ii) Table 4.2 contains statements about the structures visible in Fig. 4.1.

Complete Table 4.2 by:

- stating the name of each structure
- identifying the structure with the corresponding letter from Fig. 4.1.

Table 4.2

statement	name of structure	letter from Fig. 4.1
chamber that creates the highest blood pressure		
blood vessel containing blood with the highest concentration of oxygen		
structure that prevents blood going from ventricle to atrium		
structure that prevents backflow of blood from artery to ventricle		
chamber that receives blood from vena cava		

[5]

6 Fig. 6.1 is a diagram showing some body cells and parts of the human lymphatic and circulatory systems.

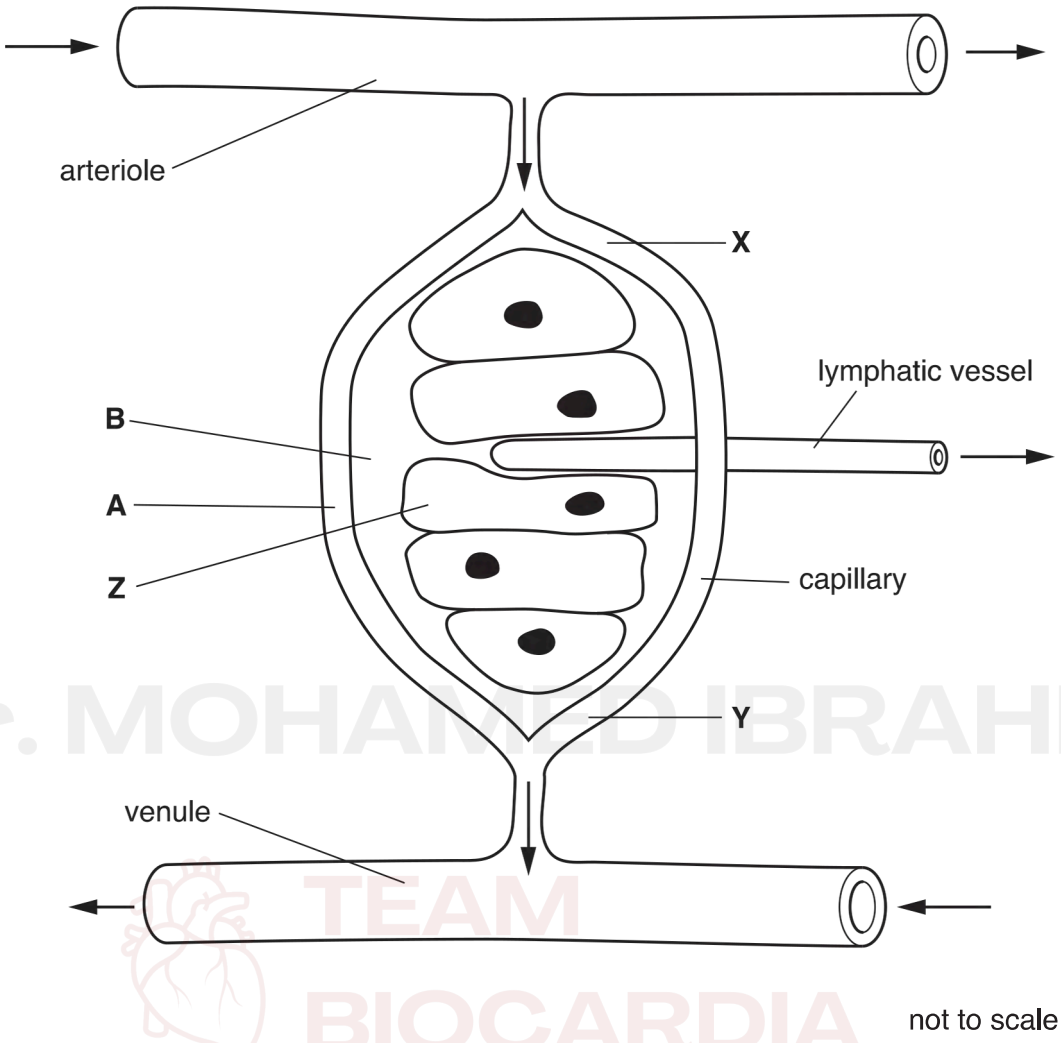


Fig. 6.1

(a) Capillaries allow blood to reach most cells in the body.

(i) State the name of the process by which oxygen moves from **A** to **Z** as shown in Fig. 6.1.

.....[1]

(ii) Describe how some of the liquid in **A** moves to **B** in Fig. 6.1.

.....

.....

.....[2]

(iii) State **one** component of blood that remains inside the capillaries as the blood flows from **X** to **Y** in Fig. 6.1.

.....[1]

(b) Lymphatic vessels are similar in structure to veins.

(i) Describe the structure of veins.

.....

.....

.....

.....

.....[2]

(c) Lacteals are another part of the lymphatic system.

State where in the body lacteals are found and state their function.

location in the body .....

function .....

.....
[2]

(d) In the lymphatic system, there are structures that contain large numbers of lymphocytes.

(i) State the name of these structures.

.....[1]

(ii) State the role of lymphocytes.

.....

.....

.....[2]

5 Fig. 5.1 shows a photomicrograph of human blood.

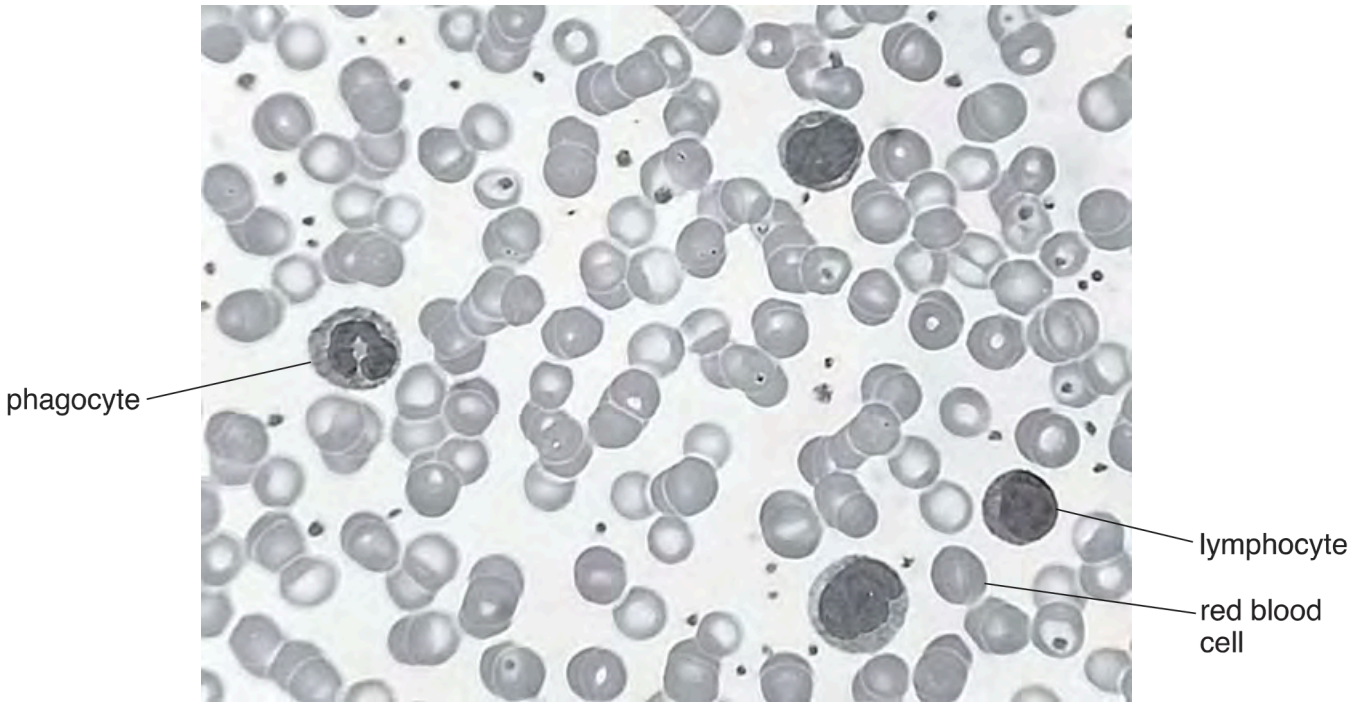


Fig. 5.1

(a) Describe the differences in appearance and the roles of the **three** cells labelled in Fig. 5.1.

.....

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..... [6]

(b) Fig. 5.2 shows some of the stages of blood clotting.

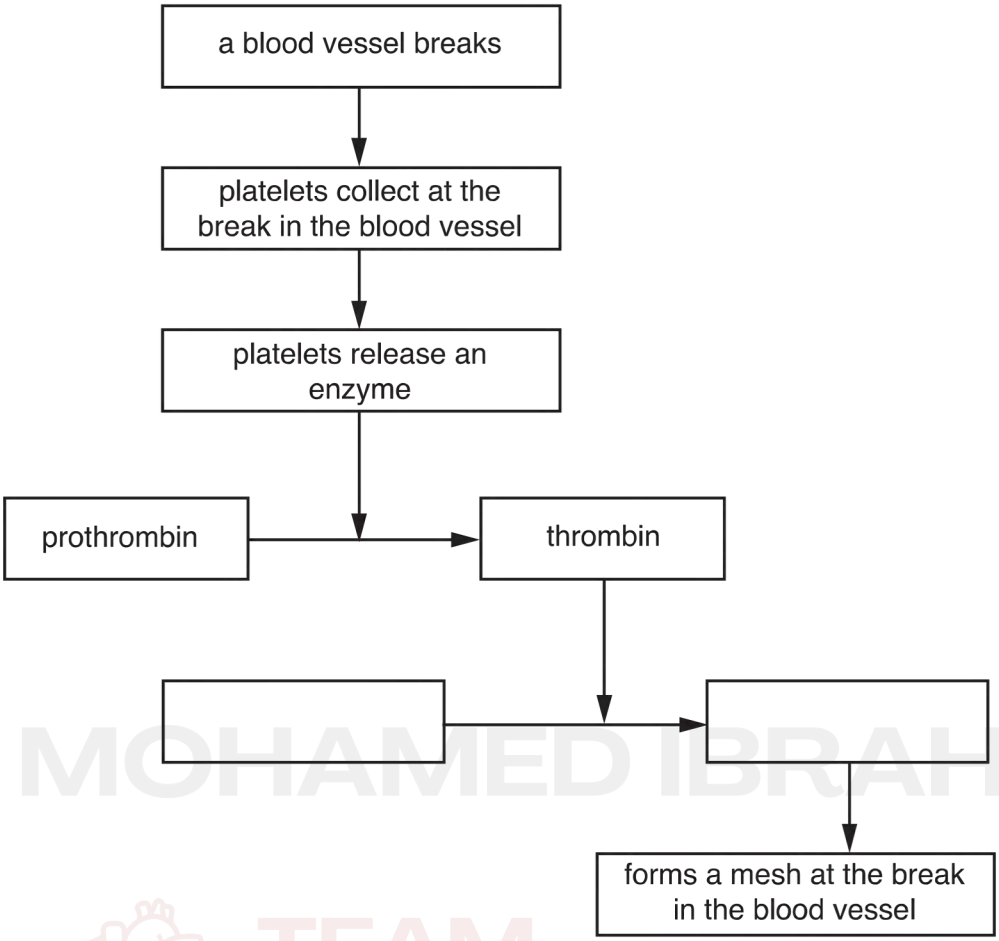

Fig. 5.2

(i) Complete Fig. 5.2 by filling in the **two** empty boxes. [1]

(ii) State **two** roles of blood clotting.

.....

.....

.....

.....

..... [2]

4 The flow of blood through the skin can be investigated by using a flow-meter.

Fig. 4.1 shows a flow-meter above a section through the skin.

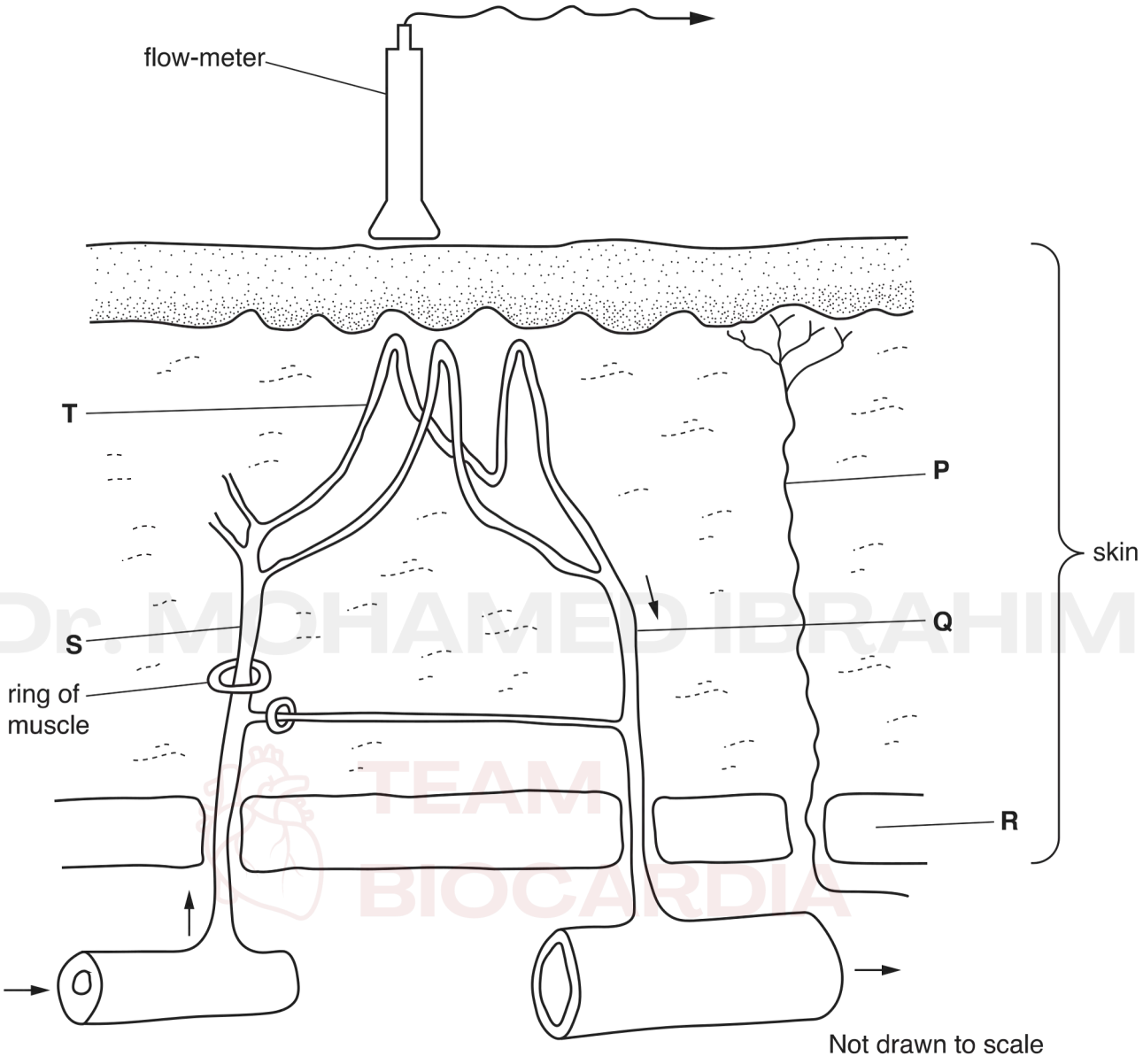

Fig. 4.1

(a) (i) State the name of cell **P**.

.....[1]

(ii) State the types of blood vessel labelled **Q**, **S** and **T**.

Q .....

S .....

T .....

[3]

(iii) State the name of the tissue at **R** that provides insulation.

.....[1]

(b) The blood flow through the skin of some volunteers was measured with a flow-meter when their skin was exposed to different temperatures.

Capsaicin is a compound that gives people the sensation of feeling hot when it is put on the skin. Researchers applied capsaicin to the skin of the volunteers and again measured the blood flow through their skin at different temperatures.

Fig. 4.2 shows the results.

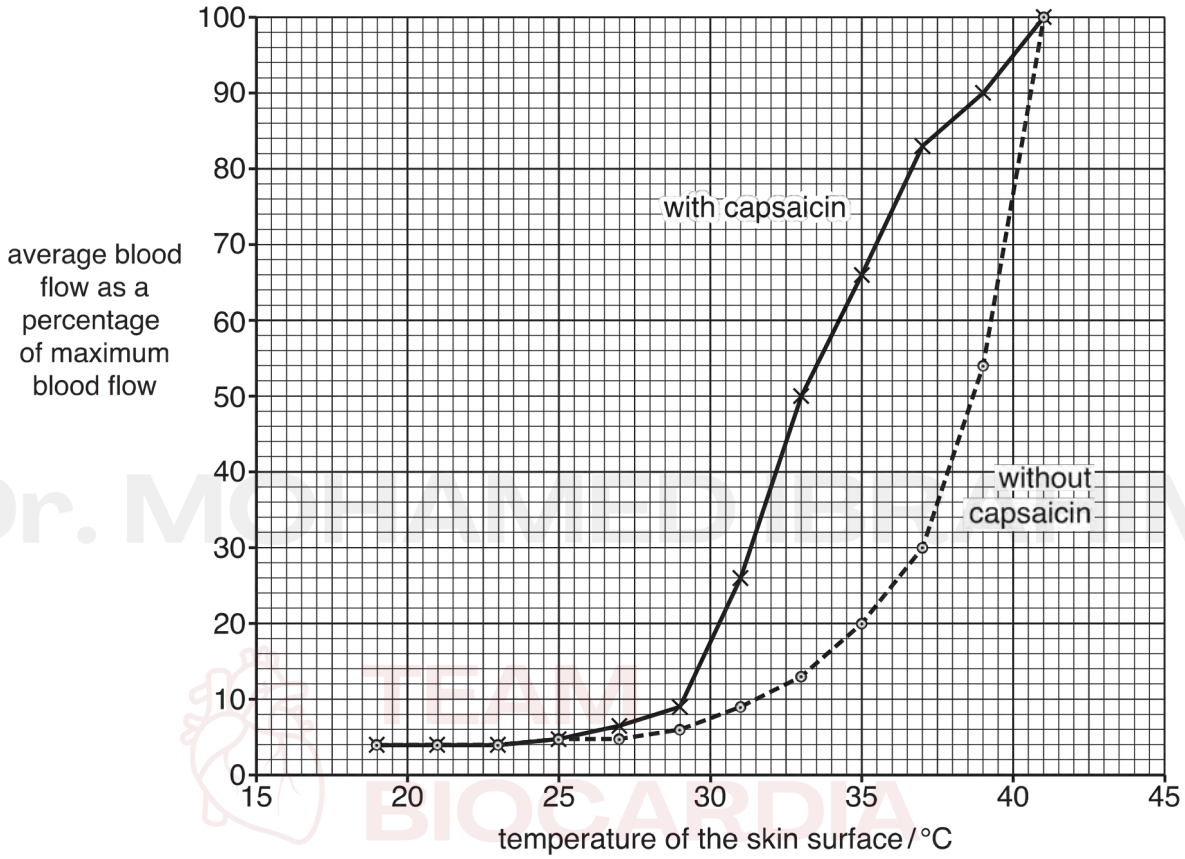

Fig. 4.2

(i) Use the information in Fig. 4.2 to describe the effect of increasing the temperature of the skin surface on blood flow to the skin **without** capsaicin.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(iii) State the difference between the average blood flow for the treatments (with and without capsaicin) at 35 °C.

Space for working.

..... % [1]

2 A group of students investigated the effect of exercise on their heart rates.

They measured their heart rates:

- before exercise
- immediately after running 1 km
- one minute after running 1 km

Before doing the investigation they wrote a hypothesis.

(a) (i) Write a hypothesis for this investigation.

.....

.....

.....

.....[2]

(b) In another investigation, a doctor tested some of her patients to determine the effect of exercise on coronary heart disease.

Coronary heart disease is caused by a blockage in the coronary artery.

Describe the effect on the heart of a blockage in the coronary artery.

.....

.....

.....

.....

.....[2]

(c) The doctor divided her coronary heart disease patients randomly into two equal groups.

Each group was given different instructions:

- group **A** – patients were given a daily exercise plan
- group **B** – patients were told to make their own exercise plan.

The doctor measured the heart rate (HR) of each patient immediately after doing exercise and again one minute later.

She calculated their heart rate recovery using this formula:

heart rate recovery = HR immediately after exercise – HR one minute after exercise.

She then calculated the average heart rate recovery for each of the two groups of patients.

The doctor repeated these measurements after three months and after six months.

The results are shown in Fig. 2.1.

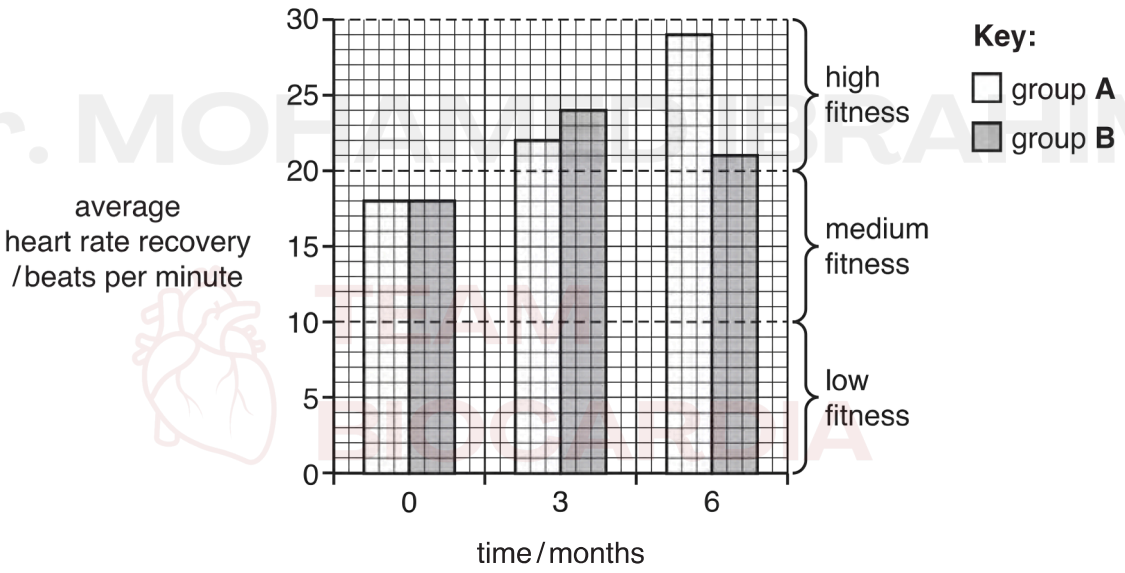

Fig. 2.1

Describe **and** explain the effect of exercise on the average heart rate recovery of the coronary heart disease patients in group **A** and group **B**.

Use data from Fig. 2.1 to support your answer.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[6]

(d) Exercise may reduce the risk of coronary heart disease.

State **one other** possible way of reducing the risk of developing coronary heart disease.

.....[1]

[Total: 13]

6 Glucose is absorbed into the blood in the small intestine. Fig. 6.1 shows the human circulatory system and the pathway taken by molecules, such as glucose, when they travel in the blood.

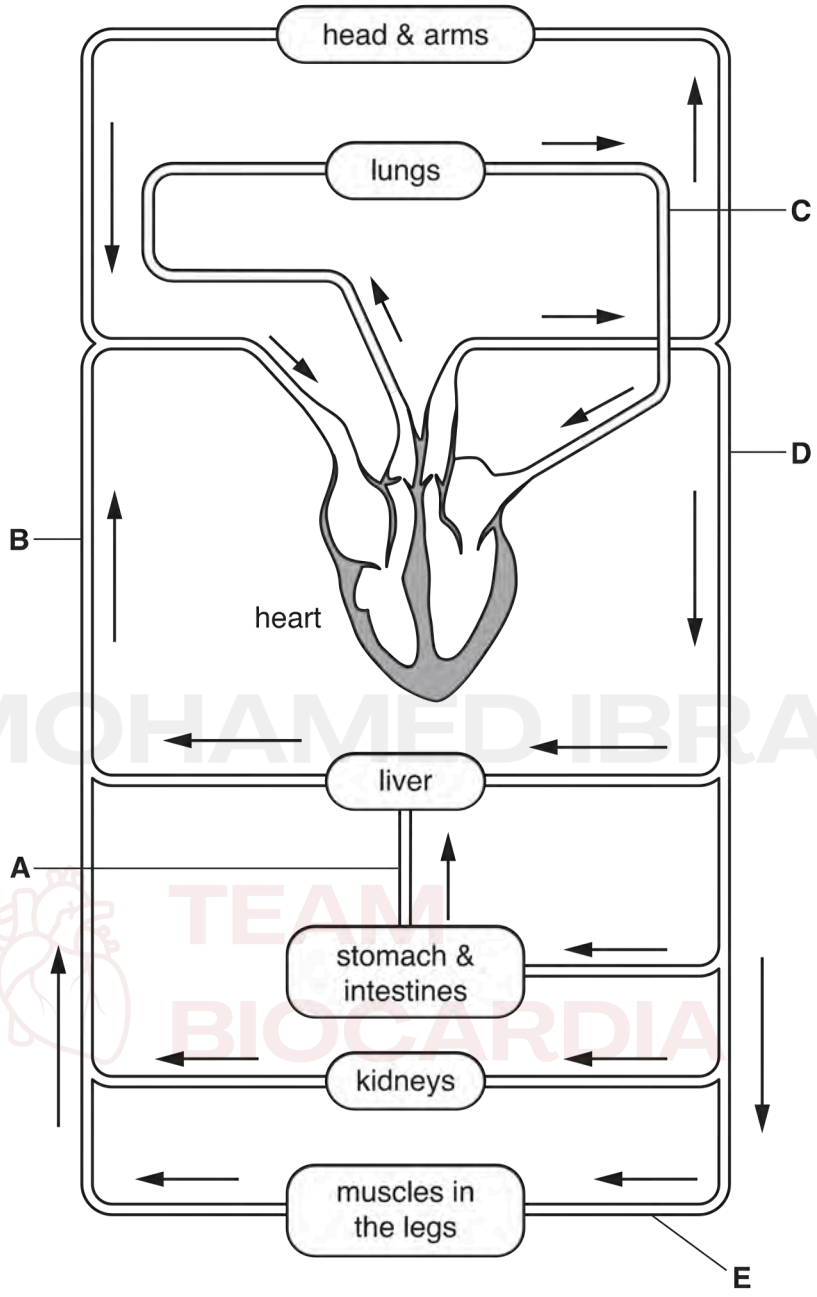

Fig. 6.1

(a) Complete Table 6.1 by naming the blood vessels labelled on Fig. 6.1 and stating whether they contain oxygenated blood or deoxygenated blood. One row has been completed for you.

Table 6.1

letter on Fig. 6.1	name of the blood vessel	oxygenated or deoxygenated blood
A		
B		
C		
D		
E	femoral artery	oxygenated

[4]

Circulatory System

2

1 Fig. 1.1 is a diagram of the human heart. The diagram shows the phase during the heart beat when the atria contract. The blood vessels that carry blood to and from the heart are labelled **A** to **F**.

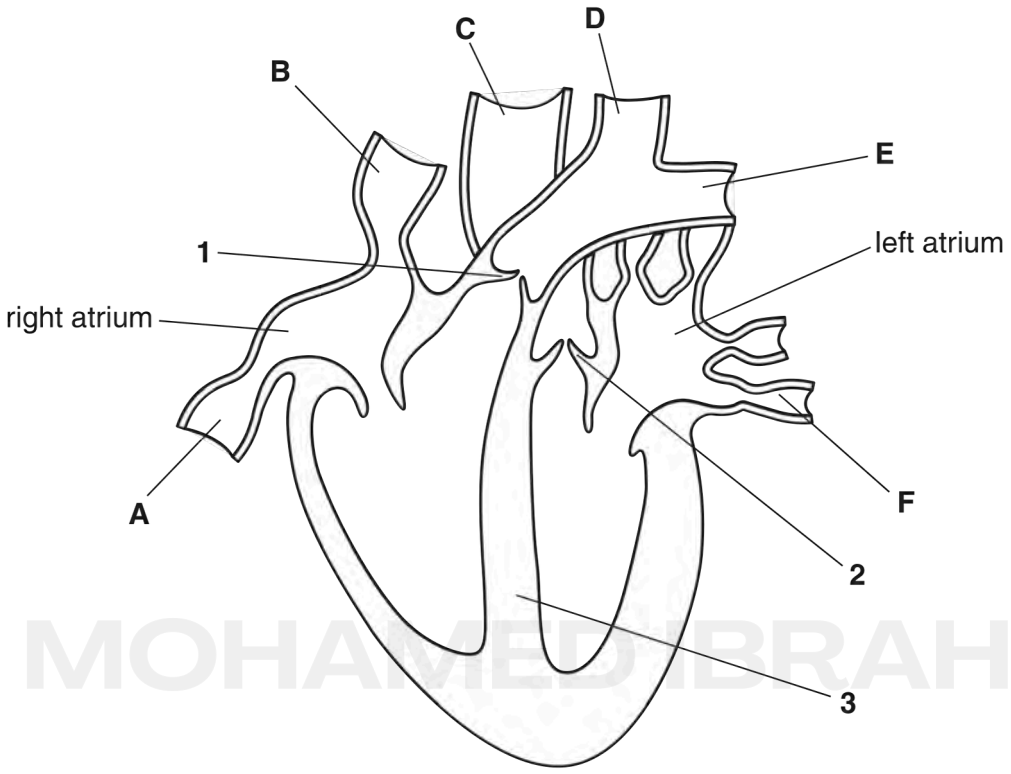

Fig. 1.1

(a) (i) Draw **one** arrow on Fig. 1.1 to show the pathway taken by blood from a vein into the **right ventricle**. [1]

(ii) Identify the letter of the blood vessel that carries blood at the highest pressure and state its name.

letter .....

name of the blood vessel .....
[1]

(b) (i) Suggest what causes the valves at **1** and **2** to close during a heart beat.

.....

.....[1]

(ii) State the function of valves **1** and **2** in the heart.

.....[1]

(c) Fig. 1.1 shows the phase of the heartbeat when the ventricles are filling with blood.

Using Fig. 1.1, describe **and** explain how the blood travels from the right ventricle to the lungs.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(d) State the name of the part of the heart labelled **3** and state its role in the mammalian circulation.

name .....

role .....

.....

[2]

[Total: 10]

3 Red blood cells in humans are produced from stem cells.

Fig. 3.1 shows how a red blood cell is produced and becomes specialised.

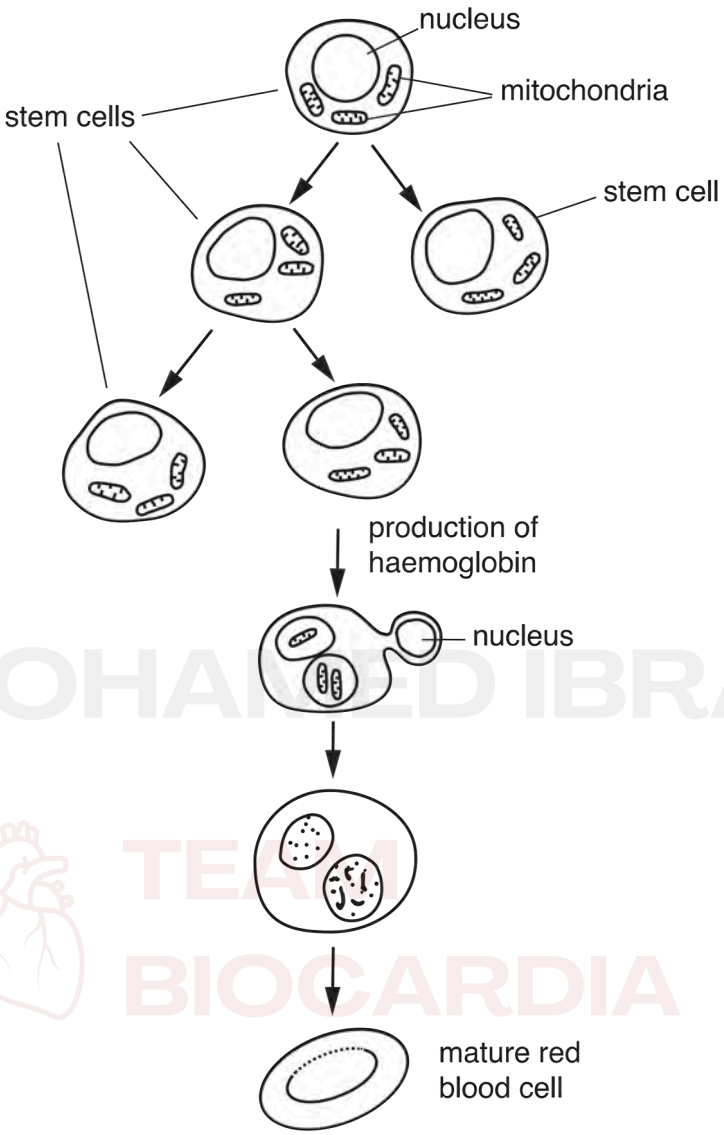

Fig. 3.1

9

(a) Use the information in Fig. 3.1 to describe how red blood cells are produced and explain how they are adapted to their function.

.....

.....

.....

.....

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.....

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.....

.....

.....

.....

.....[6]

(b) Red blood cells are suspended in the liquid part of the blood.

State the name of the liquid part of the blood.

.....[1]

(d) A type of anaemia is caused by a dietary deficiency.

(i) State the nutrient that is deficient in the diet when this type of anaemia occurs.

.....[1]

(ii) State **two** symptoms of anaemia.

1 .....

2 .....
[2]

Circulatory System

2

1 Fig. 1.1 shows a vertical section through a human heart and the major blood vessels.

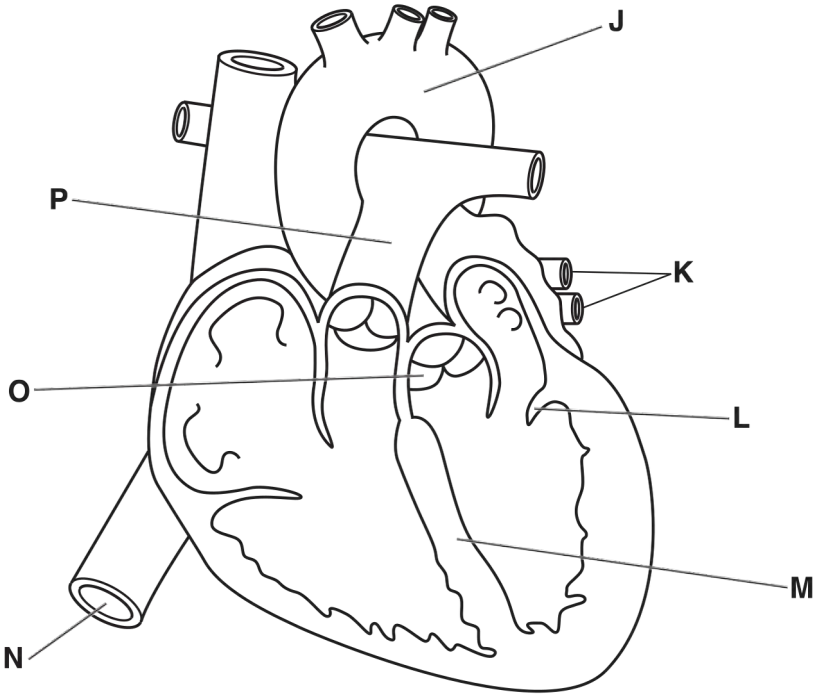

Fig. 1.1

(a) (i) State the names of the structures labelled **L**, **M** and **O** as shown in Fig. 1.1.

L .....

M .....

O .....

[3]

(ii) Identify a letter on Fig. 1.1 that represents a blood vessel that has:

blood with the highest concentration of carbon dioxide .....

blood with the highest concentration of oxygen .....

the highest pressure .....

[3]

(b) (i) Describe how blood is moved by the heart from blood vessel **K** to blood vessel **J**.

.....

.....

.....

.....

.....

.....

.....

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.....

.....

.....[5]

(ii) Explain why the wall of the left ventricle is thicker than the wall of the right ventricle.

.....

.....

.....

.....

.....[2]

[Total: 13]

5 The numbers of different cells in a blood sample were counted. The results are shown in Table 5.1.

Table 5.1

cell type	number / per mm^3	percentage
red blood cells	4 820 000	94.91
lymphocytes	1 900	0.04
phagocytes	6 000	0.12
platelets	250 000	
total	5 077 900	100.00

(a) Complete the table by calculating the percentage of platelets. Write your answer in Table 5.1 to two decimal places. [1]

(b) State the role of platelets in the blood **and** describe the process they are involved in.

.....

.....

.....

.....

.....

..... [4]

(c) Lymphocytes are white blood cells that are produced in bone marrow. Lymphocytes travel in the blood from bone marrow to lymph nodes throughout the body.

If a pathogen infects the body, some of these lymphocytes are activated.

State the role of lymphocytes in defence against pathogens.

..... [1]

(e) HIV invades specific lymphocytes that coordinate immune responses.

Fig. 5.1 shows the change in numbers of these lymphocytes following an HIV infection that has not been treated.

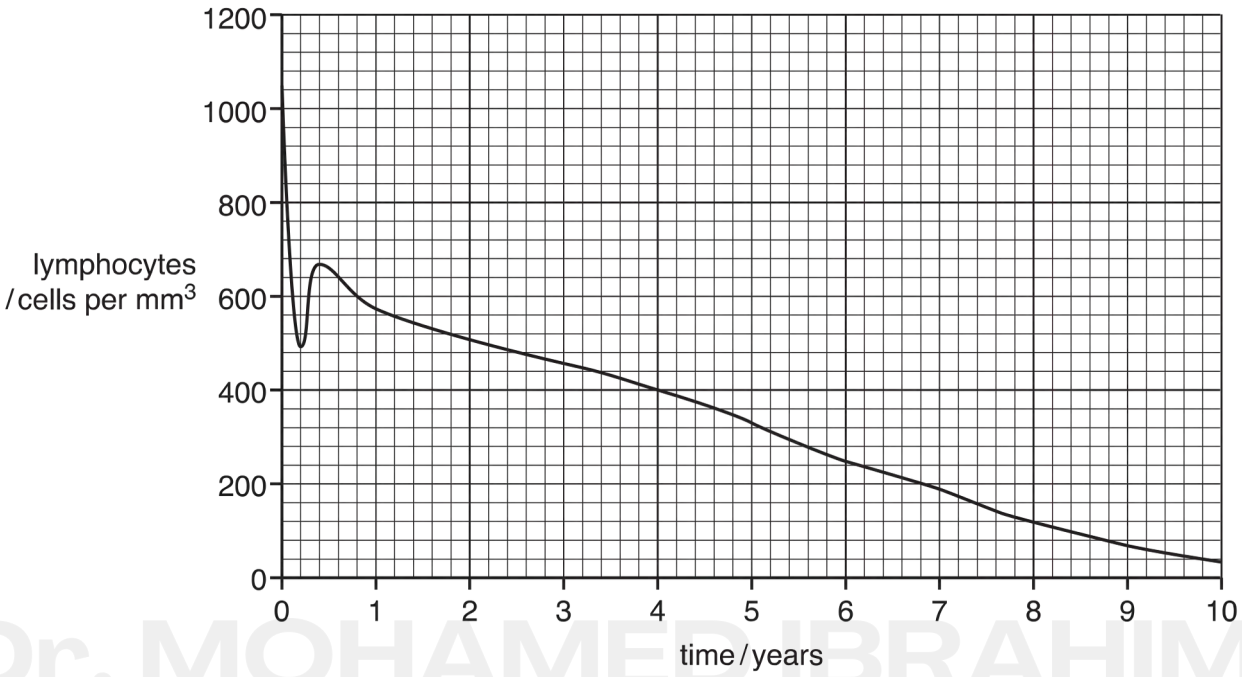

Fig. 5.1

(i) Describe the changes in lymphocyte numbers following HIV infection.

.....

.....

.....

.....

.....

..... [3]

(ii) Describe the effects on the body of an untreated HIV infection as shown in Fig. 5.1.

.....

.....

.....

.....

.....

..... [3]

[Total: 14]

1 **(a)** Fig. 1.1 shows the human heart and the main blood vessels. The functions of the parts of the heart and some of the blood vessels are given in Table 1.1.

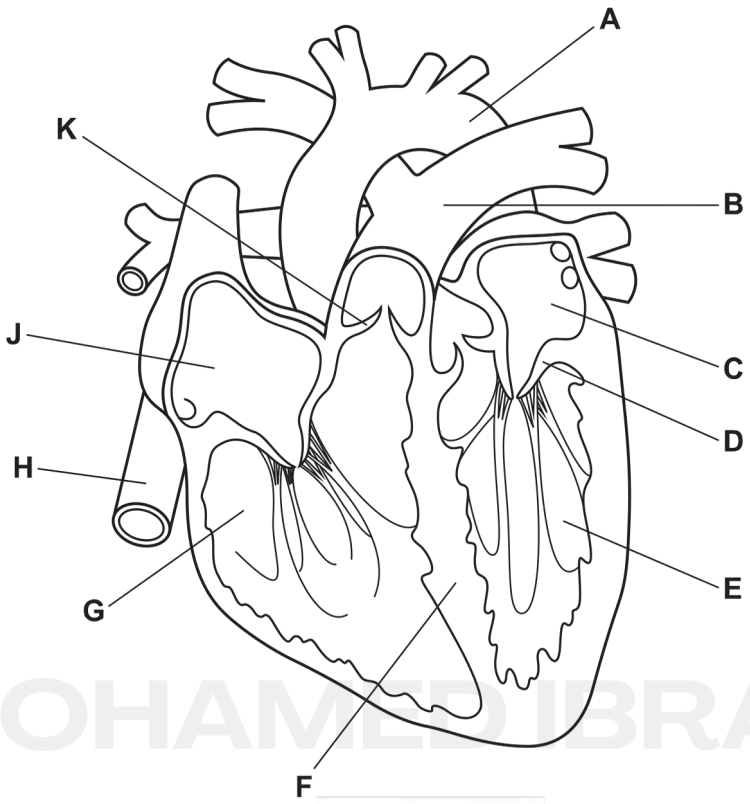

Fig. 1.1

Complete Table 1.1.

One row has been done for you.

Table 1.1

function	letter on Fig. 1.1	name
structure that separates oxygenated and deoxygenated blood		
structure that prevents backflow of blood from ventricle to atrium		
blood vessel that carries oxygenated blood	**A**	aorta
blood vessel that carries deoxygenated blood		
structure that prevents backflow of blood from pulmonary artery to right ventricle		
chamber of the heart that contains oxygenated blood		
chamber of the heart that contains deoxygenated blood		

[6]

(b) A group of students used a heart monitor to record the pulse rate of an athlete during a 5000 metre race. The recordings started just before the race began and ended just after it had finished, as shown in Fig. 1.2.

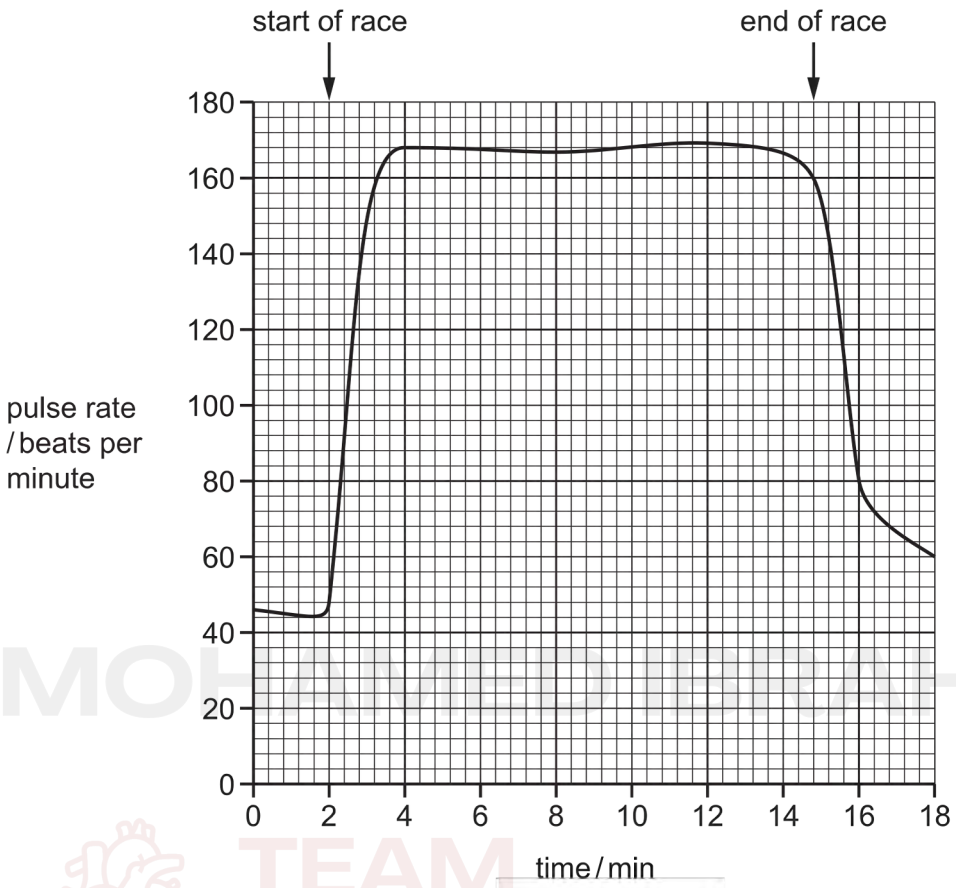

Fig. 1.2

(i) Use data from Fig. 1.2 to describe the effect of exercise on the pulse rate of the athlete.

.....

.....

.....

.....

.....

.....

..... [3]

Reproductive System

5 Fig. 5.1 shows a photomicrograph of a sperm cell reaching an egg cell.

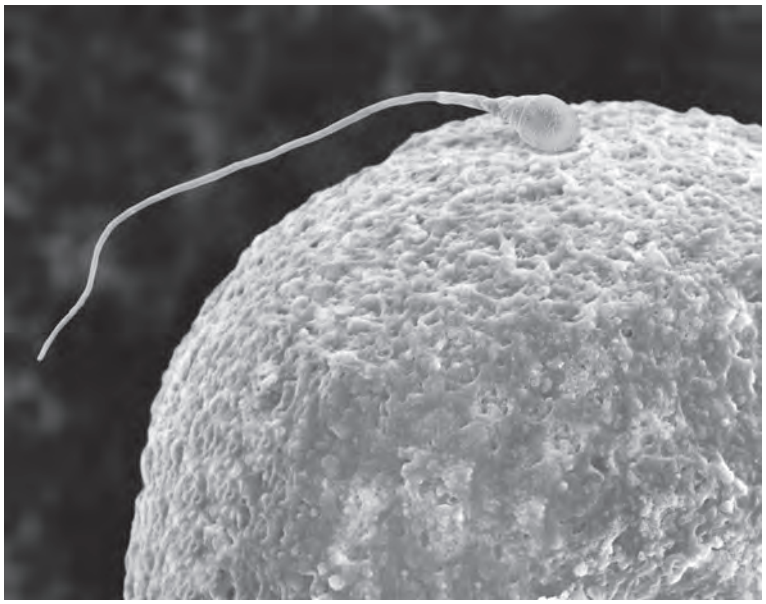

Fig. 5.1

(a) (i) Complete the sentence:

A nucleus containing a single set of unpaired chromosomes in a sperm is called a

..... nucleus. [1]

(ii) State where, in the female reproductive system, the event shown in Fig. 5.1 occurs.

..... [1]

5 **(a)** The activities of the ovaries and the uterus are regulated by the hormones FSH, LH, oestrogen and progesterone during the menstrual cycle.

Complete Table 5.1 to show the sites of production and the roles of these four hormones.

Table 5.1

hormone	site of production	target organ	role
FSH	pituitary gland	ovary	
LH	pituitary gland	ovary	
oestrogen		uterus	stimulates growth of the lining of the uterus
progesterone		uterus	

[5]

(b) Fig. 5.1 shows the changes in the lining of the uterus of a human female.

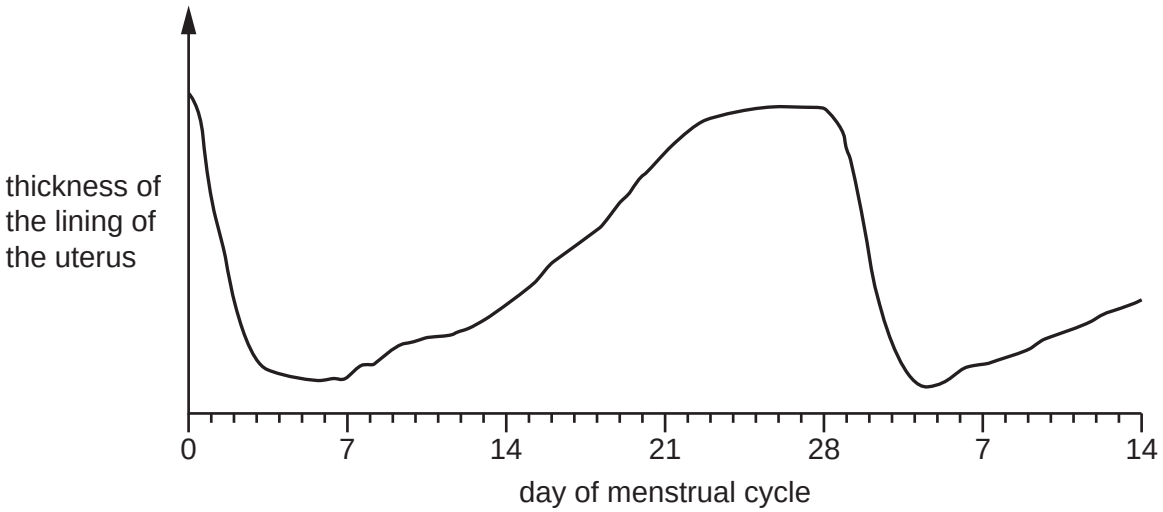

Fig. 5.1

Describe the changes in the lining of the uterus between days 0 and 28 of the menstrual cycle.

between days 0 and 7 .....

.....

.....

.....

between days 7 and 28 .....

.....

.....

.....

.....

[3]

(c) Some people are infertile.

Artificial insemination (AI) and *in vitro* fertilisation (IVF) are two methods of fertility treatment.

These two methods are outlined in Fig. 5.2.

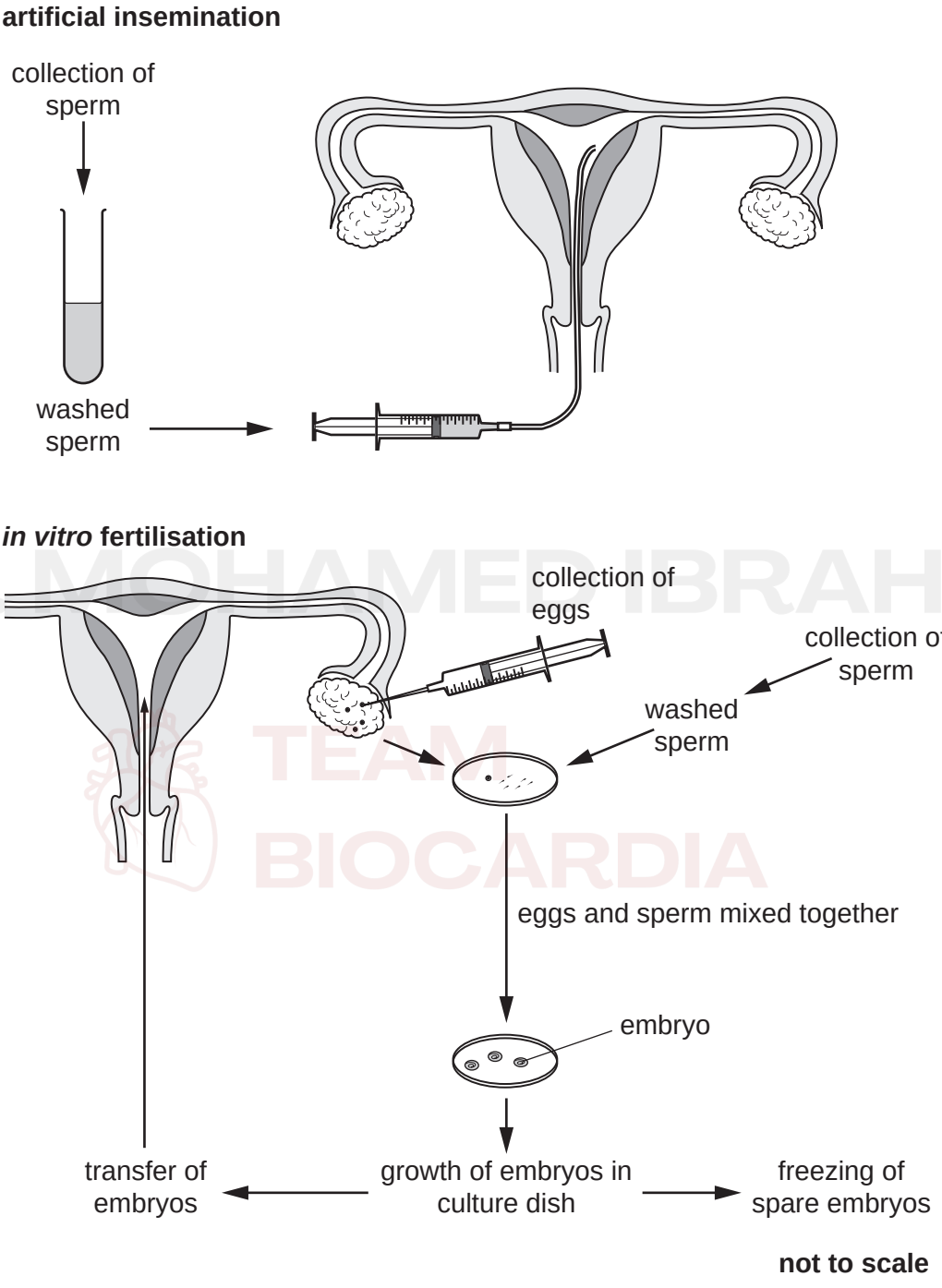

Fig. 5.2

Describe the similarities **and** differences between the two processes of fertility treatment shown in Fig. 5.2.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

[Total: 14]

(e) **(i)** State **two** immediate effects of excessive alcohol on the body.

1 .....

2 .....
[2]

(ii) State **two** long-term effects of excessive alcohol on the body.

1 .....

2 .....
[2]

(f) Pregnant women are advised not to drink alcohol as it may have harmful effects on the fetus.

(i) Outline these harmful effects.

.....

.....

.....

.....

..... [2]

(ii) State **two** harmful substances **other than alcohol** that can cross the placenta.

1 .....

2 .....
[2]

[Total: 21]

2 Pregnancy can occur after the fusion of a male gamete and a female gamete.

(a) State the name of the ball of cells that implants into the uterus after fertilisation.

..... [1]

(c) Describe the functions of amniotic fluid and the amniotic sac.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(d) The umbilical artery is found in the umbilical cord. This artery transports blood away from the heart of the fetus.

The umbilical artery is unusual because it transports deoxygenated blood.

(i) State the name of **one** other artery in the mother that transports deoxygenated blood.

..... [1]

(ii) State **one** excretory product that is transported from the fetus to the placenta.

..... [1]

(iii) State the name of the process that allows substances to move down a concentration gradient across the placenta.

..... [1]

(e) One of the functions of the placenta is to provide a barrier to toxins and pathogens.

A study was done on donated afterbirths. The afterbirth is a placenta with part of the umbilical cord attached.

The purpose of the study was to find the maximum size of particles that can pass through the placenta and enter the umbilical cord.

The researchers inserted beads with a diameter of 0.5 μm into blood vessels in the placenta. Three hours later they recorded the percentage of beads found in the blood in the placenta and in the umbilical cord.

They then repeated the tests using beads with diameters of 0.8 μm, 2.4 μm, 5.0 μm and 8.0 μm.

Their results are shown in Fig. 2.1.

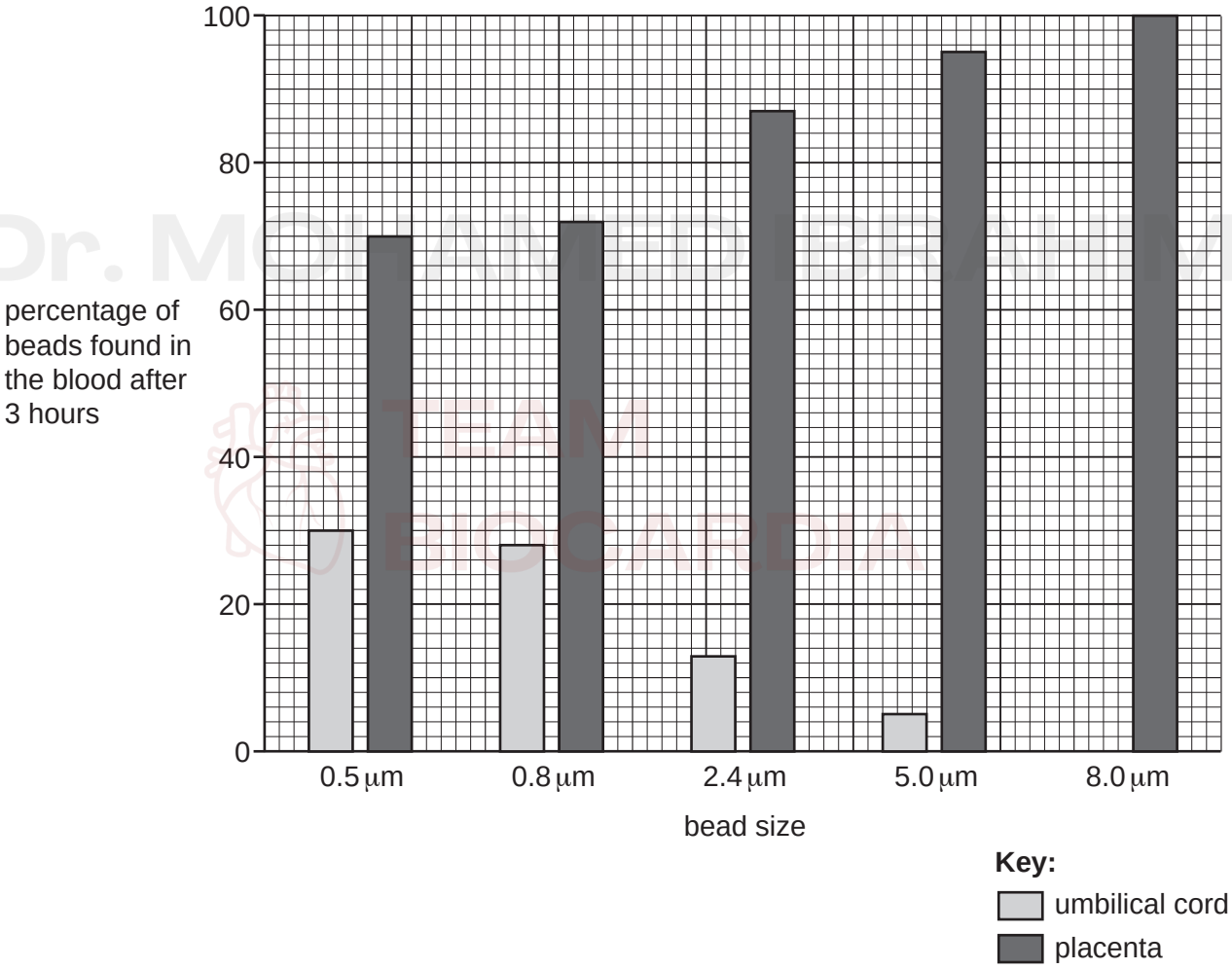

Fig. 2.1

(i) Convert the diameter of the 5.0 μm beads into millimetres (mm).

Space for working.

..... mm [1]

(ii) One million beads with a diameter of 2.4 μm were injected into the placenta.

Calculate the number of these beads in the umbilical cord after 3 hours.

Space for working.

..... beads
[2]

(iii) Table 2.1 shows a range of substances and their diameters.

Table 2.1

toxins and pathogens	diameter / μm
nicotine	2.0×10^{-2}
drug **X**	3.0×10^{-2}
rubella virus	5.0×10^{-2}
Vibrio cholerae	8.0×10^{-1}
Trypanosoma brucei	1.8×10^{1}

State the names of **all** the toxins and pathogens listed in Table 2.1 that could pass through the placenta and enter the umbilical cord.

Use the data in Fig. 2.1 to make your choice.

.....

.....

..... [1]

5 **(a)** The testes are part of the endocrine system because they produce hormones.

(i) State the name of the hormone released from the testes.

..... [1]

(ii) The testes are also part of the reproductive system. This means that the testes are part of two organ systems.

Complete Fig. 5.1 by stating **two** other organs that also belong to **two** organ systems.

One has been completed for you.

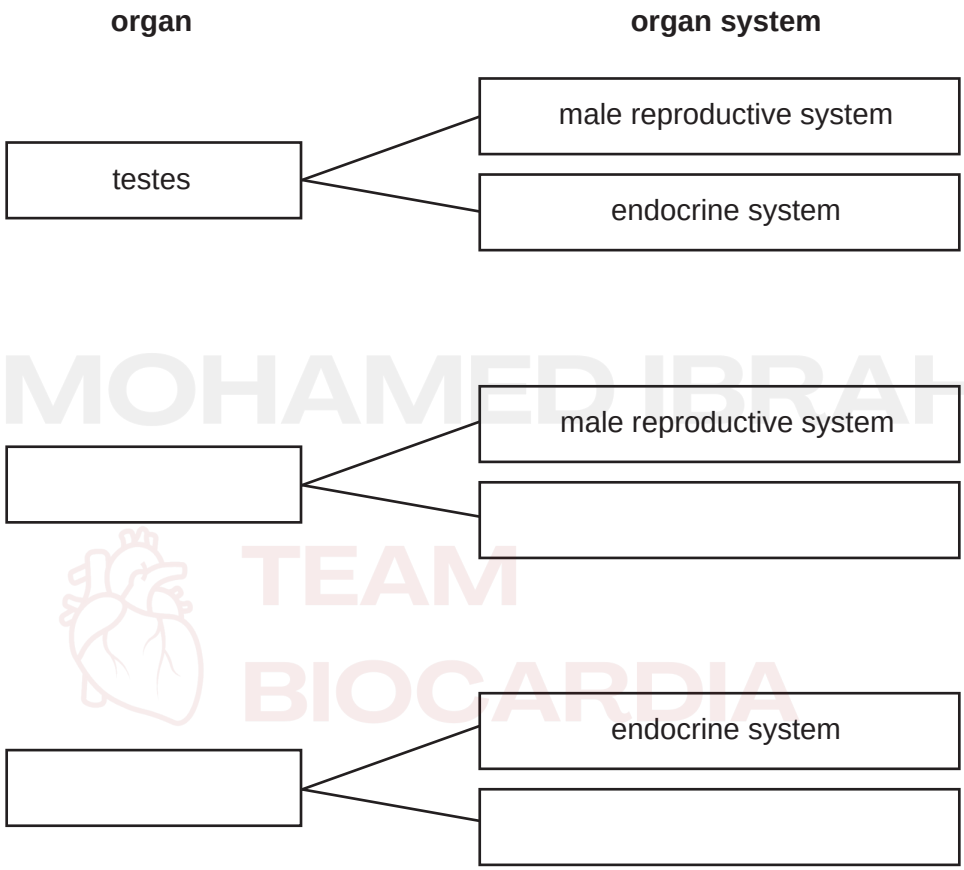

Fig. 5.1

[4]

(c) Fig. 5.3 is a photomicrograph of a section through a sperm.

Fig. 5.3

Table 5.1 shows information about the sperm shown in Fig. 5.3.

Complete Table 5.1.

Table 5.1

letter on Fig. 5.3	name of the structure	function
P		
	haploid nucleus	
		releases energy
	flagellum	

[4]

(d) Draw and label **one** human egg cell.

Include at least one labelled feature that is not found in a sperm cell.

[3]

(e) Describe what happens to a fertilised egg cell before implantation in the uterus.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 18]

4 One of the roles of the Centers for Disease Control and Prevention (CDC) in Atlanta, US, is to try to reduce the number of people who are infected with pathogens.

The CDC conducted a survey. They asked women which, if any, contraceptive methods they used.

(a) Suggest why the CDC collected data on contraceptive methods.

.....

.....

.....

.....

.....

.....

..... [3]

Fig. 4.1 shows the results of the survey.

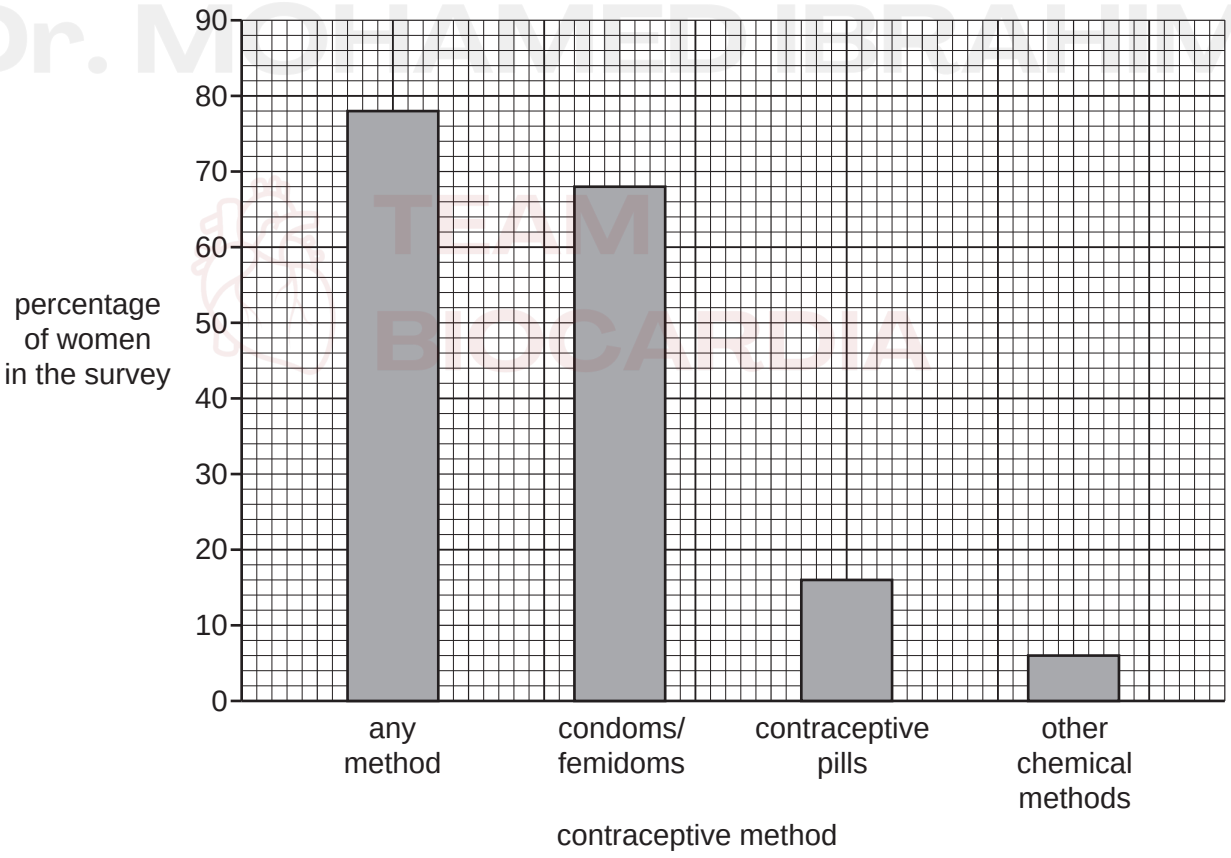

Fig. 4.1

(b) (i) State **two** hormones that are used in contraceptive pills.

1 .....

2 ..... [2]

(ii) Suggest why contraceptive pills do **not** contain FSH.

.....

.....

.....

.....

..... [3]

(iii) Give **one** example of 'other chemical methods' (fourth bar) that could be included in the bar in Fig. 4.1.

..... [1]

(iv) State **two** methods of birth control that were not listed in the survey.

1 .....

2 ..... [2]

(v) The percentage of the last three bars in Fig. 4.1 added together is 90%.

Suggest why the percentage of women who used any type of contraceptive method (first bar) is not equal to the sum of the last three bars.

.....

.....

..... [1]

[Total: 12]

6 **(a)** Fig. 6.1 is a diagram of the human female reproductive system.

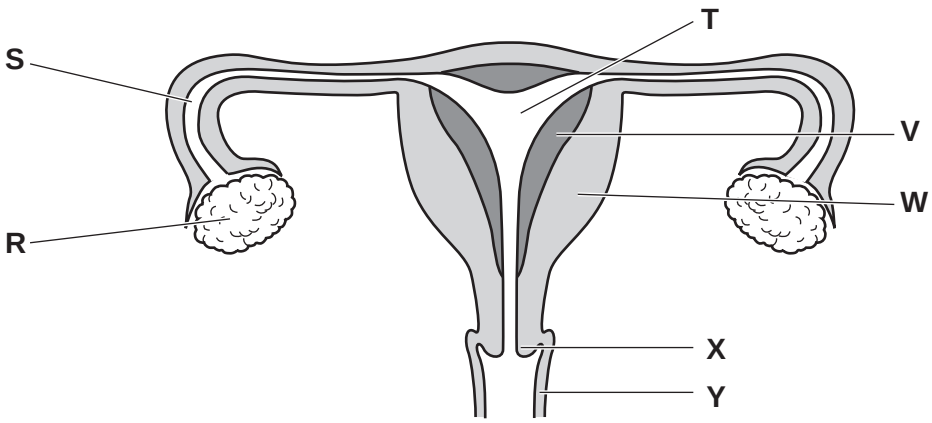

Fig. 6.1

(i) Complete Table 6.1 by stating the letter from Fig. 6.1 that identifies the structure where each process occurs.

Table 6.1

process	letter from Fig. 6.1
meiosis	
fertilisation	
implantation	

[3]

(ii) State the name of the part of the female reproductive system labelled **S** in Fig. 6.1.

..... [1]

(b) Fig. 6.2 is a diagram of a human sperm cell.

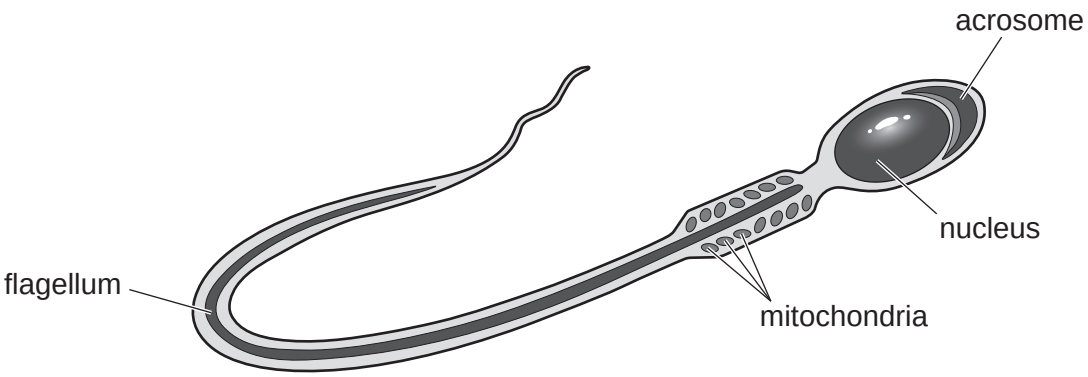

Fig. 6.2

(i) Write the formula that would be used to calculate the magnification of the diagram.

[1]

(ii) The actual length of the sperm cell in Fig. 6.2 is 0.055 mm.

Convert this value to micrometres (μm).

Space for working.

..... μm [1]

(c) Explain why the nuclei of sperm cells differ from those of other cells in the male.

.....

.....

.....

.....[2]

(d) Explain the roles of the flagellum, the mitochondria and the acrosome in sperm cells.

.....

.....

.....

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.....

.....

.....

.....

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.....

.....

.....[6]

4 Fig. 4.1 is a diagram of the human female reproductive system.

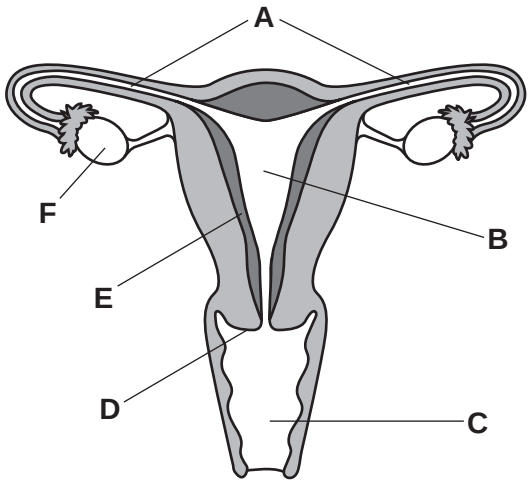


Fig. 4.1

(a) Complete Table 4.1 to show the letter and the name of each of the structures that perform these functions.

Table 4.1

function	letter	name
releases oestrogen		
site of fertilisation		
site of implantation		
dilates during the process of birth		

[4]

(b) Fertilisation is the fusion of the nuclei of a male gamete and a female gamete resulting in a zygote.

State the number of chromosomes present in a human:

female gamete .....

zygote .....

[2]

(c) Chlamydia is a sexually transmitted infection (STI).

Fig. 4.2 shows the number of reported cases of chlamydia in females in each age group in one country.

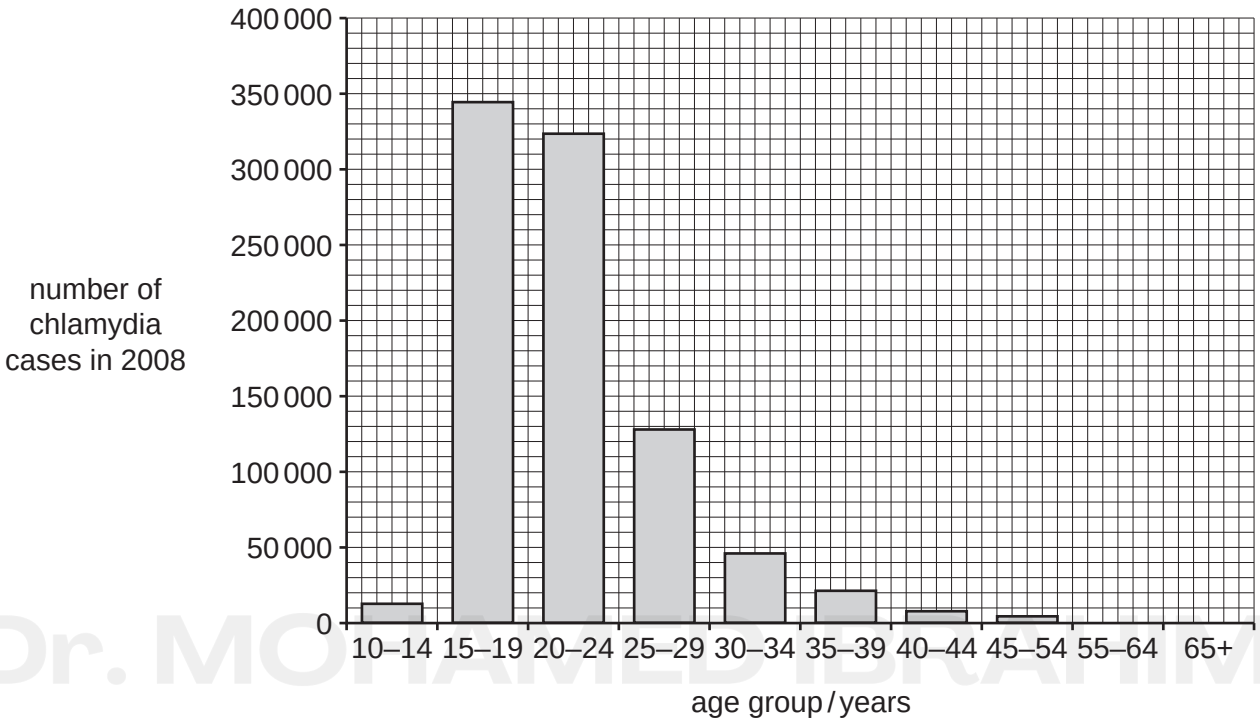


Fig. 4.2

Describe the results shown by the data in Fig. 4.2.

.....

.....

.....

.....

.....

.....

.....[3]

(d) Chlamydia is caused by a bacterium.

(i) Suggest a treatment for chlamydia.

.....[1]

(ii) State the name of **one other** STI.

.....[1]

1 An *in vitro* fertilisation (IVF) procedure is outlined in Fig. 1.1.

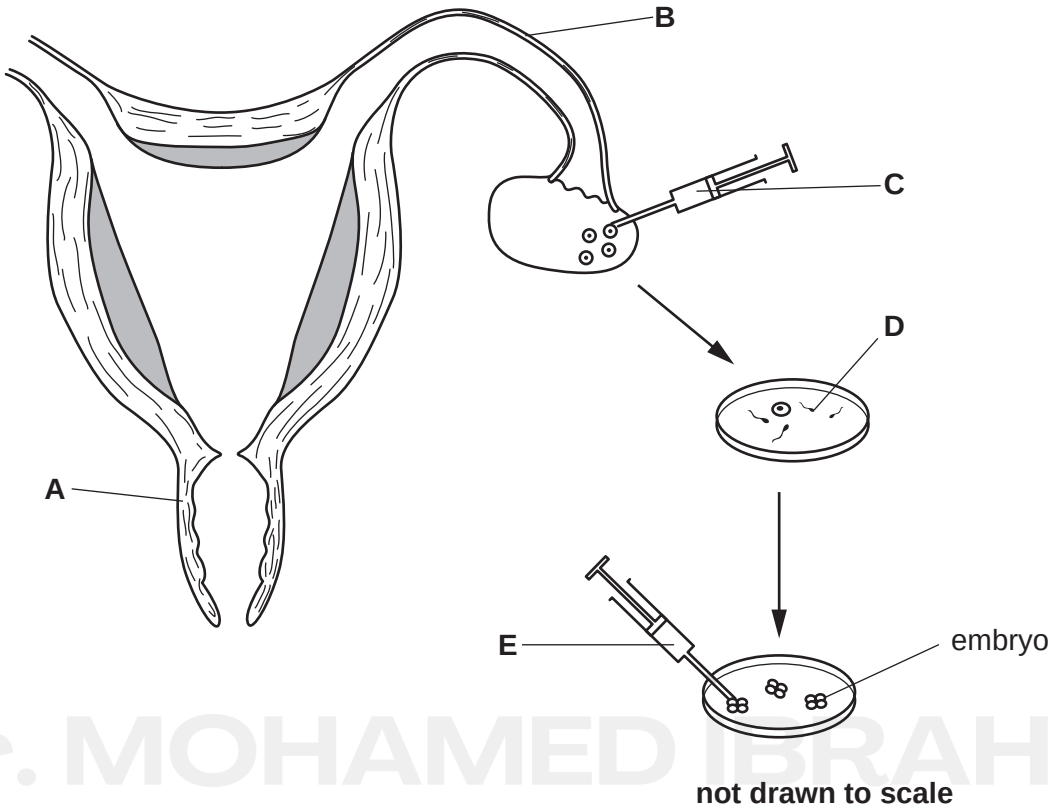


Fig. 1.1

(a) (i) Name structures **A**, **B** and **D**.

A .....

B .....

D .....

[3]

(ii) State the purpose of syringe **C**.

.....

.....[1]

(b) (i) Name a hormone that would be injected to stimulate egg cell development.

.....[1]

(ii) State when, during the menstrual cycle, this hormone should be injected.

.....[1]

(iii) Draw an **X** on Fig. 1.1 at the position where the embryos should be placed.

[1]

(c) Discuss the social implications of IVF.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 11]

(d) Testosterone is a steroid hormone that is also taken as a drug to improve sporting performance.

(iii) State where testosterone is produced in the body.

.....[1]

Nervous System & Eye

(c) Reflexes in animals are also an example of sensitivity.

(i) Describe how reflexes in animals differ from sensitivity in plants.

.....

.....

.....

.....

..... [2]

(ii) The pupil reflex is an example of a reflex that occurs in the eye. The eye is a sense organ.

Define the term *sense organ*.

.....

.....

.....

.....

..... [2]

[Total: 14]

1 **(a)** Sensitivity is one of the characteristics of life. The eye is one of the major sense organs of vertebrates.

(i) Define the term *sensitivity*.

.....

.....

.....

..... [2]

(ii) Define the term *sense organ*.

.....

.....

.....

..... [2]

(b) Accommodation (focusing) is one of the functions of the eye.

Fig. 1.1 is a diagram of an eye that is focusing on a distant object.

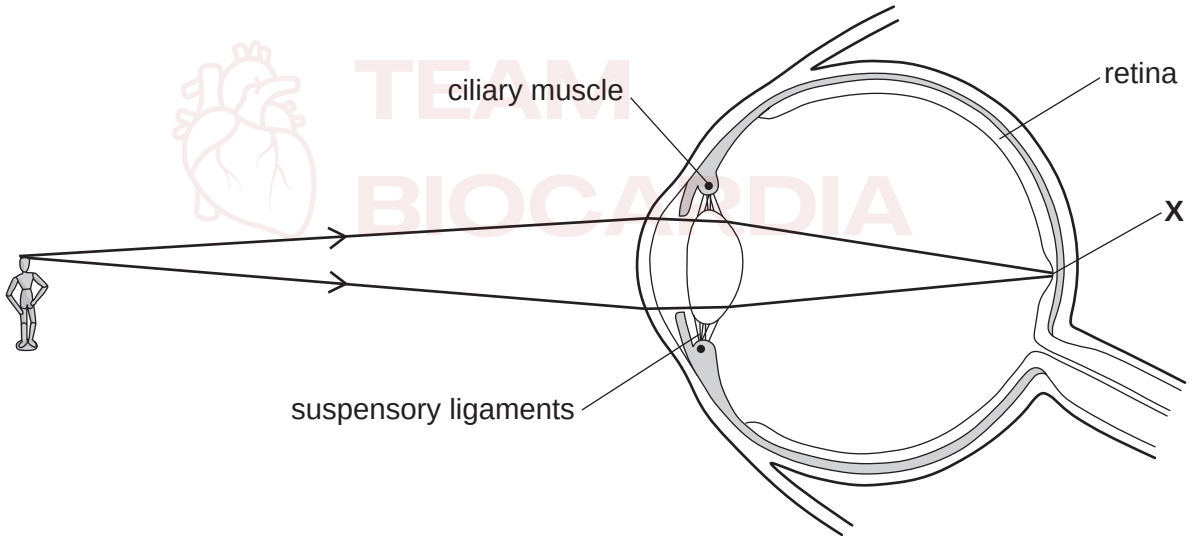


Fig. 1.1

(i) State the name of the part of the retina labelled **X**.

..... [1]

Fig. 1.2 is an incomplete diagram of an eye that is focusing on a near object.

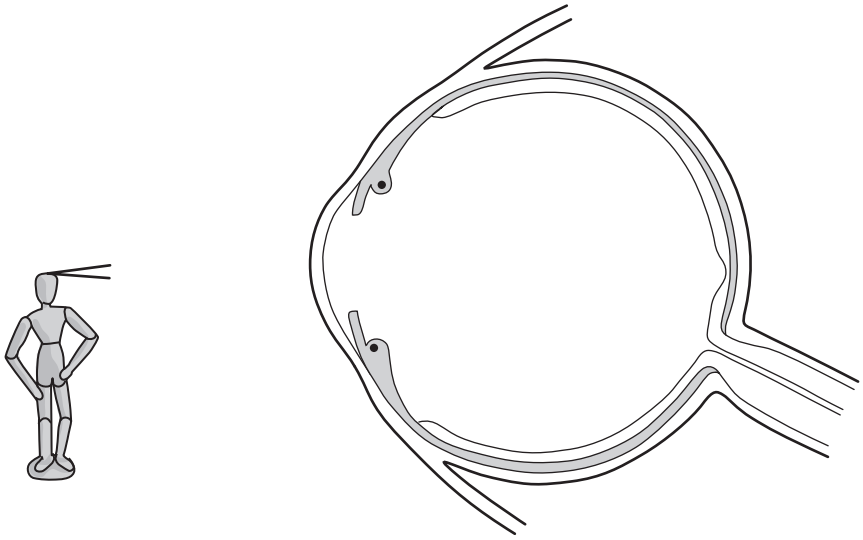


Fig. 1.2

(ii) Complete Fig. 1.2 by **drawing** the shape of the lens and the light rays from the object to the retina. [3]

(iii) Describe the roles of the ciliary muscles and suspensory ligaments in focusing on a **distant object**, as shown in Fig. 1.1.

.....

.....

.....

.....

.....

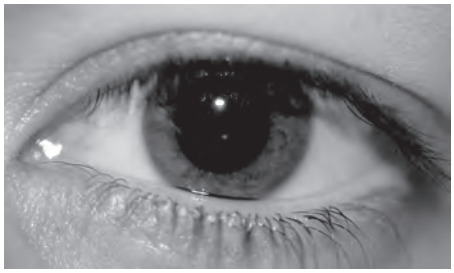
.....

.....

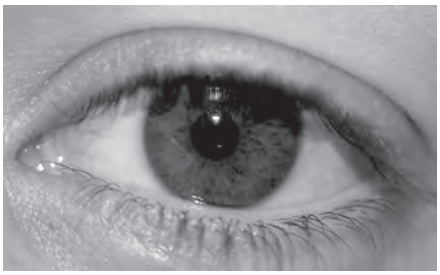
..... [3]

(c) The eye also controls the amount of light that enters the pupil.

Fig. 1.3 shows an eye in low light and in bright light.



eye in low light



eye in bright light

Fig. 1.3

Describe the changes that occur in the eye when the light becomes bright, as shown in Fig. 1.3.

.....

.....

.....

.....

.....

.....

..... [3]

(d) The change shown in Fig. 1.3 occurs automatically without thought.

State the name given to this type of action.

..... [1]

[Total: 15]

(f) Fig. 2.2 shows the junction between two neurones with drug **X** absent and two neurones with drug **X** present, immediately after a painful stimulus.

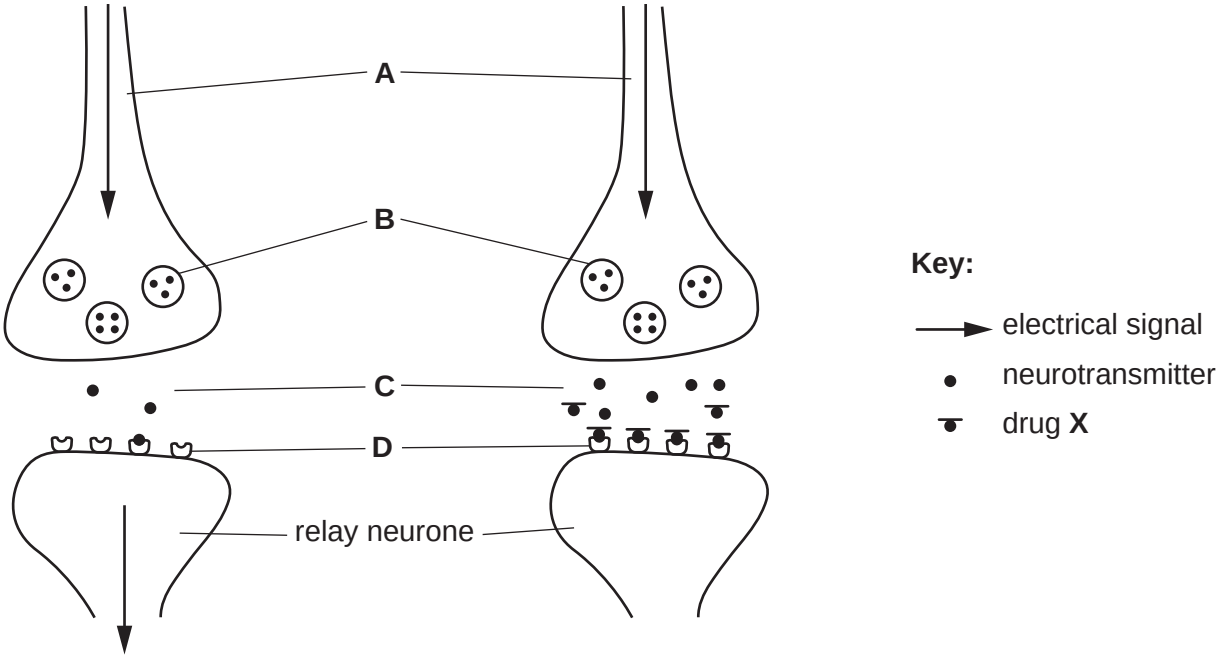


Fig. 2.2

(i) State the names of **A**, **B**, **C** and **D** in Fig. 2.2.

A .....

B .....

C .....

D .....

[4]

(ii) Describe **and** explain how drug **X** affects the function of the relay neurone shown in Fig. 2.2.

.....

.....

.....

.....

.....

.....

..... [3]

4 Neurones are part of the nervous system. Neurones are connected to each other by synapses.

(a) **(i)** Describe how the structure of a neurone is related to its function.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) The nervous system is made up of the central nervous system and the peripheral nervous system.

State the names of the organs that make up the central nervous system.

..... [1]

(b) Reflex actions allow the body to respond rapidly to changes in the external environment.

(i) Outline the pathway in a reflex arc in response to shining a bright light into the eye.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) Doctors sometimes check the reflexes of people who are unconscious.

Suggest why reflexes occur in people who are unconscious.

..... [1]

(c) Fig. 4.1 is a diagram of a synapse and parts of two neurones.

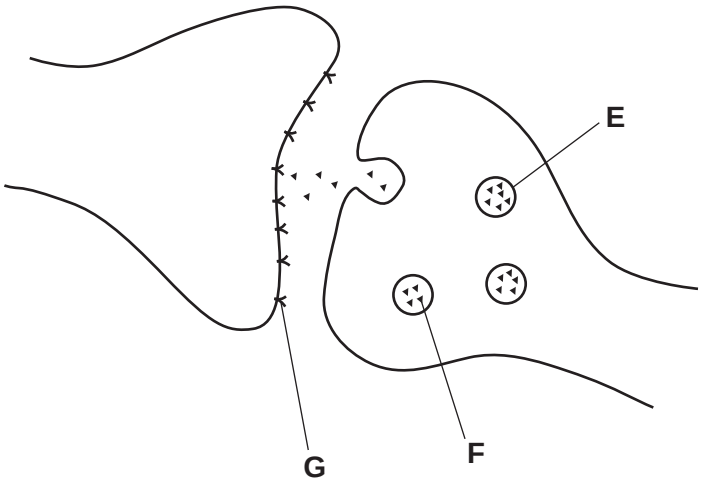


Fig. 4.1

(i) State the names of the labelled parts in Fig. 4.1.

E .....

F .....

G .....

[3]

(ii) Draw an arrow on Fig. 4.1 to show the direction in which the signal travels across the synapse. [1]

[Total: 12]

3 Reflexes are simple responses that protect the body.

(a) The letters **A** to **G** show the components involved in a reflex action.

A stimulus
B motor neurone
C sensory neurone
D receptor cell
E response
F relay neurone
G effector

Put the letters into the correct sequence involved in a reflex action. Two have been done for you.

A						**E**

[1]

(b) Impulses travel along neurones.

Describe how impulses pass from one neurone to another neurone across a synapse.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

4 The eye is a sense organ that responds to light.

Fig. 4.1 is a diagram of a section through the human eye.

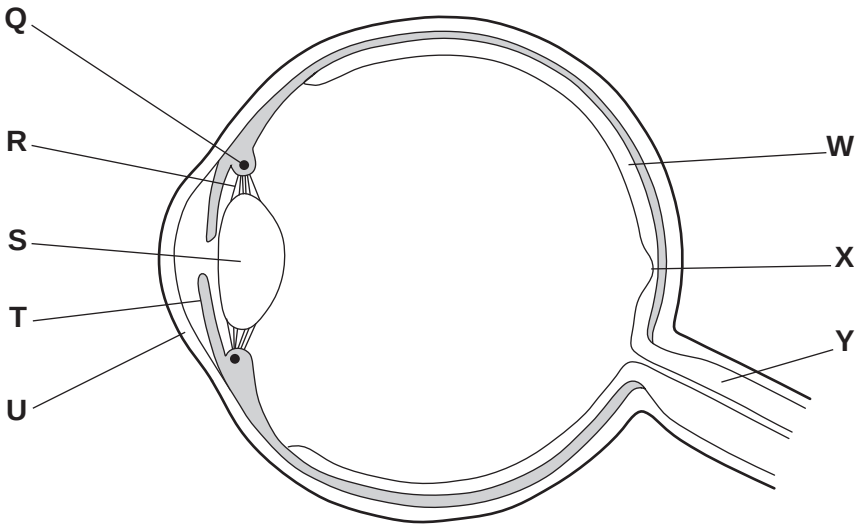


Fig. 4.1

(a) Table 4.1 describes some of the functions of the parts of the eye.

Complete the table by:

- naming the parts of the eye
- using the letters on Fig. 4.1 to identify the parts of the eye.

Table 4.1

function	name of part	letter on Fig. 4.1
carries impulses to the brain		
focuses light onto the back of the eye		
controls the tension of the suspensory ligaments		
tissue that detects light and colour		
location of most of the cone cells		

[5]

(b) **(i)** A pair of muscles in the eye work in opposition to each other to adjust the amount of light entering the pupil.

State the term that describes the action of a pair of muscles working in opposition to each other.

.....[1]

(ii) A different pair of muscles in the eye work in opposition to each other to view objects at different distances from the eye.

State the name of the process that allows the eye to view objects at different distances.

.....[1]

(c) Explain why the eye cannot easily identify different colours in **low** levels of light.

.....

.....

.....

.....

.....[2]

There are pain receptors in the skin. These receptors transmit impulses along sensory neurones to the spinal cord.

Fig. 3.1 shows the synapses between sensory neurone **A** and a relay neurone and sensory neurone **B** and a relay neurone, in the spinal cord.

Fig. 3.2 is an enlarged view of the synapse between sensory neurone **A** and the relay neurone, as indicated by the circle on Fig. 3.1.

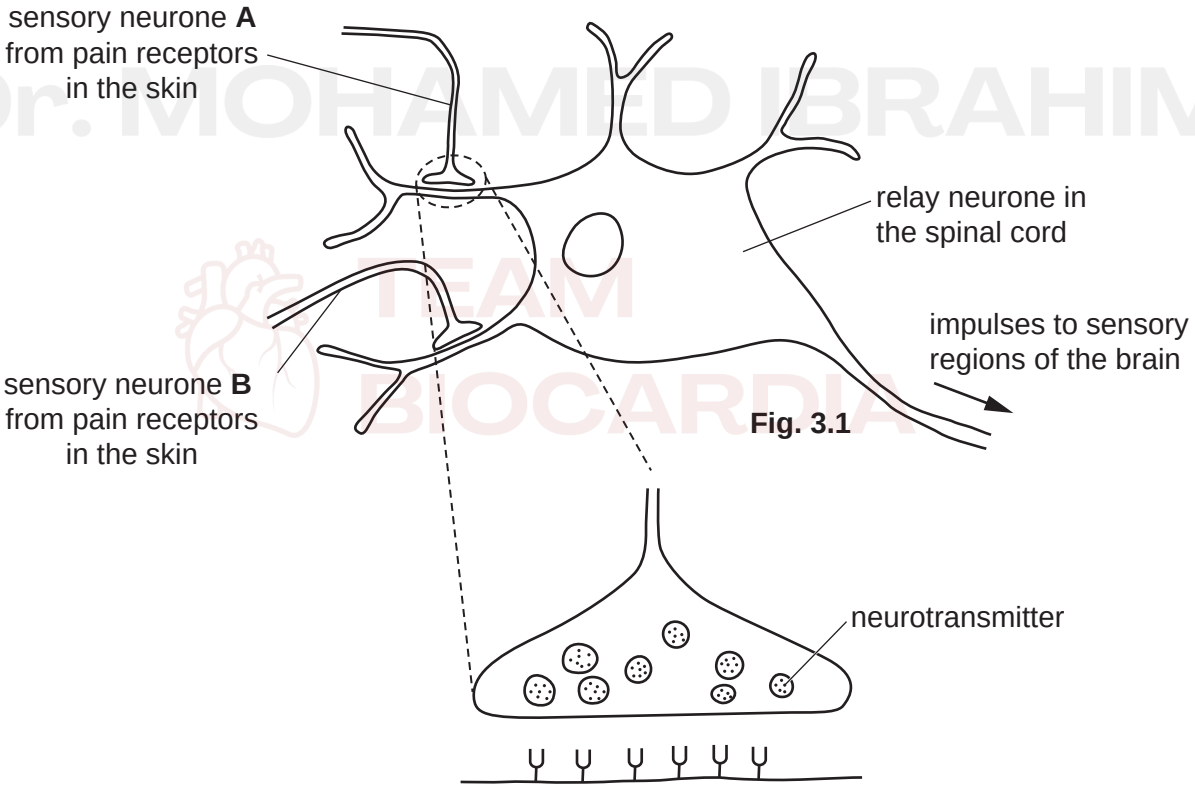


Fig. 3.1

Fig. 3.2

(b) Describe how impulses are transmitted across the synapse.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(c) Suggest how the structure of a synapse ensures that impulses travel in one direction.

.....

.....

.....

.....

.....[2]

(e) List **three** stimuli, other than pain, which humans can detect.

1.....

2.....

3.....
[3]

[Total: 14]

3 Colour blindness in humans is caused by a fault in some of the light receptor cells in the retina of the eye. Rod cells and cone cells are two types of light receptor.

(a) Complete Table 3.1 to state the function of three types of cell in the eye.

Table 3.1

type of cell in the eye	function
rod cells	....
cone cells	....
sensory neurones	....

[3]

(b) The number of rod cells and cone cells at places across the retina were recorded.

The diagram of an eye in Fig. 3.1 shows the angles from the fovea where the recordings were made.

The graph in Fig. 3.1 shows the number of rod cells and cone cells across the retina.

Use Fig. 3.1 to describe **and** explain the distribution of rod cells and cone cells across the retina.

.....

.....

.....

.....

.....

.....

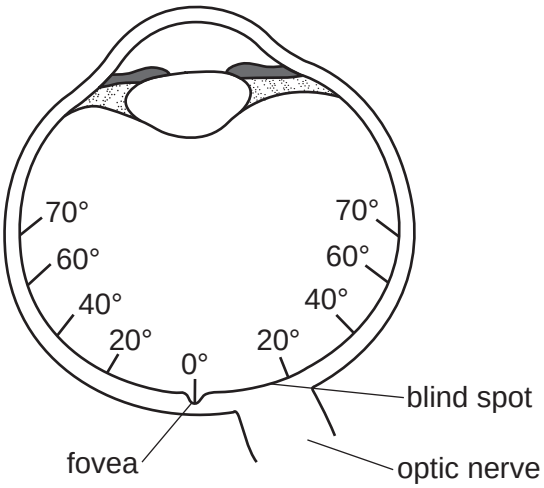
.....

.....

.....

.....

.....[5]


70°
70°
60°
60°
40°
40°
20°
20°
0°
blind spot
fovea
optic nerve

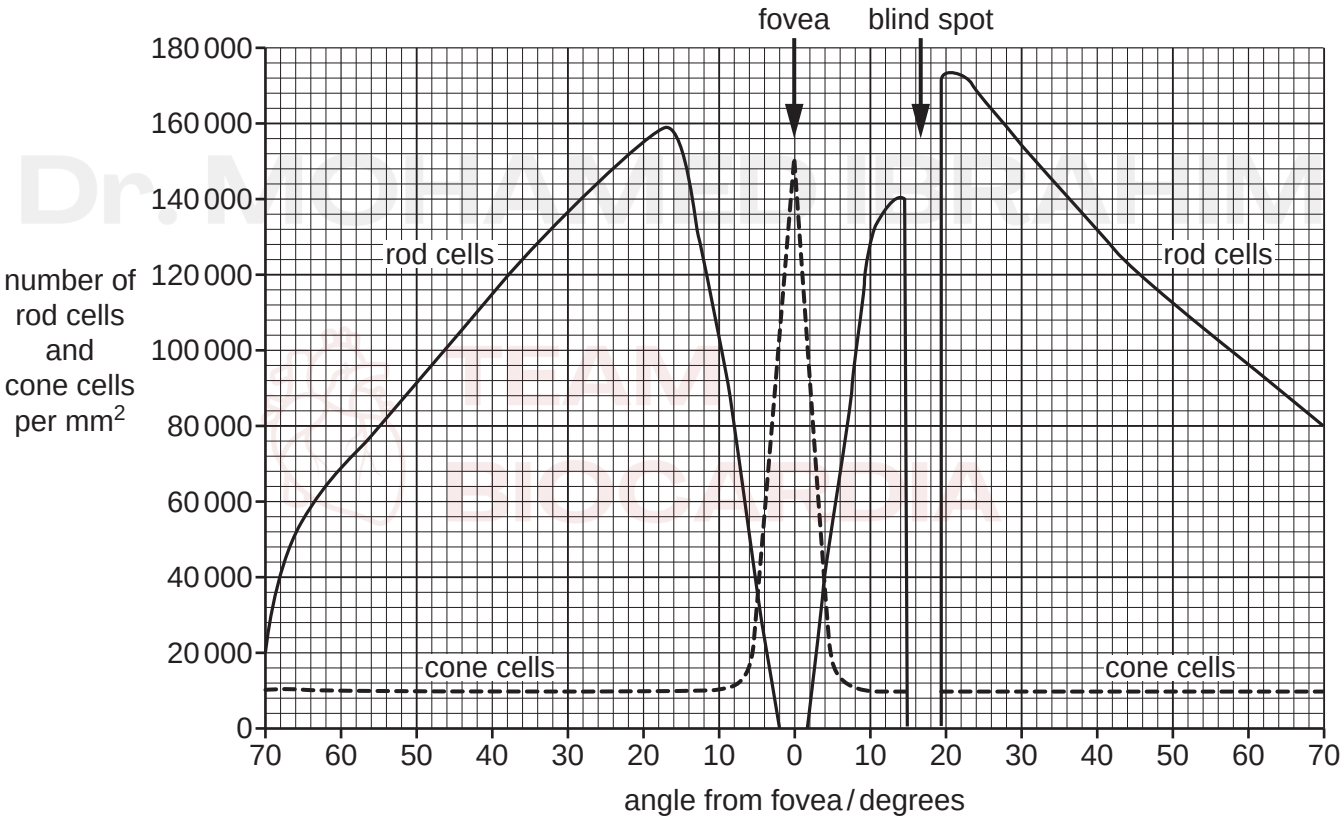

fovea
blind spot
180 000
160 000
140 000
120 000
100 000
80 000
60 000
40 000
20 000
0
number of rod cells and cone cells per mm2
rod cells
rod cells
cone cells
cone cells
70 60 50 40 30 20 10 0 10 20 30 40 50 60 70
angle from fovea / degrees

Fig. 3.1

2 The nervous system coordinates the responses of animals to changes in their environment.

(a) Fig. 2.1 shows the arrangement of the nervous system in a mammal.

Complete Fig. 2.1 by writing the names of the missing parts of the mammalian nervous system in the boxes.

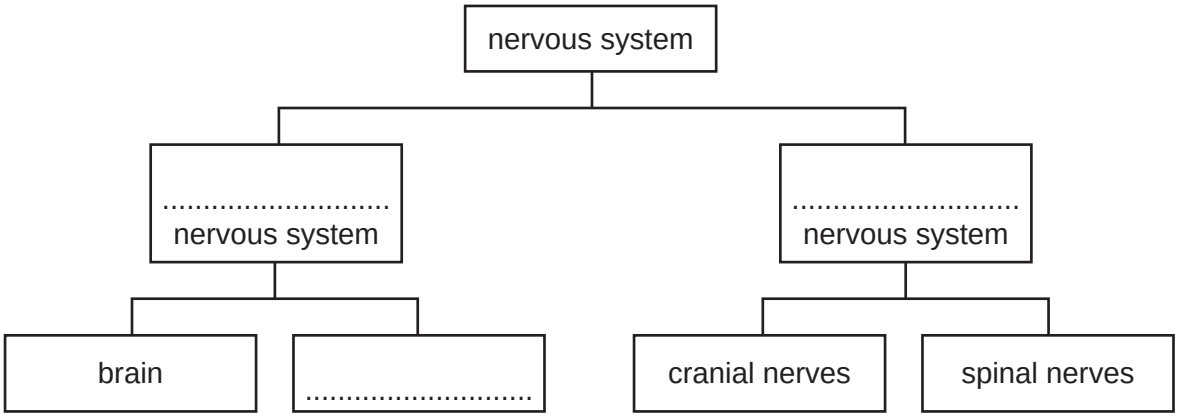


Fig. 2.1

[3]

(b) Fig. 2.2 is a flow chart that shows how an involuntary action is controlled.

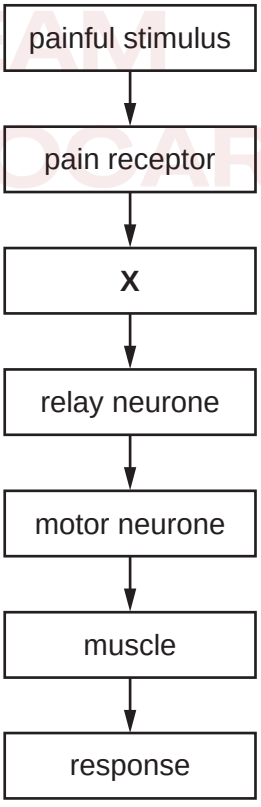


Fig. 2.2

(i) State the structure found at **X**.

..... [1]

(ii) State the type of involuntary action shown by the flow chart.

..... [1]

(iii) State **two** ways in which a voluntary action differs from an involuntary action.

1 .....

.....

2 .....

.....

[2]

2 Reflexes are simple responses that protect the body.
The pathway that nerve impulses travel along during a reflex is called a reflex arc.

(a) Letters **A** to **G** show the components of a reflex arc.

A stimulus
B motor neurone
C sensory neurone
D receptor cell
E response
F relay neurone
G effector

Put the components into the correct sequence. Two have been done for you.

A						**E**

[1]

(b) Impulses travel between neurones across a synapse.

Describe how impulses travel across the synapse from one neurone to another.

.....

.....

.....

.....

.....

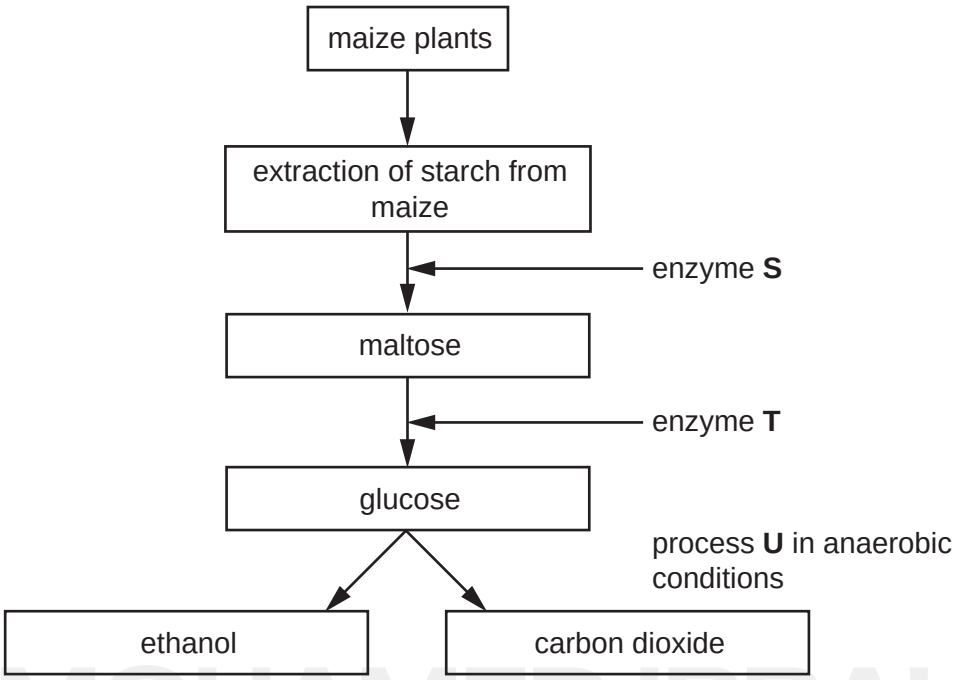
.....

.....[3]

Respiration & Gas Exchange

(b) Yeast is used in the production of ethanol to manufacture a type of biofuel.

Fig. 4.2 is a flow chart of the process.



(ii) Yeast is used in process **U**. Complete the balanced chemical equation for anaerobic respiration in yeast.

..... ⟶ .....C_2H_5OH + ...

[2]

Describe the role of the liver in the recovery from oxygen debt after strenuous exercise.

.....

.....

.....

.....

..... [2]

1 The gas exchange system is one of the organ systems of the human body.

Fig. 1.1 shows parts of the gas exchange system during breathing in and breathing out.

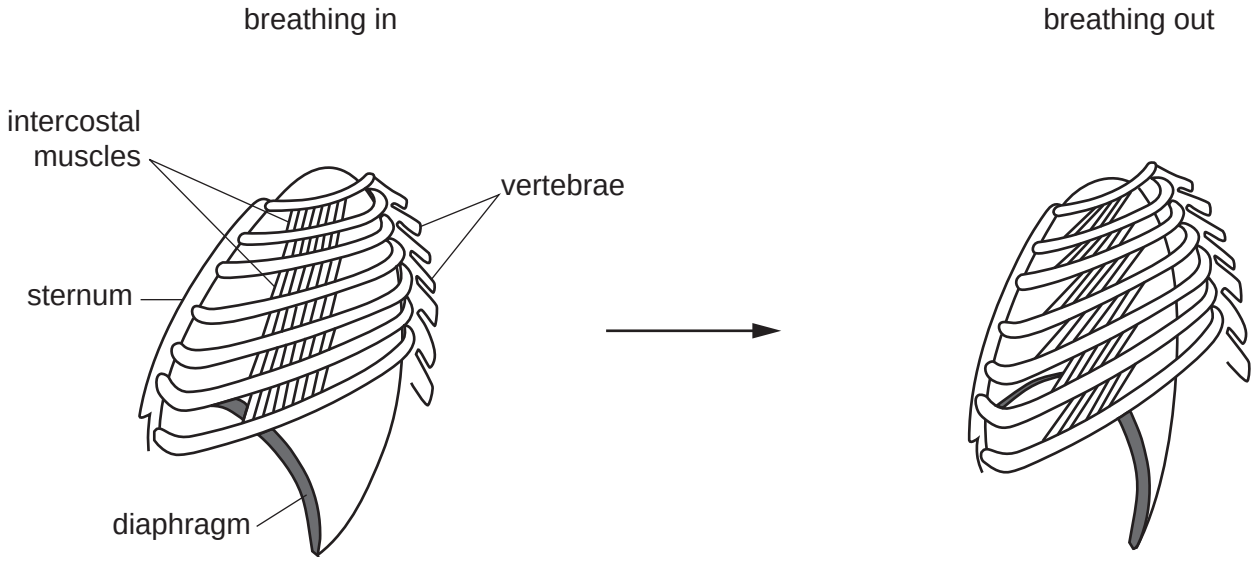


Fig. 1.1

(a) Complete Table 1.1 to show:

- the functions of the diaphragm and the intercostal muscles during breathing in and breathing out
- the pressure changes in the thorax.

Use these words:

contract
relax
increases
decreases.

Table 1.1

	diaphragm	intercostal muscles		pressure change in the thorax
		internal	external	
breathing in				
breathing out				

[4]

Fig. 1.2 shows part of the gas exchange surface of a human.

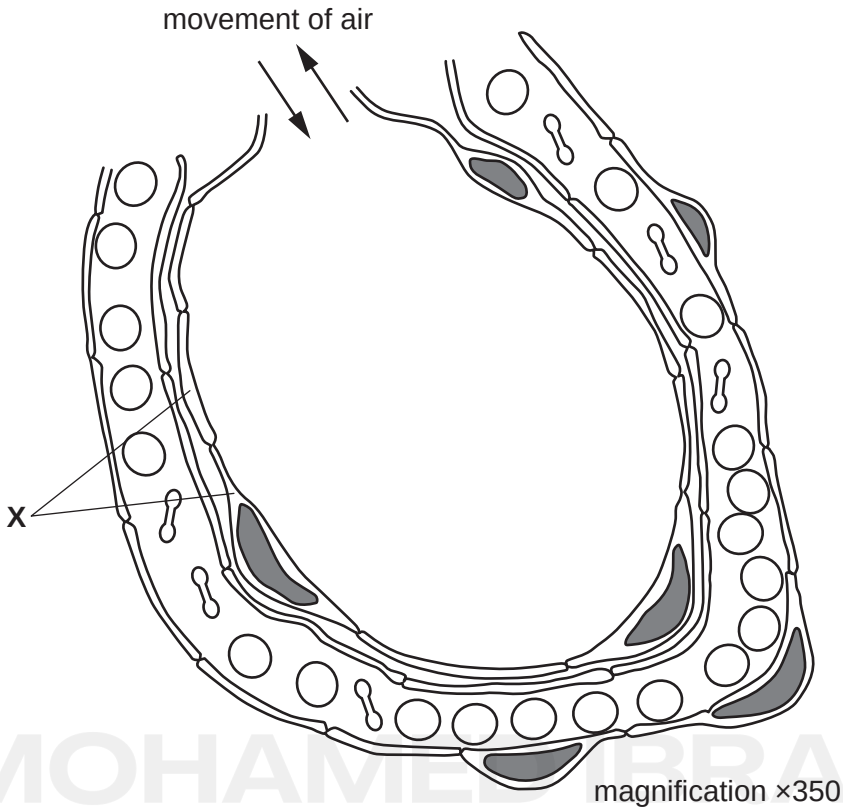


Fig. 1.2

(b) State **two** features of the gas exchange surface that are **visible** in Fig. 1.2.

1 .....

2 .....

[2]

(c) The cells labelled **X** on Fig. 1.2 form a tissue.

(i) Define the term *tissue*.

.....

.....

.....

.....

..... [2]

(ii) Cartilage is another tissue found in the gas exchange system.

State the functions of cartilage in the gas exchange system.

.....

.....

.....

.....

..... [2]

[Total: 10]

(b) A person who does not smoke can be exposed to tobacco smoke from other people smoking.

Researchers studied the effect of exposure to tobacco smoke on the development of lung cancer in three groups of women who did not smoke:

- group 1 – no exposure to tobacco smoke
- group 2 – low level exposure to tobacco smoke
- group 3 – high level exposure to tobacco smoke.

Their results are shown in Table 1.1.

Table 1.1

group	number of women studied	number of women who died from lung cancer	percentage of women who died from lung cancer
1	21 895	32	0.15
2	44 184	86	
3	25 461	56	0.22

(i) Calculate the percentage of women in group 2 who died from lung cancer.

Write your answer, to **two** significant figures, in Table 1.1.

[2]

(ii) Many countries have laws that ban smoking in public buildings.

Discuss the evidence from Table 1.1 that supports these laws.

.....

.....

.....

.....

.....

.....

..... [3]

(iii) Smoking has been found to increase the risk of developing diseases other than cancer.

State **two** other diseases that can be caused by smoking.

1 .....

2 .....
[2]

[Total: 14]

2 **(a)** Fig. 2.1 shows the transfer of materials between blood and tissues.

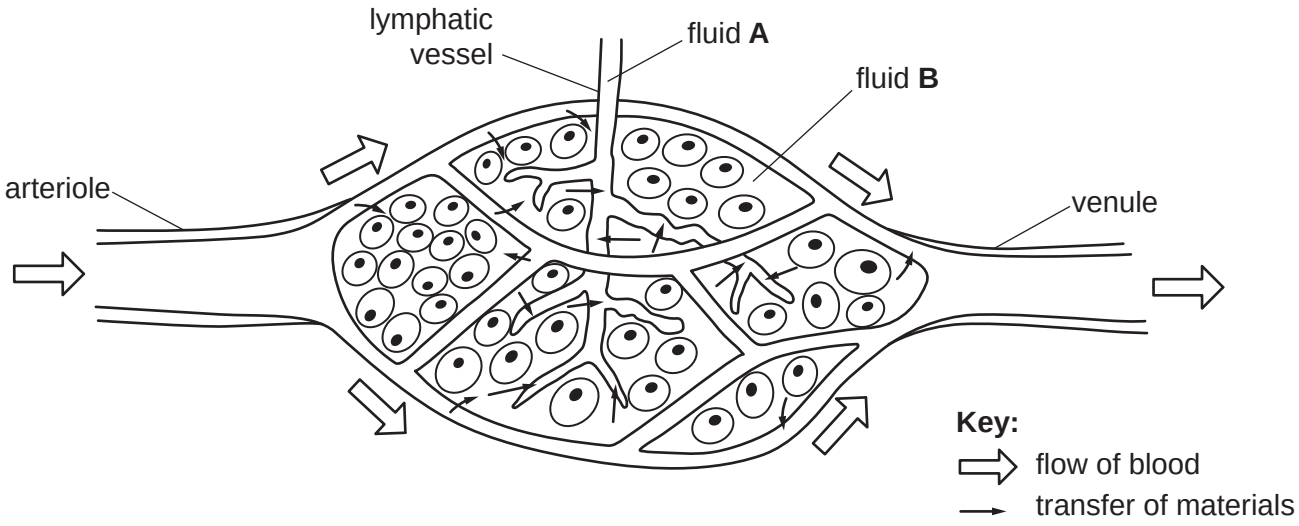


Fig. 2.1

(i) Complete Table 2.1 by:

- stating the names of the fluids
- writing **yes** if the fluid contains red blood cells or **no** if the fluid does **not** contain red blood cells.

Table 2.1

letter on Fig. 2.1	name of the fluid	contains red blood cells
A		
B		

[2]

(ii) State the name of the process by which oxygen is transferred from fluid **B** to the cells.

..... [1]

(iii) Explain why cells need oxygen.

.....

.....

.....

.....

..... [2]

1 Bacteria are classified in the Prokaryote kingdom.

(a) State **two** features of animal cells that are **not** found in bacteria.

1 .....

2 .....
[2]

(b) The bacterium *Bacillus megaterium* was grown in the laboratory fermenter shown in Fig. 1.1.

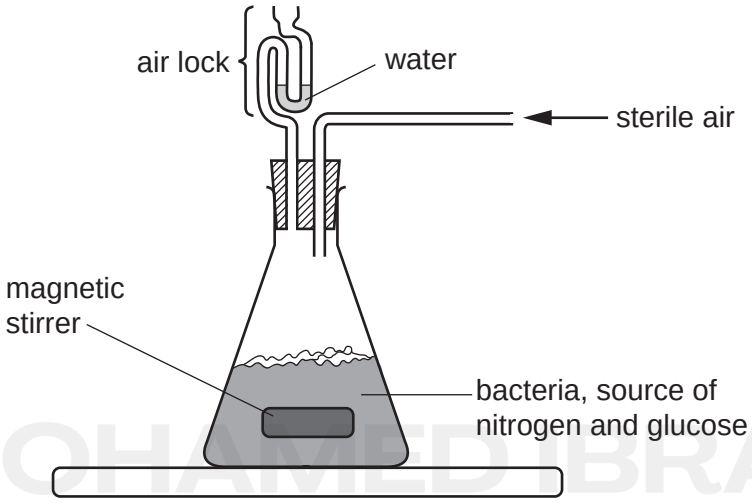


Fig. 1.1

(i) Explain why a source of nitrogen and glucose were added to the fermenter.

nitrogen .....

.....

glucose .....

.....
[2]

(ii) Suggest why it is important to stir the contents of the fermenter continuously.

.....

.....

.....

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.....

.....

..... [3]

(c) Samples were taken from the fermenter at frequent intervals and the number of live bacteria was determined. The results are shown in Fig. 1.2.

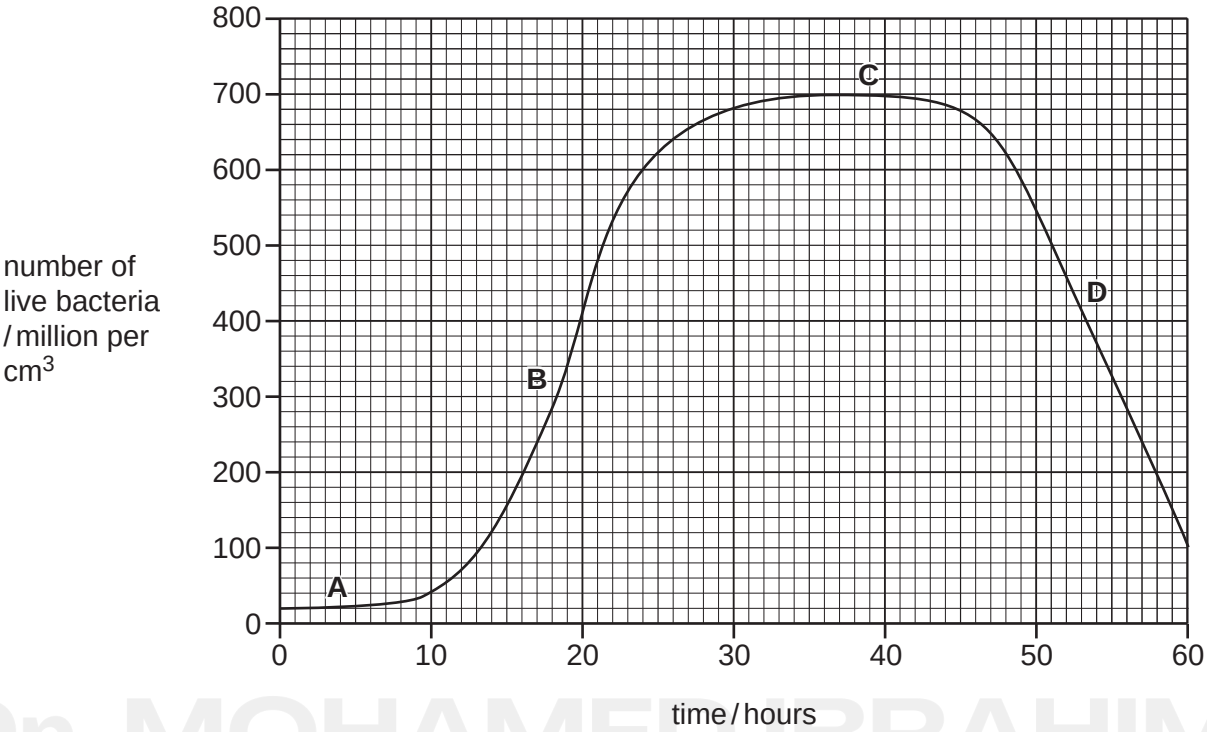

Fig. 1.2

Describe **and** explain what happens to the number of live bacteria shown in the stages labelled **A**, **B**, **C** and **D** in Fig. 1.2.

.....

.....

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.....

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.....

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.....

..... [6]

[Total: 13]

(c) A respirometer is shown in Fig. 5.2. It can be used to estimate an organism's rate of respiration.

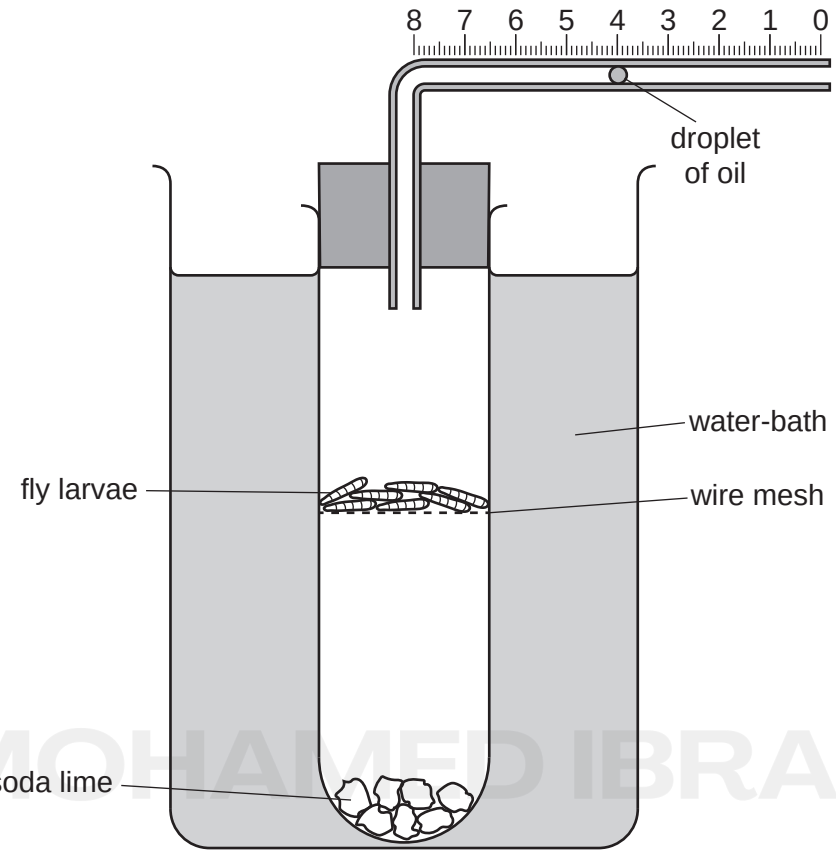


Fig. 5.2

(i) Complete the sentences:

A respirometer can be used to calculate the ..... of oxygen used by the fly larvae by measuring the ..... the droplet of oil moves in one minute. A water-bath is used to ..... the temperature of the apparatus.

[3]

(ii) The soda lime in the respirometer absorbs carbon dioxide.

Explain why this is important in this investigation.

.....

.....

..... [1]

(iii) Fly larvae respire to release energy.

State **two** uses of energy in a fly larva.

1 .....

2 .....

[2]

(d) A student used a respirometer to investigate the effect of temperature on the rate of respiration of germinating seeds.

Predict the results of this investigation and explain your prediction.

prediction .....

.....

.....

explanation .....

.....

.....

.....

.....

.....

[4]

[Total: 15]

5 **(a)** State the balanced chemical equation for aerobic respiration.

.....[2]

(b) Researchers in the Czech Republic investigated oxygen consumption in horses. They measured the oxygen consumption of the horses while they were exercising at four different paces: walking, trotting, cantering and galloping.

The results are shown in Fig. 5.1.

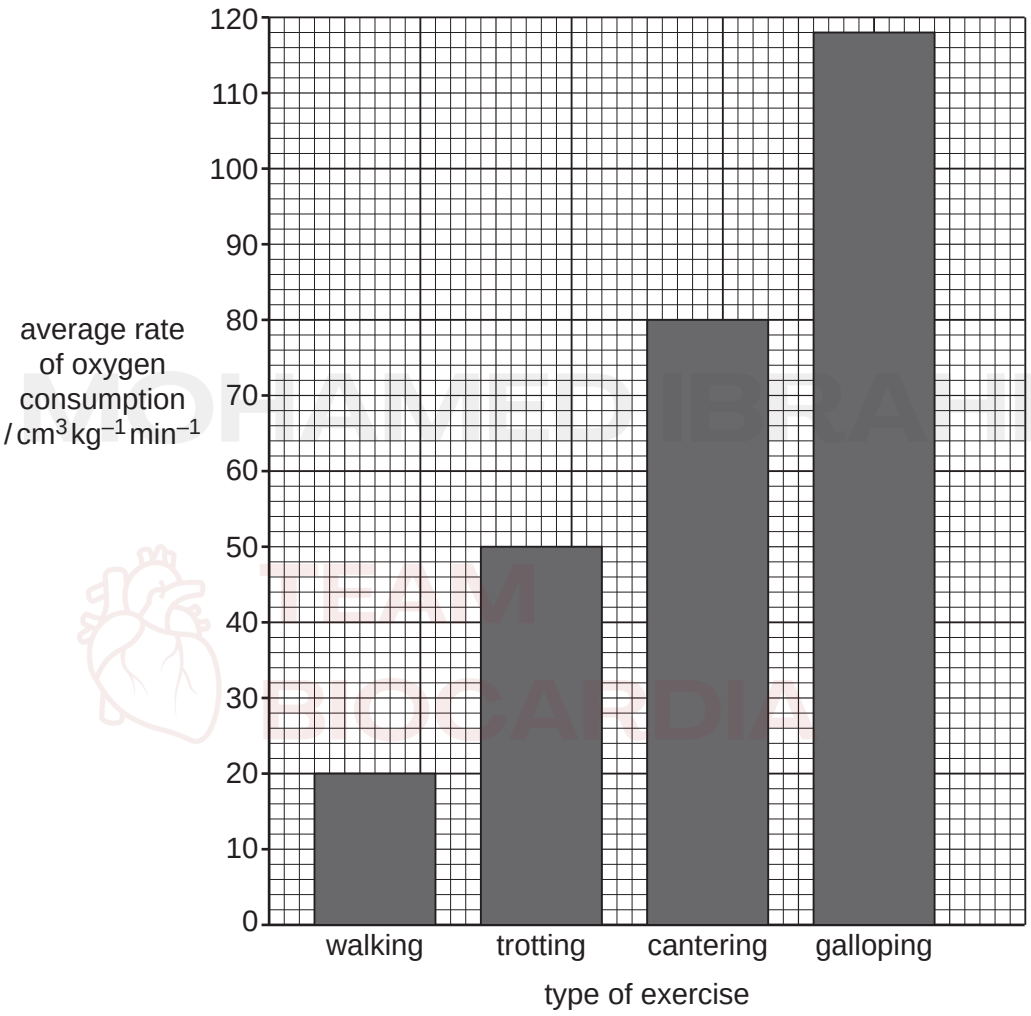


Fig. 5.1

Calculate the percentage increase in the average rate of oxygen consumption as the horses change from walking to trotting.

Show your working.

..... %
[2]

(c) The researchers also calculated the oxygen debt for each type of exercise.

They found that the horses developed a larger oxygen debt when they exercised by galloping and cantering rather than when they walked.

Explain why the horses developed an oxygen debt when they exercised.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(d) Describe how the horses would recover from an oxygen debt when they stop exercising.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total:11]

7

Describe **and** explain the changes in blood lactic acid concentration shown in Fig. 2.1.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[6]

(c) The concentration of lactic acid in the blood of two athletes was investigated. One athlete, **P**, had been training and the other, **Q**, was returning to training after an injury.

Blood samples were taken from both athletes during a training session. The results are shown in Fig. 2.2.

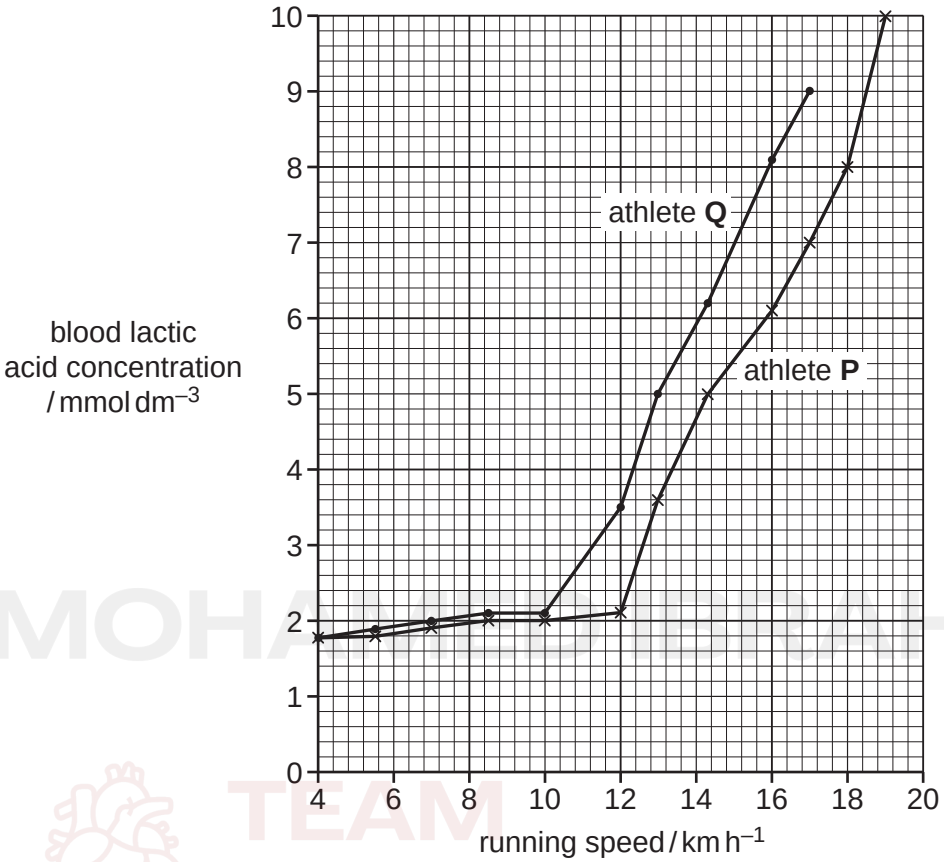


Fig. 2.2

(i) The lactic acid threshold is the level of exercise where the lactic acid concentration begins to increase exponentially.

State the lactic acid threshold for athletes **P** and **Q**.

P ..... km h^{-1}

Q ..... km h^{-1}

[1]

(ii) Suggest a reason for the difference in lactic acid threshold of athletes **P** and **Q**.

.....

.....

.....[1]

(iii) Explain the link between physical activity and breathing.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 14]

(iii) Describe how the ventilation of the lungs will change while the athlete exercises.

.....

.....

.....

.....

.....[2]

[Total: 12]

4 Tobacco smoke is made up of over 7000 chemicals.

(b) Describe the effect on the gas exchange system of the following components of tobacco smoke:

carbon monoxide .....

.....

.....

.....

tar .....

.....

.....

.....

[4]

(c) A study compared the percentages of men and women aged between 35 and 54 years who smoked cigarettes. The annual death rate caused by lung cancer was also recorded.

The results are shown in the two graphs in Fig. 4.1.

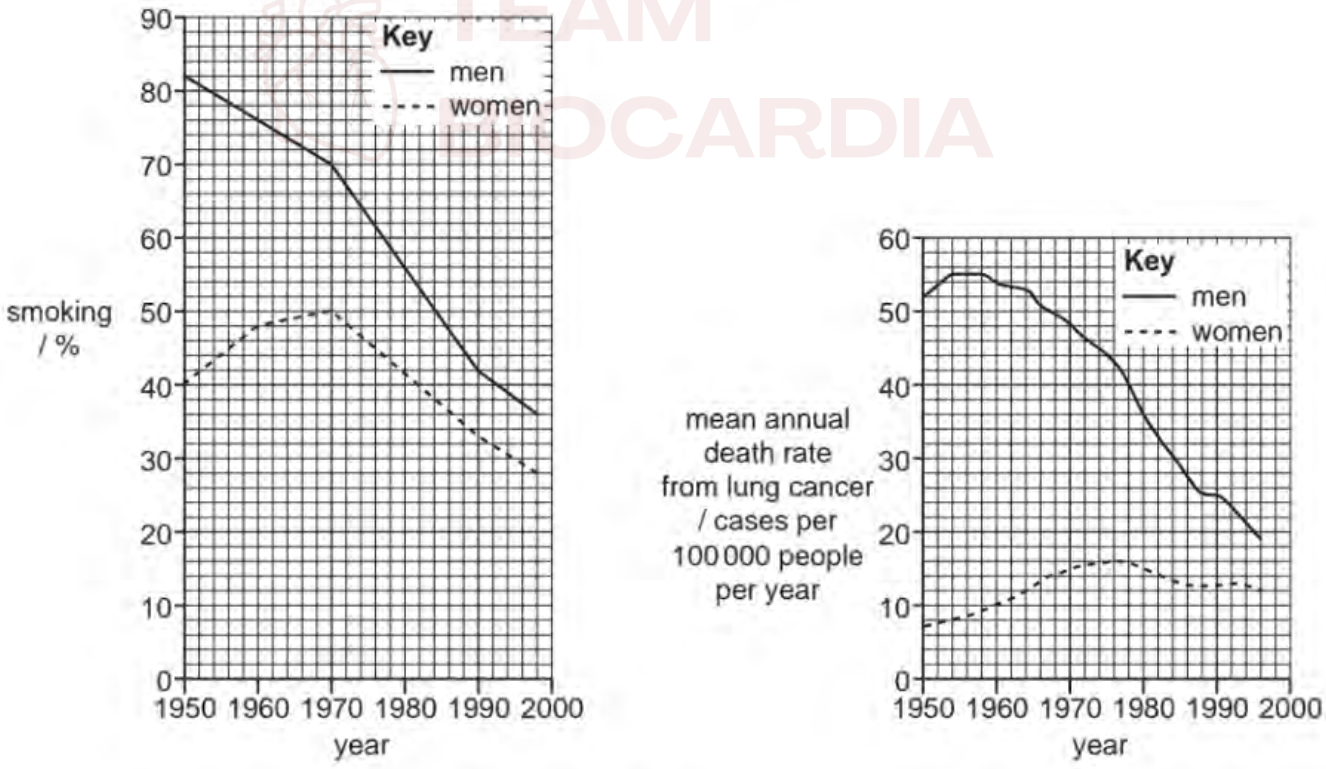


Fig. 4.1

(i) Use the data shown in Fig. 4.1 to compare the percentages of men and women who smoked cigarettes between **1950** and **1998**.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

Fig. 5.1 shows the total mass of wild fish caught worldwide between 1950 and 2012 and the mass of farmed fish produced worldwide over the same period.

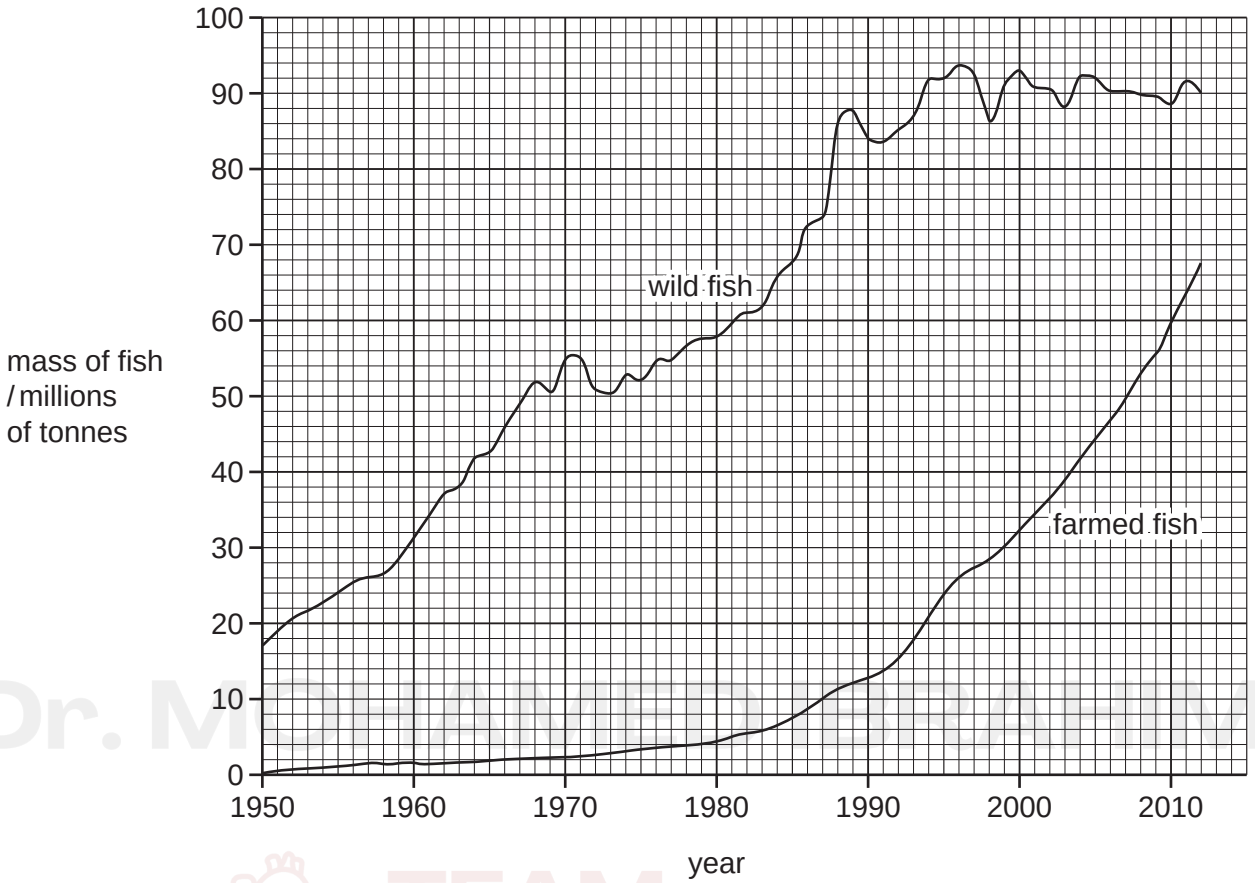


Fig. 5.1

(b) Describe the changes in the mass of **wild fish** caught between 1950 and 2012.

You will gain credit if you use data from Fig. 5.1.

.....

.....

.....

.....

.....

.....

..... [3]

3 Yeast is used in bread-making. It respires anaerobically, producing carbon dioxide.

(a) Write the balanced chemical equation for anaerobic respiration of yeast in bread-making.

.....[2]

A baker wants to increase the rate of carbon dioxide production in the bread-making process.
The baker trialled different concentrations of glucose solution in the bread dough.
Fig. 3.1 shows the results.

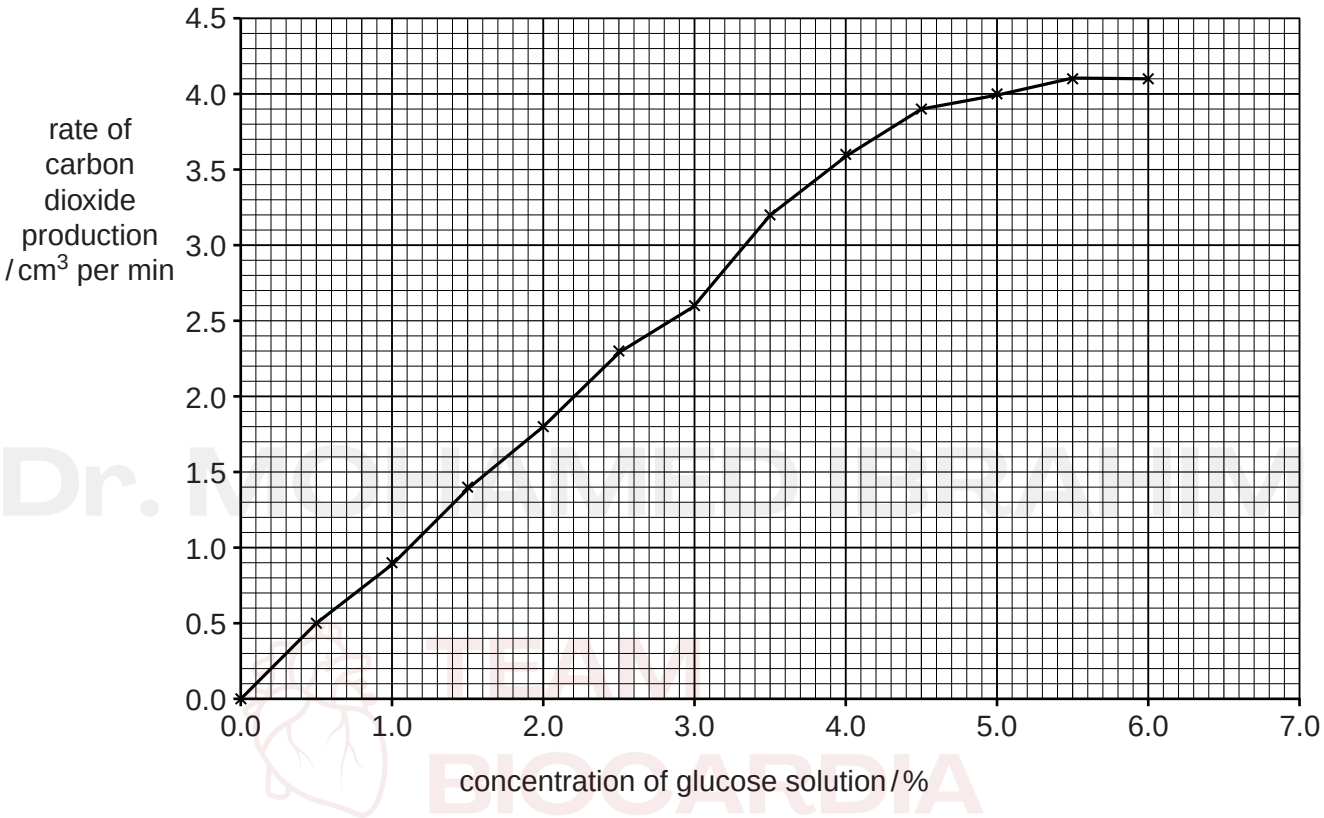


Fig. 3.1

(b) (i) Predict the rate of carbon dioxide production if the concentration of the glucose solution was 7.0%.

..... cm^3 per min [1]

(ii) The baker carried out the trials at 30 °C.
The trials were repeated at 20 °C.
Draw a line on Fig. 3.1 to show the rate of carbon dioxide production at 20 °C. [2]

(iii) The baker carried out another trial at 80 °C. No carbon dioxide was released.

State why no carbon dioxide was produced.

.....[1]

(c) Name **one** other industrial process that uses yeast.

.....[1]

(d) During the production of penicillin, large fermenters are used. Fig. 3.2 shows a fermenter.

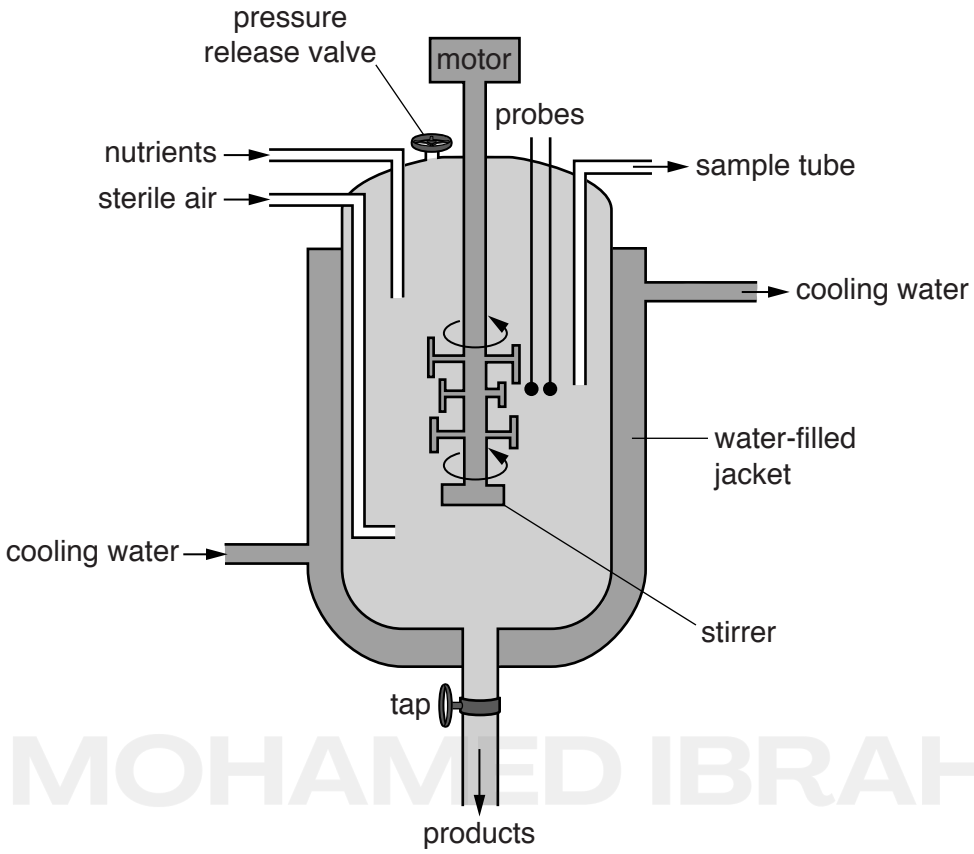


Fig. 3.2

(i) Explain the functions of the following parts of the fermenter:

stirrer .....

.....

water-filled jacket .....

.....

probes .....

.....

[3]

(ii) The air and nutrients that are added to the fermenter are sterile.

State why they must be sterile.

.....

.....

.....[1]

[Total: 11]

4 **(a)** Increasing human population is linked to a change in carbon dioxide concentration in the atmosphere. Fig. 4.1 shows the carbon dioxide concentration between 1958 and 2010 measured at Mauna Loa, Hawaii.

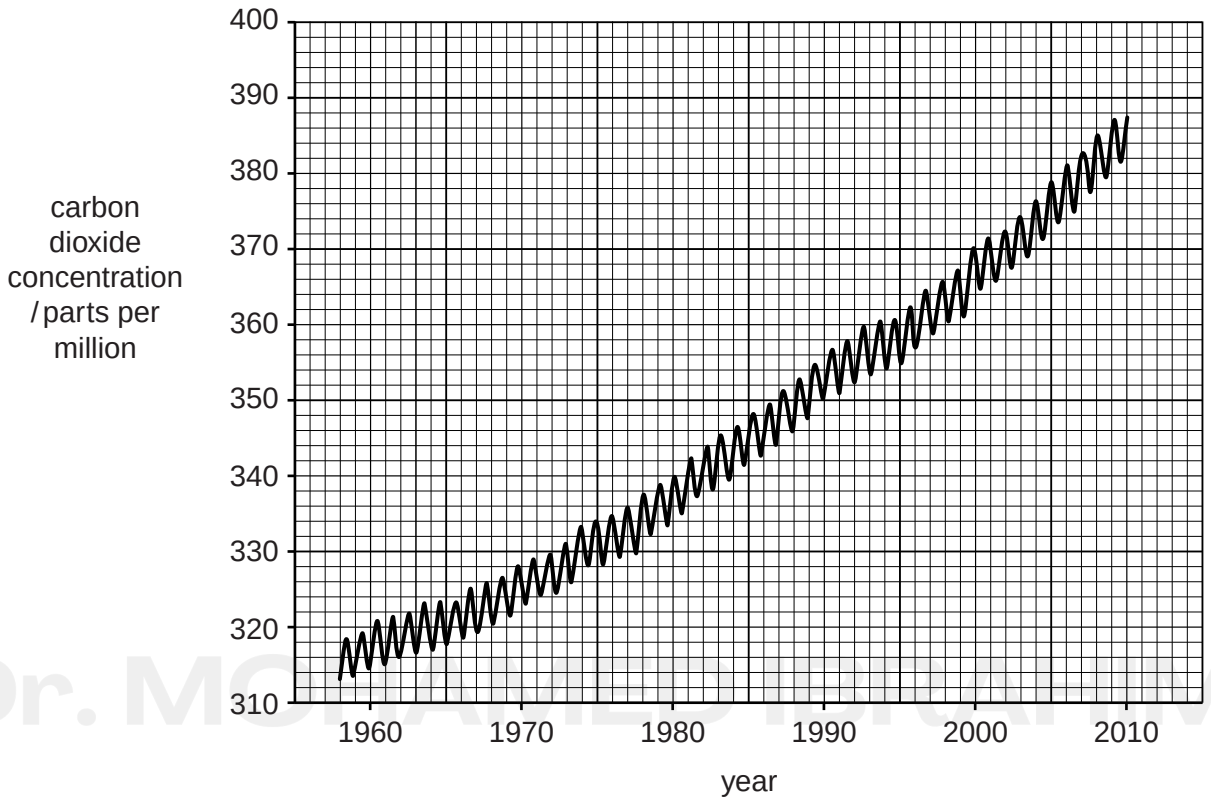


Fig. 4.1

Describe how the carbon dioxide concentration has changed between 1958 and 2010. You will gain credit for using data from Fig. 4.1.

.....

.....

.....

.....

.....

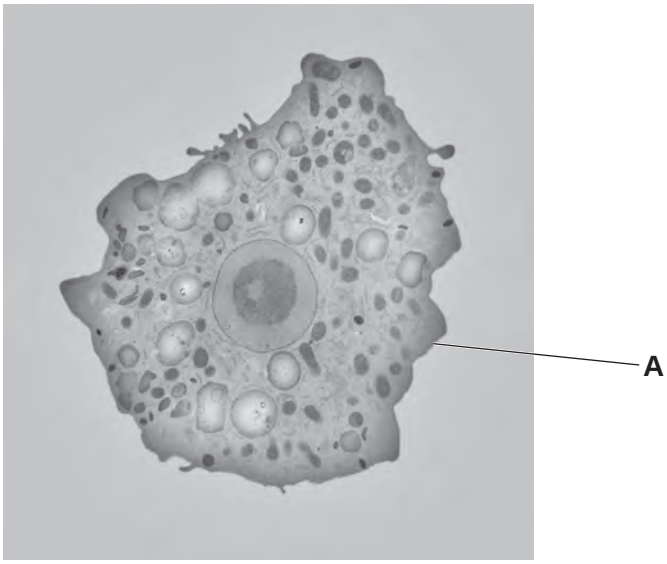
.....

.....[3]

Excretory System

3 All living organisms excrete waste products.

(a) Fig. 3.1 is a photomicrograph of *Naegleria fowleri*, a single-celled protoctist that lives in watery environments.



magnification ×4000

Fig. 3.1

(iii) Suggest how *N. fowleri* excretes carbon dioxide.

.....

..... [1]

(b) Urea is a toxin that is excreted by the kidneys in humans.

Describe how **and** where in the body urea is formed.

.....

.....

.....

.....

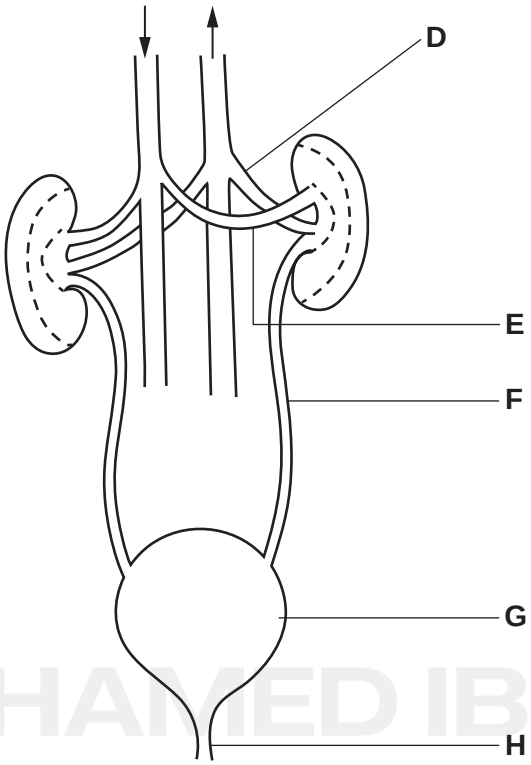
.....

.....

..... [3]

(c) Fig. 3.2 shows part of the human excretory system and associated blood vessels.

The arrows indicate the direction of blood flow.



not to scale

Fig. 3.2

(i) Draw a label line and the letter **X on Fig. 3.2** to show the location of the cortex in **one** of the kidneys. [1]

(ii) Table 3.1 contains statements about the labelled structures in Fig. 3.2.

Complete the table by:

- stating the name of the structure
- identifying the letter that labels that structure.

Table 3.1

description	name of structure	letter from Fig. 3.2
organ that stores urine		
tube that carries urine out of the kidney		
blood vessel with the lowest concentration of urea		
blood vessel with the lowest concentration of carbon dioxide		
tube that carries urine out of the body		

[5]

(d) Doctors wanted to investigate the effect of exercise on the excretion of salts.

They collected urine from people before and after running a long distance on a hot day.

The results of their investigation are shown in Table 3.2.

Table 3.2

	before running	after running
average volume of urine / cm^3	1156.0	569.0
average concentration of sodium in urine / mmol per dm^3	85.6	78.2

(i) Suggest why there is a difference in the volume of urine produced before running compared with after running.

Use the information in Table 3.2 in your answer.

.....

.....

.....

.....

..... [2]

(ii) Calculate the percentage decrease in the average sodium concentration after running compared with before running.

Give your answer to one significant figure.

Space for working.

..... %
[3]

(iii) Describe how the kidney tubules enable the excretion of salts.

.....

.....

.....

.....

.....

.....

..... [3]

(e) Large plasma proteins are usually prevented from entering the urine.

State the name of **one** protein found in blood plasma.

..... [1]

[Total: 22]

(c) Fig. 3.1 is a photomicrograph of a glomerulus in a kidney.

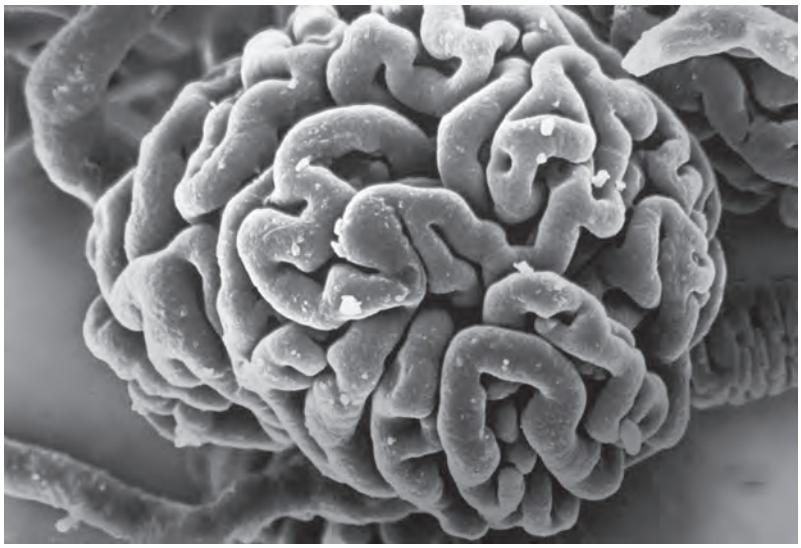


Fig. 3.1

(i) Describe the structure of a glomerulus.

You may refer to Fig. 3.1 in your answer.

.....

.....

.....

.....

..... [2]

(ii) Describe the role of the glomerulus.

.....

.....

.....

.....

..... [2]

(d) Table 3.1 shows some comparisons between a human and a mouse.

Table 3.1

feature	human	mouse
body mass / kg	60.0	0.025
kidney mass / g	320.0	0.310
water intake / dm^3 per day	1.5	0.005
water reabsorption / dm^3 per day	179.0	0.168
salt filtration rate / g per day	580.0	0.556
salt reabsorption / g per day	575.0	0.551

(i) Table 3.1 shows that salts are reabsorbed in the kidneys of both humans and mice.

Describe how salts are reabsorbed **against** a concentration gradient.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(c) Table 1.1 shows the concentrations of four solutes:

- in the blood in the renal artery
- in the fluid in the kidney tubule
- in the urine.

Table 1.1

solute	solute concentration / g dm^{-3}		
	blood in the renal artery	fluid in the kidney tubule	urine
glucose	0.9	0.9	0.0
protein	83.0	0.0	0.0
salts	8.0	8.0	16.5
urea	0.2	0.2	20.0

(i) Calculate the percentage increase in the concentration of urea between the blood in the renal artery and the urine.

Show your working.

..... %
[2]

(ii) Describe the results for the concentration of salts shown in Table 1.1.

.....

.....

.....

.....

..... [2]

(iii) State the reason for the difference in the concentration of protein between the blood in the renal artery and the fluid in the kidney tubule.

.....

..... [1]

(iv) State the reason for the difference in the concentration of glucose between the fluid in the kidney tubule and the urine.

.....

..... [1]

(c) The liver is also involved in the processing of toxins.

(ii) Alcohol is another toxin that is processed in the liver.

The effect of alcohol consumption on the risk of dying from liver disease was investigated in men and women.

The results are shown in Fig. 5.1.

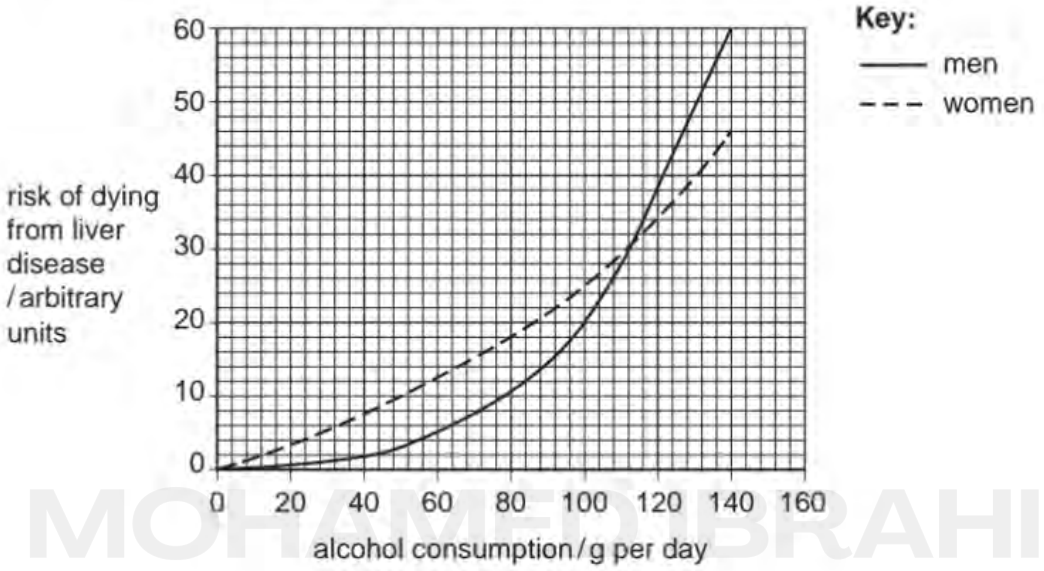


Fig. 5.1

Describe the results shown in Fig. 5.1.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

1 The lungs and the kidneys are part of the excretory system of mammals.

(a) **(i)** State the name of **one** substance that is excreted from the lungs and state where in the body it is produced.

name .....

site of production .....
[2]

(ii) State the name of **one** excretory substance, that is removed by the kidneys, that contains nitrogen.

Explain why it is excreted.

name .....

explanation .....

.....
[2]

(b) Blood is filtered as it flows through the kidneys.

(i) State the name of the structure within a kidney that filters the blood.

.....[1]

(ii) State **two** components of blood that do **not** pass through the filter.

1 .....

2 .....
[2]

(c) The filtrate which is formed from the blood in the kidneys contains many useful substances, which are reabsorbed into the blood.

Fig. 1.1 is a photomicrograph of a cross-section of some of the cells that carry out reabsorption.

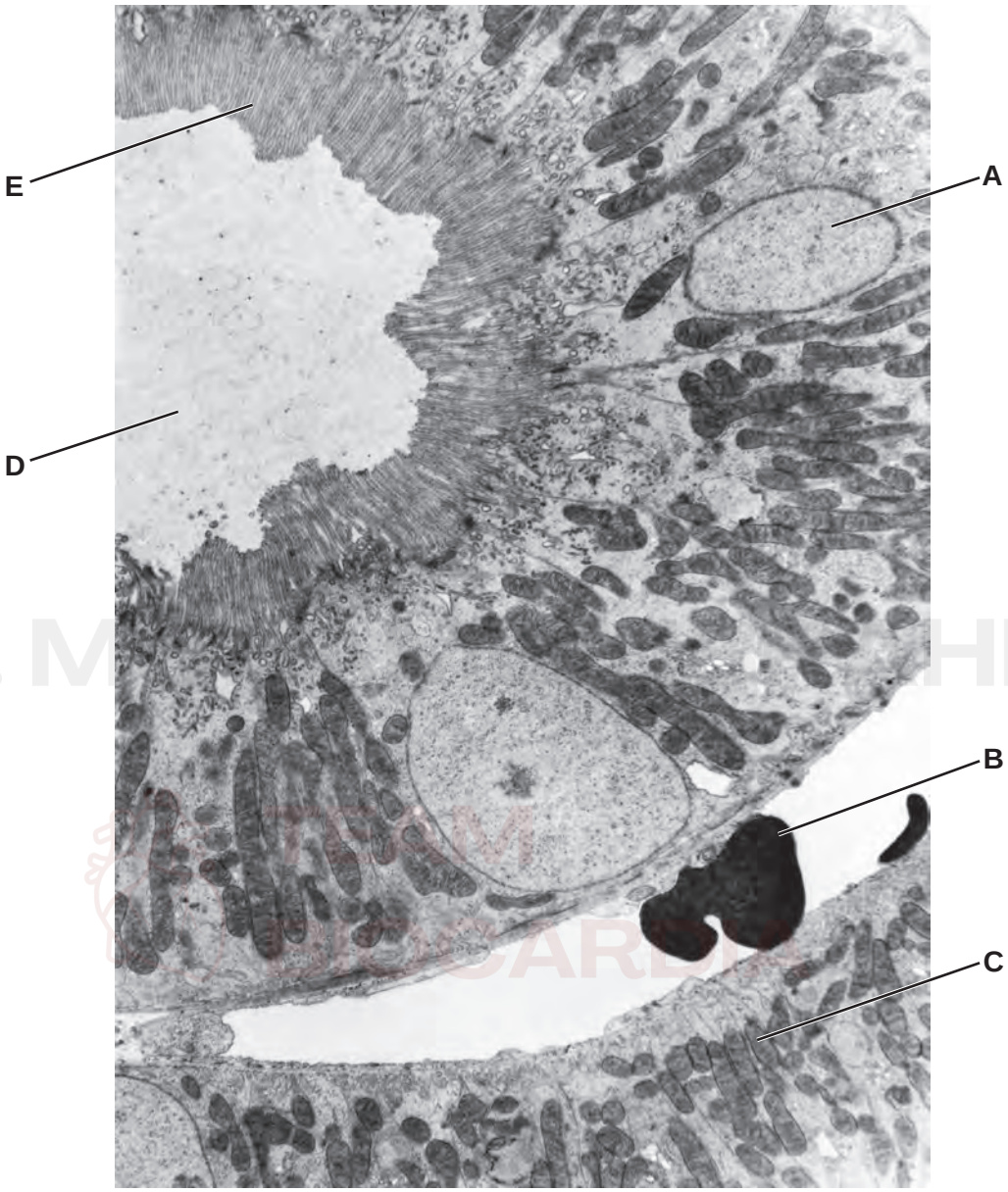


Fig. 1.1

(i) Complete the table by stating the letter in Fig. 1.1 that identifies each structure.

structure	letter on Fig. 1.1
microvilli	
nucleus	
mitochondrion	

[3]

(ii) State **one** function of the nucleus.

.....

.....[1]

(iii) State the name of **one** part of the mammalian body **other than** the kidney that has cells with microvilli.

.....[1]

(iv) The cells that line the kidney tubules, such as those in Fig. 1.1, absorb many compounds from the filtrate.

Use Fig. 1.1 to explain how the cells are adapted for absorption.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 16]

2 A person who wanted to begin a fitness programme did some vigorous exercise.

A fitness trainer took a drop of blood from the person's finger before, during and after vigorous exercise and tested it for lactic acid.

(b) The results of the tests for lactic acid are shown in Fig. 2.1.

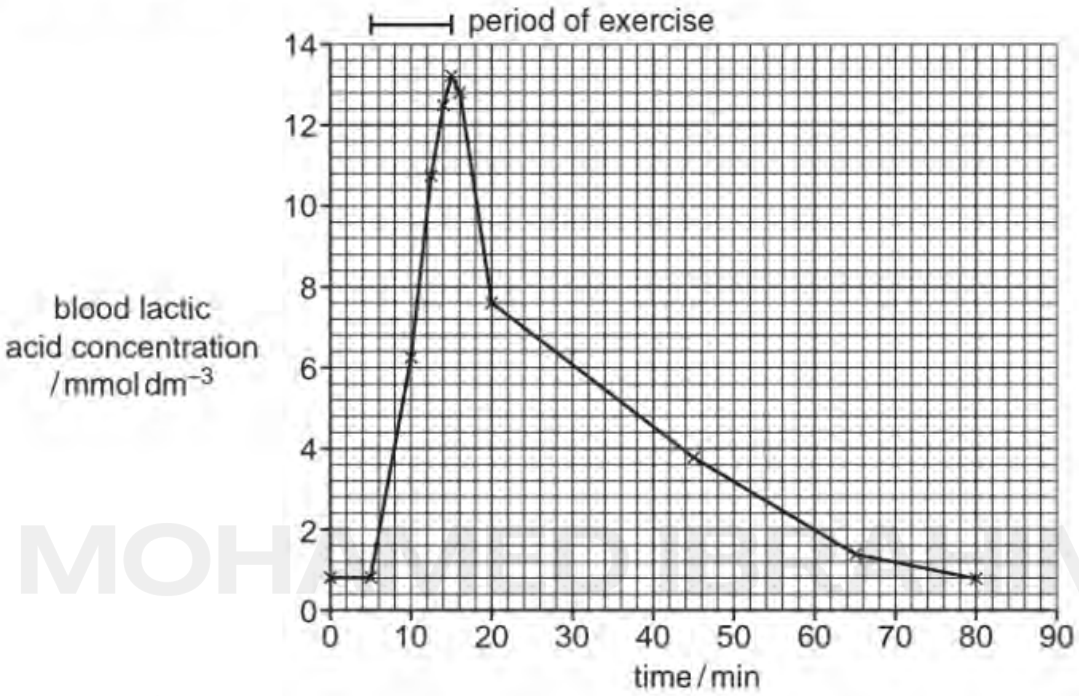


Fig. 2.1

(c) Explain the role of the kidney in excretion.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(e) The half-life of a drug is the time it takes for the concentration in the blood to decrease by a factor of a half. The half-life of one form of testosterone taken to improve sporting performance is 7 days.

A person received an injection of this form of testosterone. A blood sample taken almost immediately showed its concentration to be 50 ng cm^{-3}.

Predict the concentration after 14 days, assuming the person does not have another injection, **and** show your working.

..... ng cm^{-3} [2]

[Total: 17]

Homeostasis

(ii) Adrenaline is a hormone that is released in 'fight or flight' situations. It causes a change in the eye.

Complete Table 6.1 by stating the parts of the eye that change when adrenaline is released into the blood.

Table 6.1

action	part of the eye
muscle that relaxes	
muscle that contracts	
widens	

[3]

1 Homeostasis is the maintenance of a constant internal environment.

(a) Human skin is involved in the maintenance of a constant internal body temperature.

(i) Skin is an organ.

State why the skin is an organ.

.....

.....

..... [1]

(ii) State the name of the organ that coordinates the control of body temperature.

..... [1]

Fig. 1.1 shows a diagram of a section through human skin.

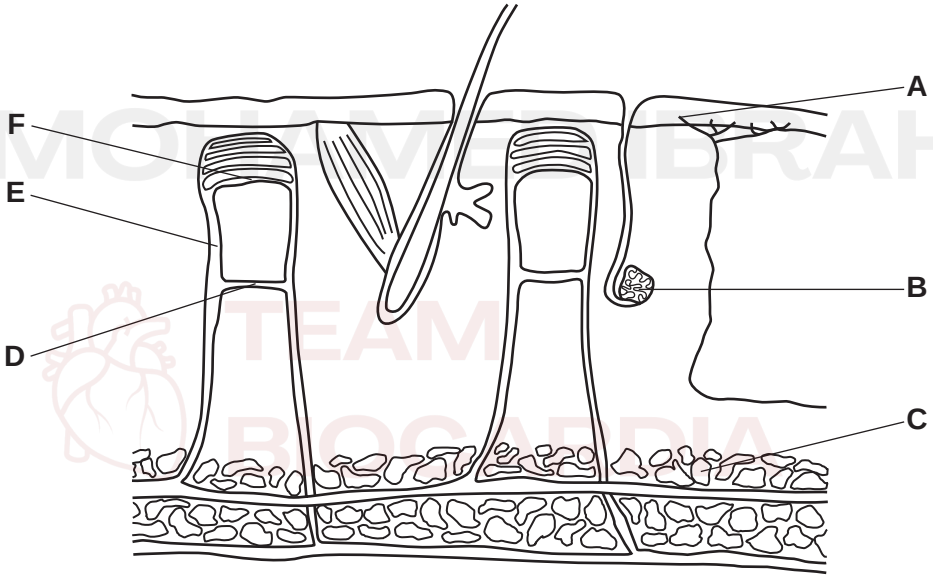


Fig. 1.1

(iii) State the names of structures **A**, **B** and **C** in Fig. 1.1.

A .....

B .....

C .....

[3]

(iv) Structure **D** is a shunt vessel and **E** is an arteriole.

Describe how these blood vessels are involved in maintaining a constant internal body temperature in a cold environment.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Energy is used to maintain body temperature.

State **three other** uses of energy in humans.

1 .....

2 .....

3 .....

[3]

[Total: 11]

(c) Scientists investigated the effect of adrenaline on blood glucose concentration in rats.

The rats were put into two groups:

- group **A** was given an injection of adrenaline
- group **B** was given an injection that did **not** contain adrenaline.

The blood glucose concentrations of the rats in both groups were monitored for three hours after the injections.

The rats did not eat for 12 hours before the investigation or while they were being monitored.

The results are shown in Fig. 3.1.

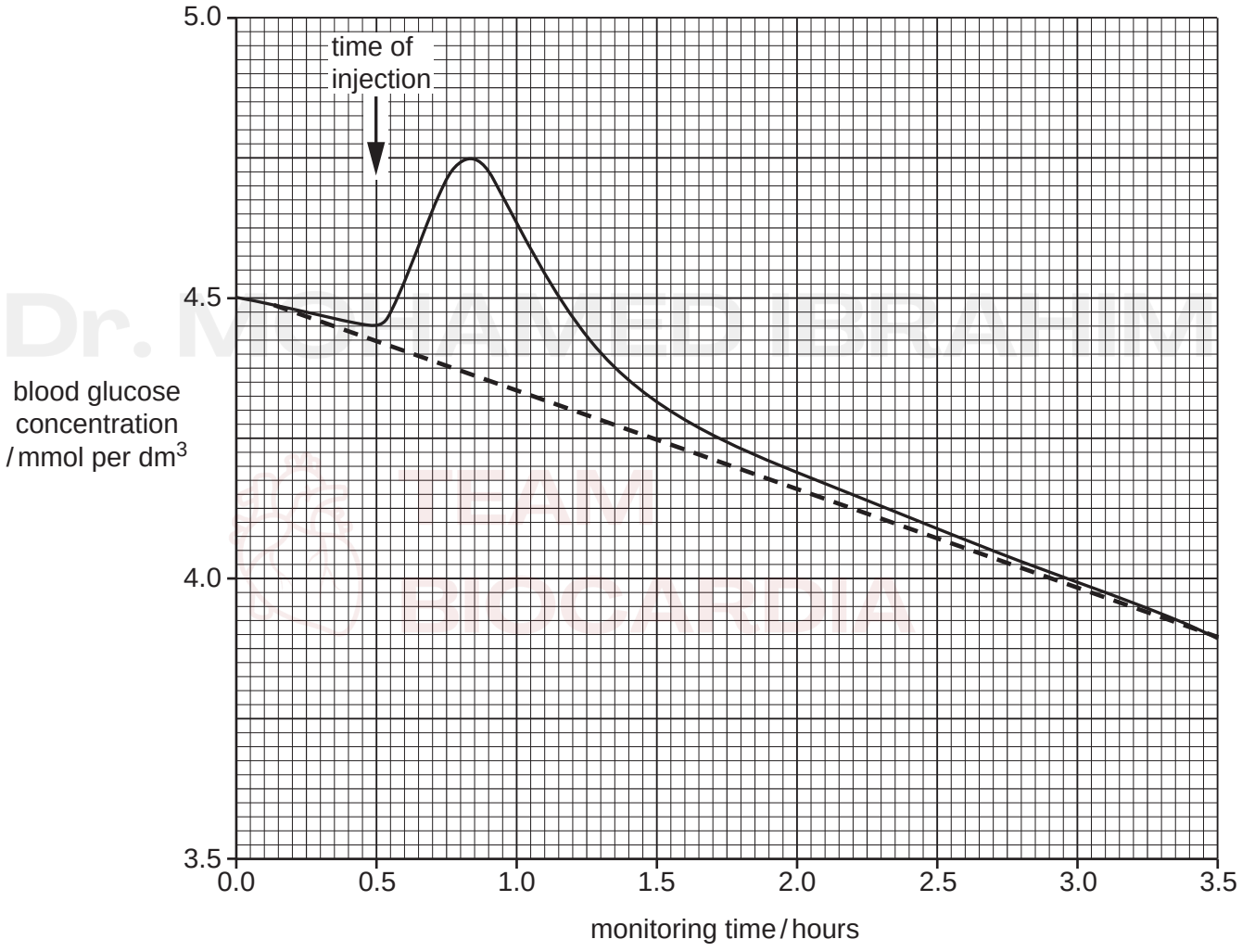


Fig. 3.1

(i) Suggest why group **B** was given an injection that did **not** contain adrenaline.

.....

.....

.....

.....

..... [2]

(ii) Describe and explain the results shown in Fig. 3.1 for group **A**.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(d) Another group of rats was given an injection that did **not** contain adrenaline.

These rats were given food after 2 hours of monitoring.

Predict the changes to blood glucose concentration in this group of rats.

Sketch a line to show your prediction on the graph in Fig. 3.1. [2]

(e) Describe **two** effects of adrenaline on the body, **other** than a change in blood glucose concentration.

1 .....

2 .....

[2]

[Total: 14]

4 Insulin is a hormone that regulates the concentration of glucose in the blood.

(a) Define the term *hormone*.

.....

.....

.....

.....

.....

..... [3]

(b) Two people, **A** and **B**, visited a doctor to discuss their similar symptoms. The doctor thought that their blood glucose concentrations were not very well controlled. A glucose tolerance test was carried out on both people.

A and **B** did not eat or drink anything other than water for eight hours before the test. They then drank a glucose solution. Blood samples were taken at 30 minute intervals. The samples were tested for glucose concentration.

The results are shown in Fig. 4.1.

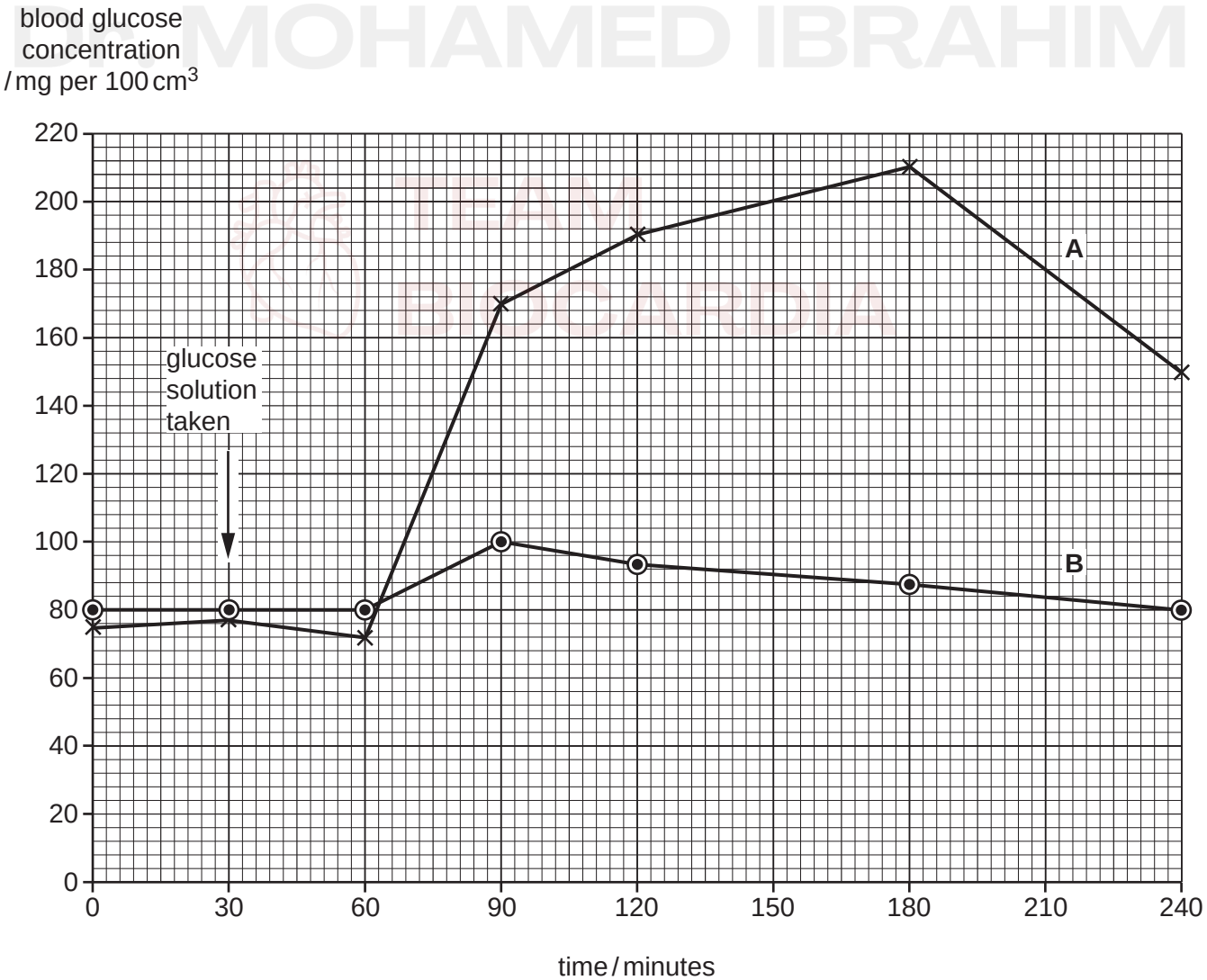


Fig. 4.1

(i) Use Fig. 4.1 to state the blood glucose concentrations of **A** and **B** at 180 minutes.

A ..... mg per 100 cm^3

B ..... mg per 100 cm^3
[1]

(ii) Calculate the percentage increase in the blood glucose concentration in person **A** between 60 and 90 minutes.

Give your answer to the nearest whole number.

Show your working.

..... %
[2]

(iii) Describe how the response of person **A** differs from the response of person **B** in Fig. 4.1.

.....

.....

.....

.....

..... [2]

(iv) Explain the results of the glucose tolerance test shown by person **B**.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(v) The doctor thought that person **A** had Type 1 diabetes.

Describe **three** symptoms of Type 1 diabetes.

.....

.....

.....

.....

..... [3]

[Total: 15]

5 The liver is an important organ in many processes.

(a) The liver responds to changes in insulin concentration.

Insulin is a hormone.

(i) Define the term *hormone*.

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.....[3]

(ii) Describe how the liver responds to an increase in insulin concentration.

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.....[2]

(b) The liver is also involved in the processing of amino acids.

(i) Describe how excess amino acids are broken down.

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.....[2]

(ii) State the name of the process that assembles amino acids to form proteins.

.....[1]

4 The flow of blood through the skin can be investigated by using a flow-meter.

Fig. 4.1 shows a flow-meter above a section through the skin.

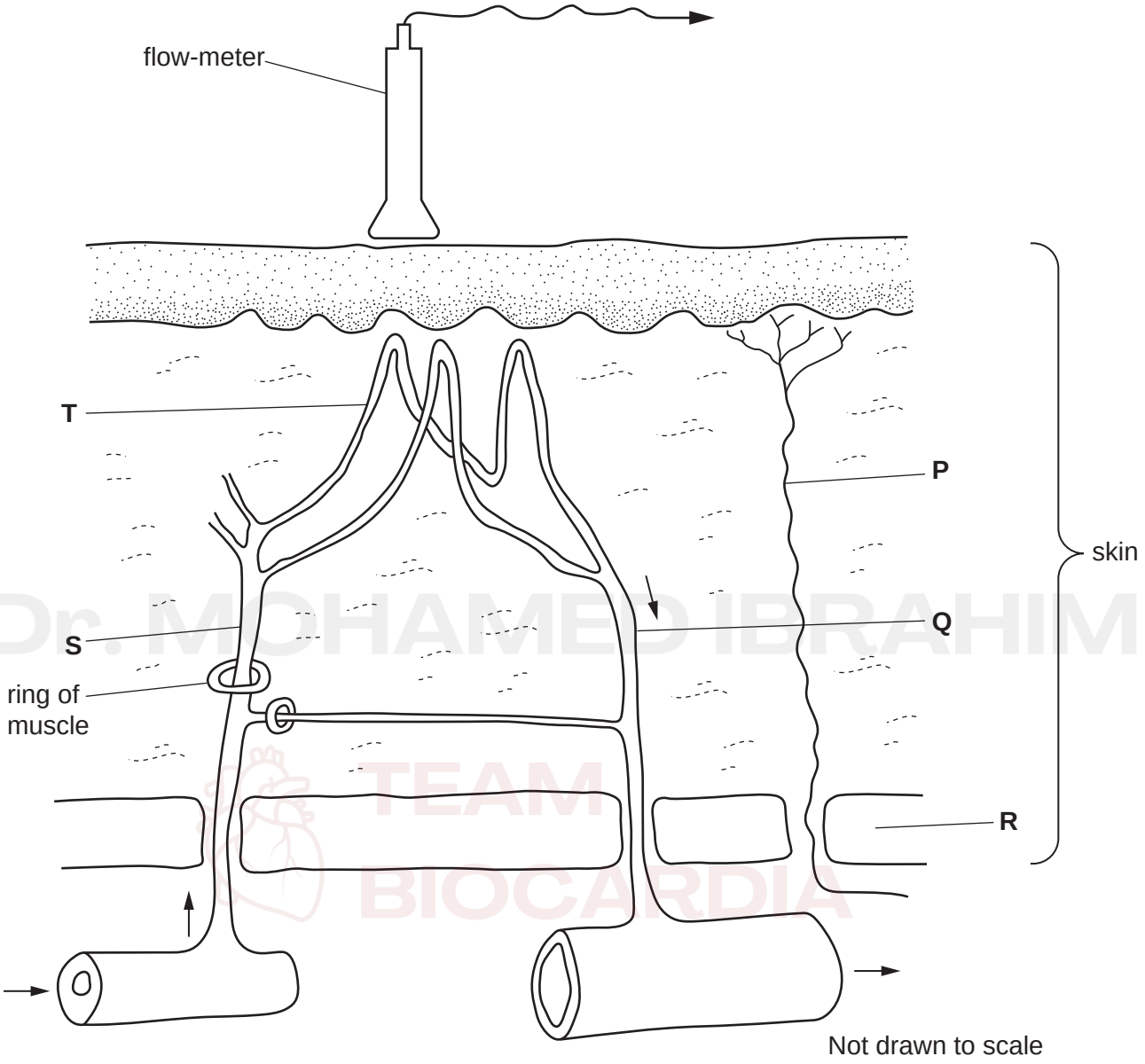

Fig. 4.1

(a) (i) State the name of cell **P**.

.....[1]

(ii) State the types of blood vessel labelled **Q**, **S** and **T**.

Q .....

S .....

T .....

[3]

(iii) State the name of the tissue at **R** that provides insulation.

.....[1]

(b) The blood flow through the skin of some volunteers was measured with a flow-meter when their skin was exposed to different temperatures.

Capsaicin is a compound that gives people the sensation of feeling hot when it is put on the skin. Researchers applied capsaicin to the skin of the volunteers and again measured the blood flow through their skin at different temperatures.

Fig. 4.2 shows the results.

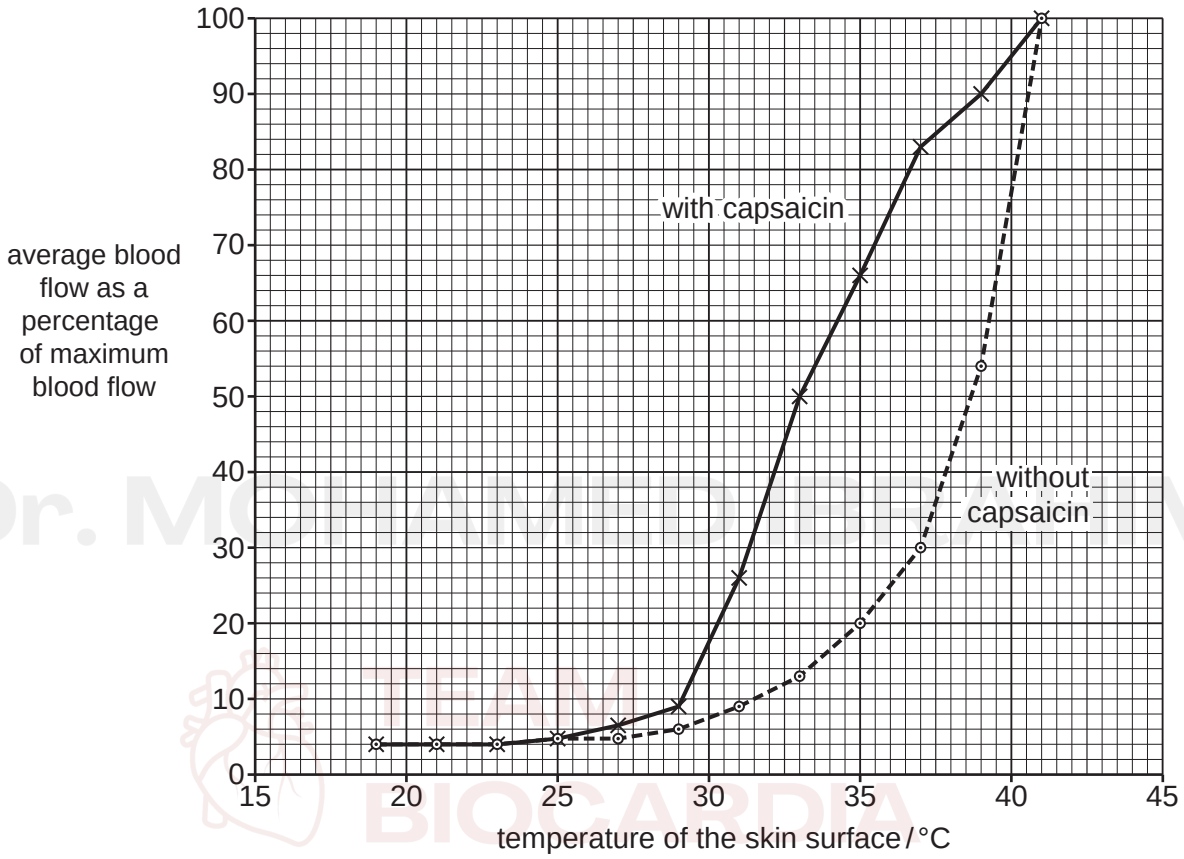

Fig. 4.2

(i) Use the information in Fig. 4.2 to describe the effect of increasing the temperature of the skin surface on blood flow to the skin **without** capsaicin.

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..... [3]

(ii) Explain the mechanism that increases blood flow through the skin.

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.....[3]

(iii) State the difference between the average blood flow for the treatments (with and without capsaicin) at 35 °C.

Space for working.

..... % [1]

(iv) The researchers thought that capsaicin stimulated receptors in the skin.

Explain the process by which capsaicin could reach these receptors.

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.....[3]

(c) Explain the importance of regulating body temperature in humans.

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.....[4]

(d) Body temperature is controlled by both hormones and nerves.

Explain how co-ordination by hormones differs from co-ordination by nerves.

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.....[3]

[Total: 22]

6 Fig. 6.1 is a flow chart of some of the events that occur to maintain a constant body temperature.

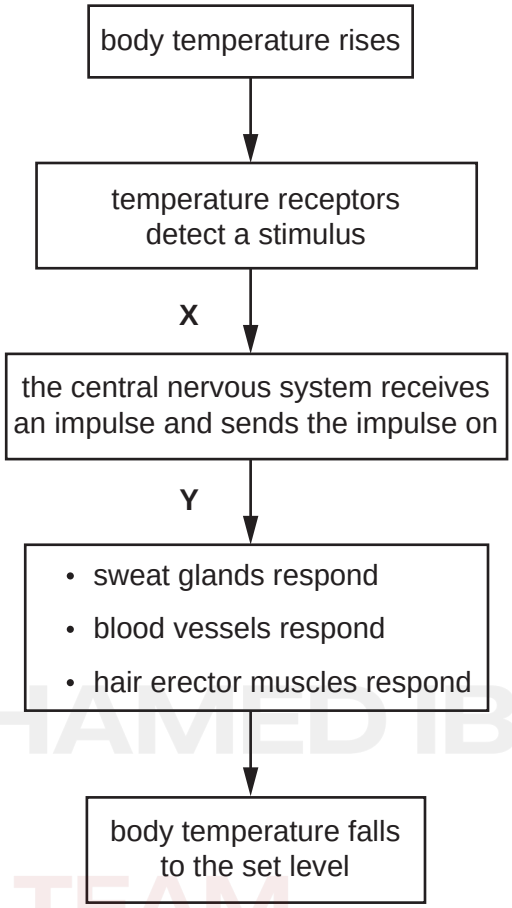

Fig. 6.1

(a) (i) State the names of the types of neurones at **X** and **Y** in Fig. 6.1.

X .....

Y .....
[2]

(ii) State the name of **one** effector shown in Fig. 6.1.

.....[1]

(iii) State the name of the mechanism that controls homeostasis which is represented by the flowchart in Fig. 6.1.

.....[1]

(b) (i) Describe how shunt vessels in the skin function to help cool the body when the body temperature is high.

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.....[3]

(ii) Describe how the sweat glands and the hair erector muscles function in mammals when the external environment is hot.

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.....[3]

(c) **(i)** Suggest an advantage of using neurones rather than hormones to regulate body temperature.

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.....[1]

(ii) List **two** hormones that are involved in homeostasis.

1 .....

2 .....
[2]

[Total: 13]

(a) Complete Table 6.1 by naming the blood vessels labelled on Fig. 6.1 and stating whether they contain oxygenated blood or deoxygenated blood. One row has been completed for you.

Table 6.1

letter on Fig. 6.1	name of the blood vessel	oxygenated or deoxygenated blood
A		
B		
C		
D		
E	femoral artery	oxygenated

[4]

(b) Insulin is a hormone that is secreted by the pancreas.

(i) Define the term *hormone*.

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.....

.....[2]

(ii) Describe the role of insulin in the body.

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.....[3]

(c) Explain how blood flow in the skin helps to maintain a constant body temperature in very hot conditions.

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.....[3]

[Total: 12]

(d) Testosterone is a steroid hormone that is also taken as a drug to improve sporting performance.

(i) Define the term *hormone*.

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..... [3]

(ii) State where testosterone is produced in the body.

..... [1]

(e) The half-life of a drug is the time it takes for the concentration in the blood to decrease by a factor of a half. The half-life of one form of testosterone taken to improve sporting performance is 7 days.

A person received an injection of this form of testosterone. A blood sample taken almost immediately showed its concentration to be 50 ng cm^{-3}.

Predict the concentration after 14 days, assuming the person does not have another injection, **and** show your working.

..... ng cm^{-3} [2]

Scientists have found that mice can suffer from Type 1 diabetes. They also found that vitamin D affects the development of Type 1 diabetes in mice.

Two groups of mice were studied. One group were normal and the other group were vitamin D-deficient. The percentage of mice in each group that developed Type 1 diabetes was recorded every fifty days.

Table 4.1 shows their results.

Table 4.1

age / days	percentage of mice with Type 1 diabetes	
	normal mice	vitamin D-deficient mice
0	0	0
50	1	1
100	8	35
150	34	62
200	45	65
250	46	65

(c) Describe the effect of vitamin D deficiency on the development of Type 1 diabetes in mice. Use the data in Table 4.1 to support your answer.

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.....[3]

(d) Suggest the symptoms that mice with Type 1 diabetes would have.

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.....[4]

(e) Describe the treatment for human patients with Type 1 diabetes.

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.....[3]

[Total: 16]

6 Fig. 6.1 shows the changes in glucose concentration of the blood.

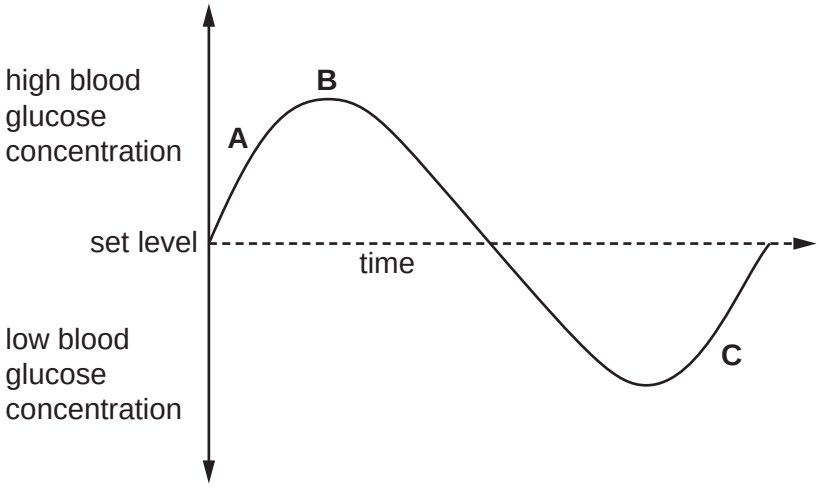

Fig. 6.1

(a) Name the process that maintains blood glucose concentration within set limits.

..... [1]

(b) **(i)** Name the hormone that would be secreted in response to the increasing blood glucose concentration at **A** in Fig. 6.1.

..... [1]

(ii) Name an organ that is responsible for the decrease in blood glucose concentration after **B** in Fig. 6.1.

..... [1]

(iii) Name the compound that is converted to glucose at **C** in Fig. 6.1.

..... [1]

(c) Describe the symptoms **and** treatment of Type 1 diabetes.

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..... [5]

[Total: 9]

Diseases & Immunity

2 Pathogens cause disease.

(a) Fig. 2.1 shows some cells that are part of the human immune system. These cells are responding to one type of pathogen.

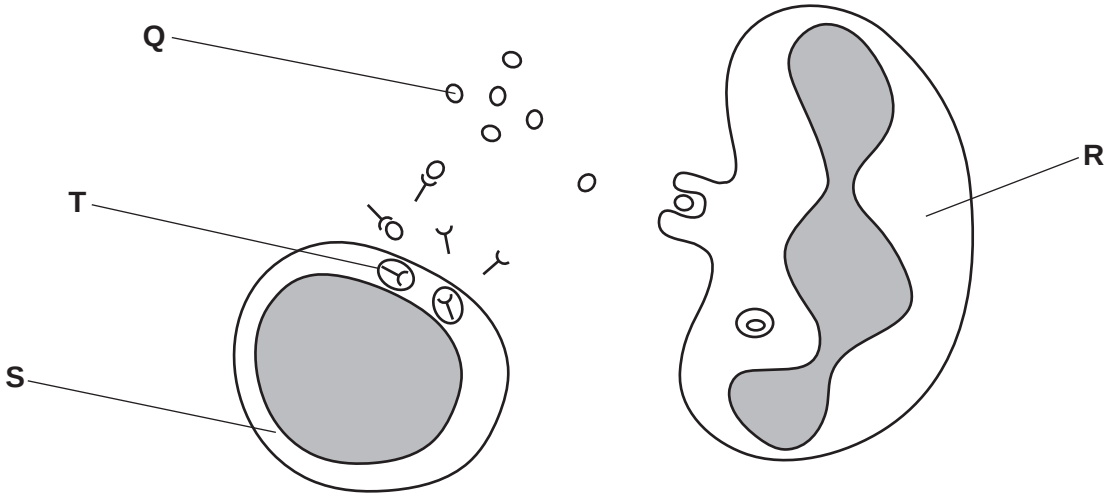

Fig. 2.1

Explain how the immune system responds to an invasion of pathogens.

Use the letters in Fig. 2.1 in your answer.

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..... [6]

(b) A vaccine was introduced in 1942 for a particular disease.

Fig. 2.2 shows the effect of introducing the vaccine on the number of cases of the disease in one country.

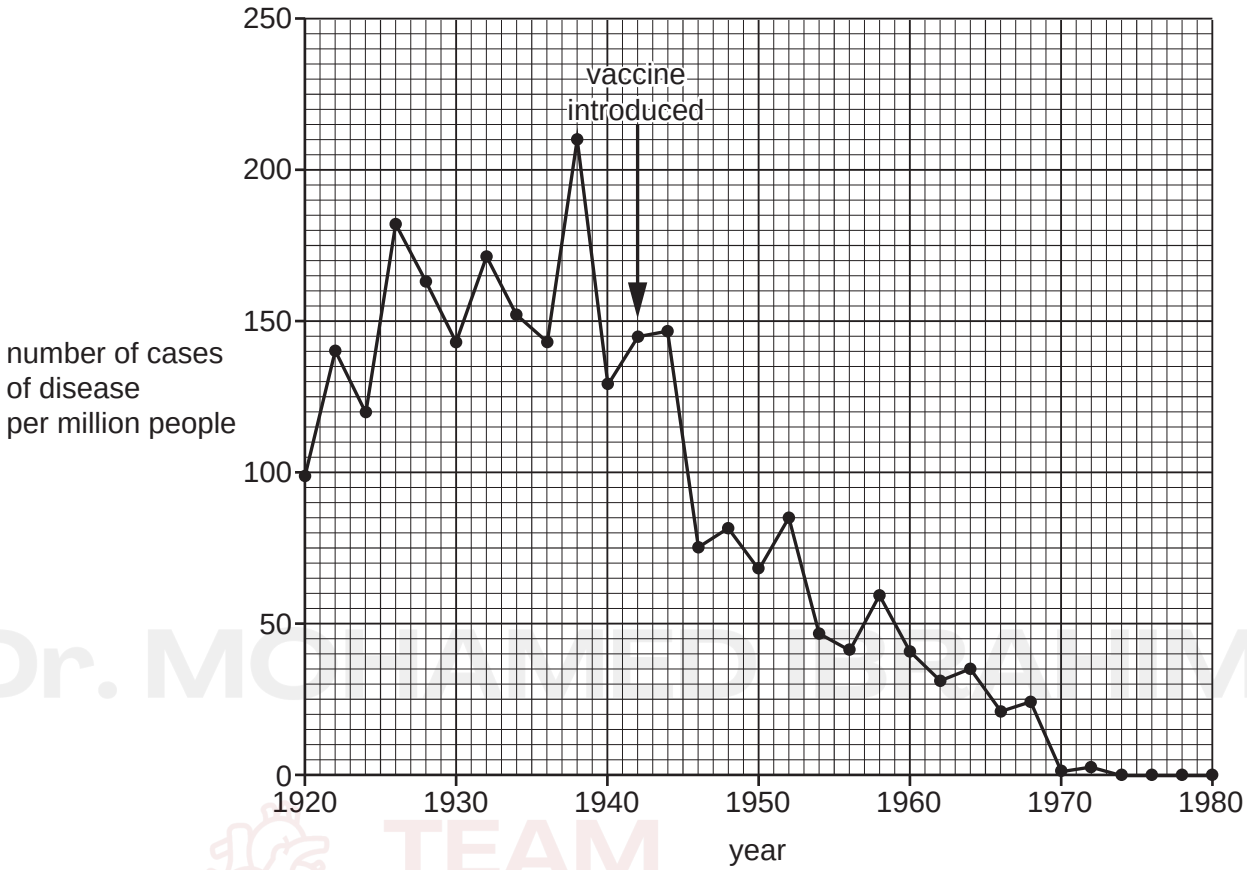

Fig. 2.2

In 1946 the government of the country concluded that the vaccine was successful.

Discuss the evidence, shown in Fig. 2.2, for **and** against this conclusion.

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..... [4]

[Total: 10]

(b) Methicillin-resistant *Staphylococcus aureus* (MRSA) is a type of bacterium that is resistant to some antibiotics.

Fig. 5.1 shows how a population of bacteria may develop antibiotic resistance and how the antibiotic resistance can be passed from one strain of bacterium to another.

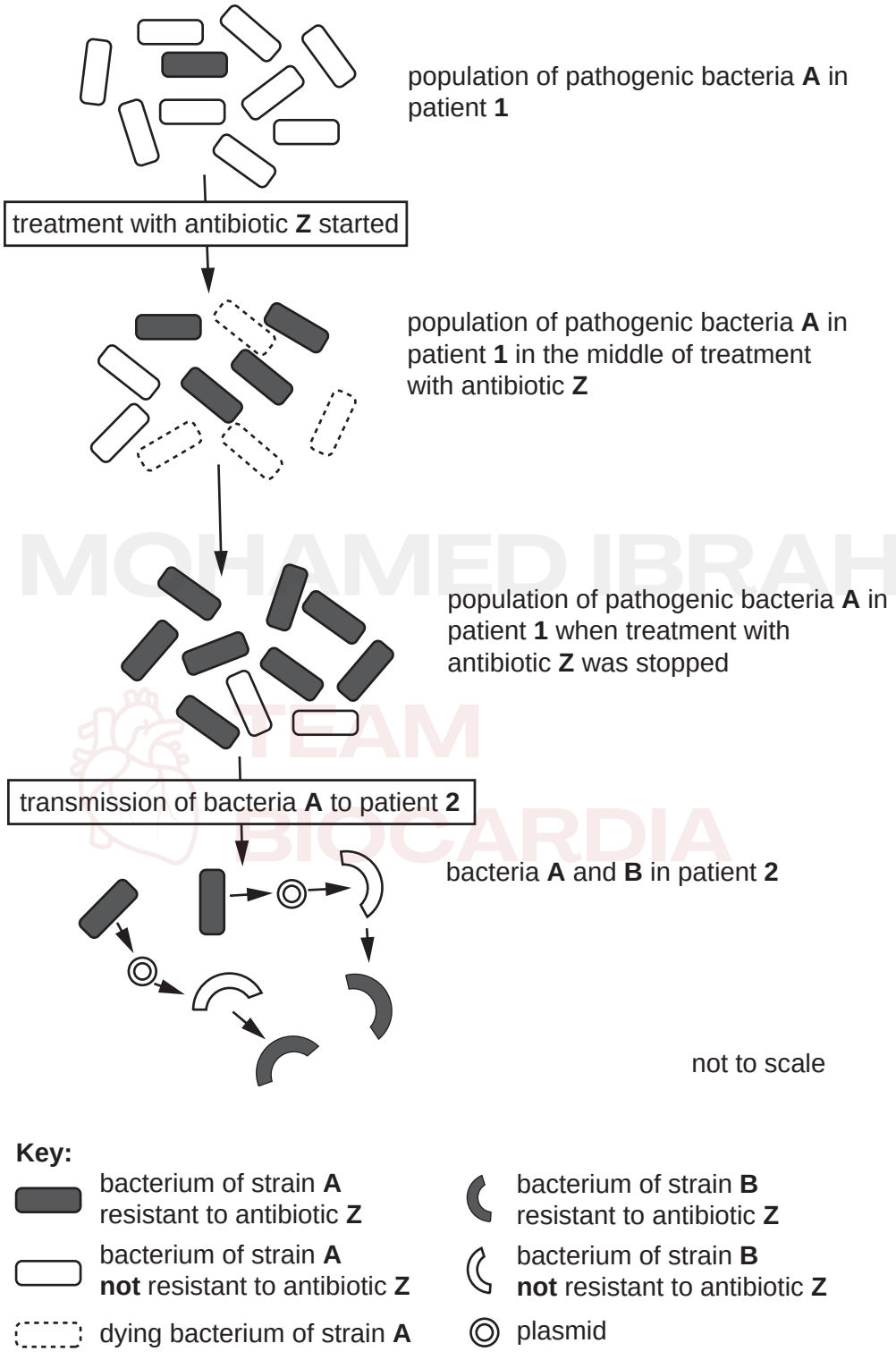

Fig. 5.1

Explain how resistance to an antibiotic develops in a population of bacteria and spreads in the human population.

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.... [6]

(c) Explain how the development of resistant bacteria, such as MRSA, can be minimised.

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.... [3]

[Total: 11]

(e) One of the functions of the placenta is to provide a barrier to toxins and pathogens.

A study was done on donated afterbirths. The afterbirth is a placenta with part of the umbilical cord attached.

The purpose of the study was to find the maximum size of particles that can pass through the placenta and enter the umbilical cord.

The researchers inserted beads with a diameter of 0.5 μm into blood vessels in the placenta. Three hours later they recorded the percentage of beads found in the blood in the placenta and in the umbilical cord.

They then repeated the tests using beads with diameters of 0.8 μm, 2.4 μm, 5.0 μm and 8.0 μm.

Their results are shown in Fig. 2.1.

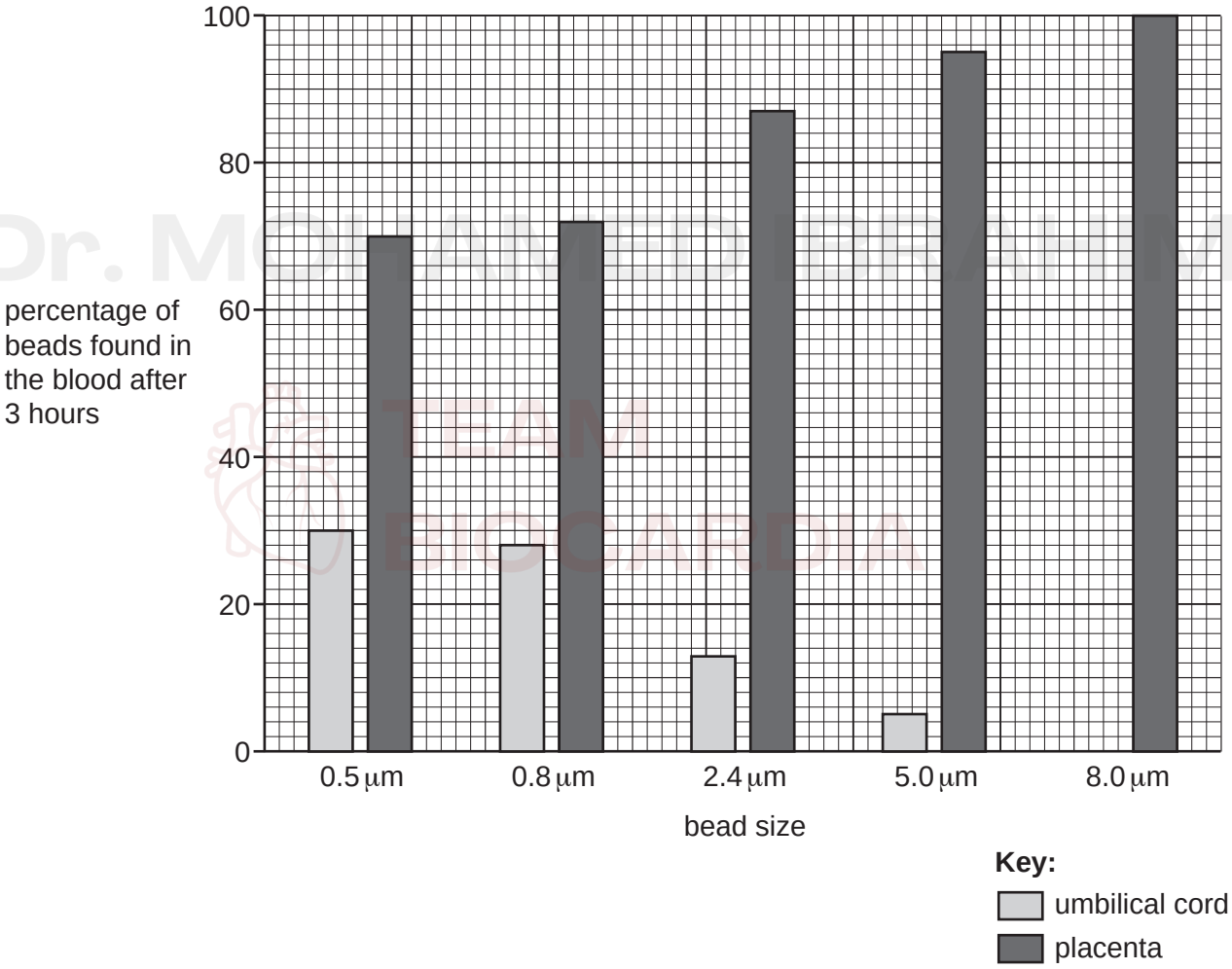

Fig. 2.1

(i) Convert the diameter of the 5.0 μm beads into millimetres (mm).

Space for working.

..... mm [1]

(ii) One million beads with a diameter of 2.4 μm were injected into the placenta.

Calculate the number of these beads in the umbilical cord after 3 hours.

Space for working.

..... beads
[2]

(iii) Table 2.1 shows a range of substances and their diameters.

Table 2.1

toxins and pathogens	diameter / μm
nicotine	2.0×10^{-2}
drug **X**	3.0×10^{-2}
rubella virus	5.0×10^{-2}
Vibrio cholerae	8.0×10^{-1}
Trypanosoma brucei	1.8×10^{1}

State the names of **all** the toxins and pathogens listed in Table 2.1 that could pass through the placenta and enter the umbilical cord.

Use the data in Fig. 2.1 to make your choice.

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.....

..... [1]

(g) Drug **X** can be injected into the body. This is one way that HIV can be transmitted.

Describe **two** other ways that HIV can be transmitted.

1 .....

.....

2 .....

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[2]

[Total: 23]

(c) The cholera bacterium can survive in the small intestine and the large intestine. The bacterium releases a toxin that interacts with receptors on the surface of cells.

Fig. 3.3 shows the effect of the toxin. The arrows indicate the direction of movement.

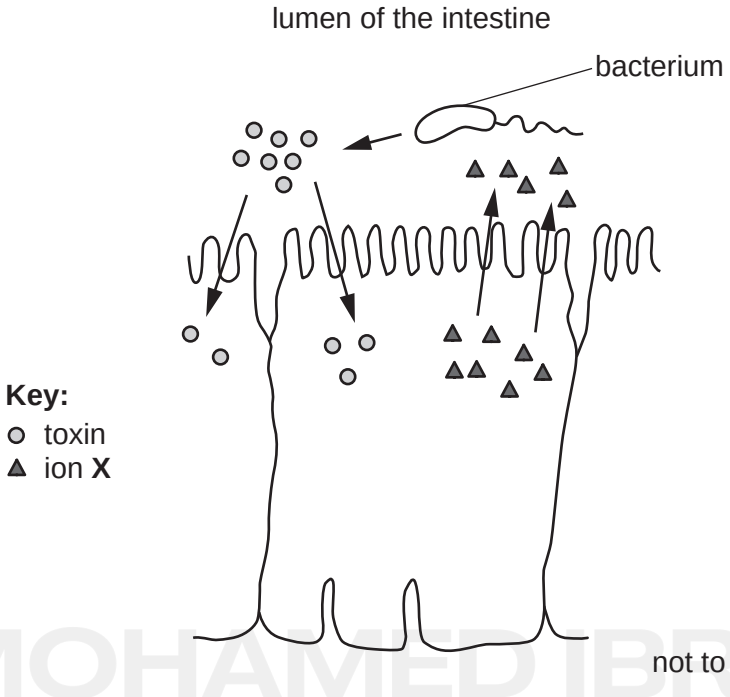

Fig. 3.3

The toxin stimulates the secretion of ion **X** out of the intestinal cell.

(i) State the name of ion **X**.

..... [1]

(ii) Describe the effects on the body of the secretion of ion **X** into the lumen of the intestine.

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..... [4]

[Total: 15]

(ii) The water that passed out of the sewage works was often cloudy with suspended matter.

Scientists discovered that ciliates reduce the cloudiness of water during sewage treatment.

Suggest how the ciliates reduce the cloudiness of the water using the information in Fig. 5.4.

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..... [2]

(b) A person who does not smoke can be exposed to tobacco smoke from other people smoking.

Researchers studied the effect of exposure to tobacco smoke on the development of lung cancer in three groups of women who did not smoke:

- group 1 – no exposure to tobacco smoke
- group 2 – low level exposure to tobacco smoke
- group 3 – high level exposure to tobacco smoke.

Their results are shown in Table 1.1.

Table 1.1

group	number of women studied	number of women who died from lung cancer	percentage of women who died from lung cancer
1	21 895	32	0.15
2	44 184	86	
3	25 461	56	0.22

(i) Calculate the percentage of women in group 2 who died from lung cancer.

Write your answer, to **two** significant figures, in Table 1.1.

[2]

(ii) Many countries have laws that ban smoking in public buildings.

Discuss the evidence from Table 1.1 that supports these laws.

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..... [3]

4 **(b)** Researchers at a hospital recorded the total number of children admitted to the hospital between 1984 and 2002.

A common reason for children being admitted to this hospital was severe diarrhoea.

Table 4.1 shows this information.

Table 4.1

year	total number of children admitted to the hospital
1984	1386
1986	1604
1988	1955
1990	2054
1992	1726
1994	1143
1996	1422
1998	1419
2000	1580
2002	1161

(i) Calculate the percentage decrease in the total number of children admitted to the hospital between 1998 and 2002.

Give your answer to the nearest whole number.

Space for working.

..... %
[3]

(ii) Health workers in the communities near the hospital were trained in the prevention and treatment of diarrhoea. This affected the total number of children being admitted to the hospital.

Suggest the year in which the training took place.

Give a reason for your answer.

year .....

reason .....

.....

.....
[2]

(iii) The health workers provided advice to the community on ways of preventing the spread of the pathogens that cause diarrhoea.

Suggest the advice that was given to the community.

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..... [3]

[Total: 12]

4 **(a)** Explain how the human gas exchange system is protected against pathogens.

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..... [4]

(b) Tuberculosis (TB) is a transmissible disease caused by a bacterial pathogen. The spread of this disease can be controlled by vaccination.

Explain how vaccination provides a defence against transmissible diseases.

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..... [4]

(c) TB is a disease that can be treated with antibiotics. HIV infection cannot be treated with antibiotics.

Explain why viral diseases **cannot** be treated with antibiotics.

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..... [2]

(d) Lung cancer is a disease that is strongly linked with smoking tobacco.

Fig. 4.1 shows some data about smoking and lung cancer in country **A** between 1900 and 2020 (2020 data has been estimated):

- percentage of the male population that smoke tobacco
- percentage of the female population that smoke tobacco
- number of deaths in males from lung cancer per 100 000 of the male population
- number of deaths in females from lung cancer per 100 000 of the female population.

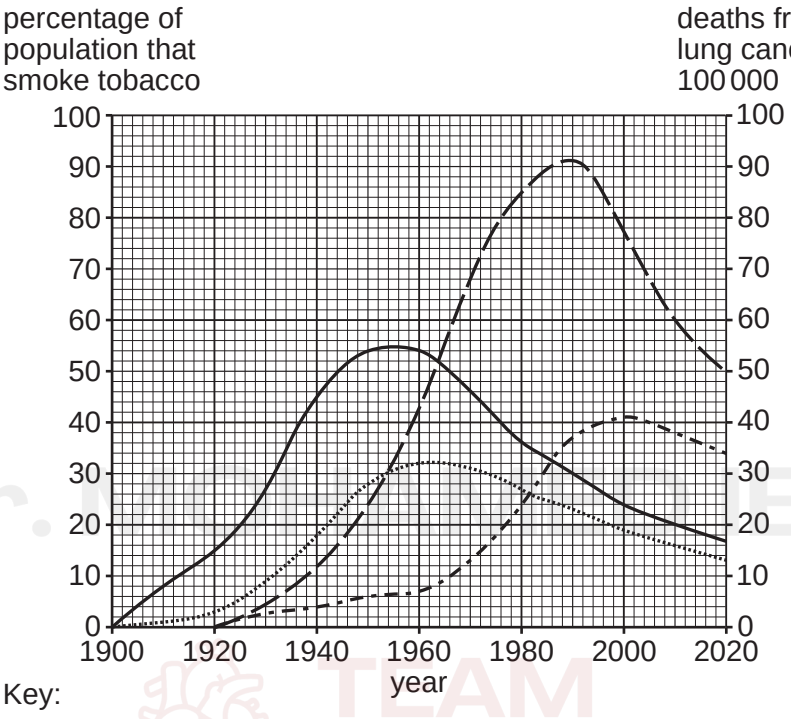

Fig. 4.1

(i) Describe the differences between the percentages of males and females in country **A** that smoke as shown in Fig. 4.1.

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..... [3]

(ii) Fig. 4.2 shows the same smoking statistics for country **B** between 1950 and 2020.

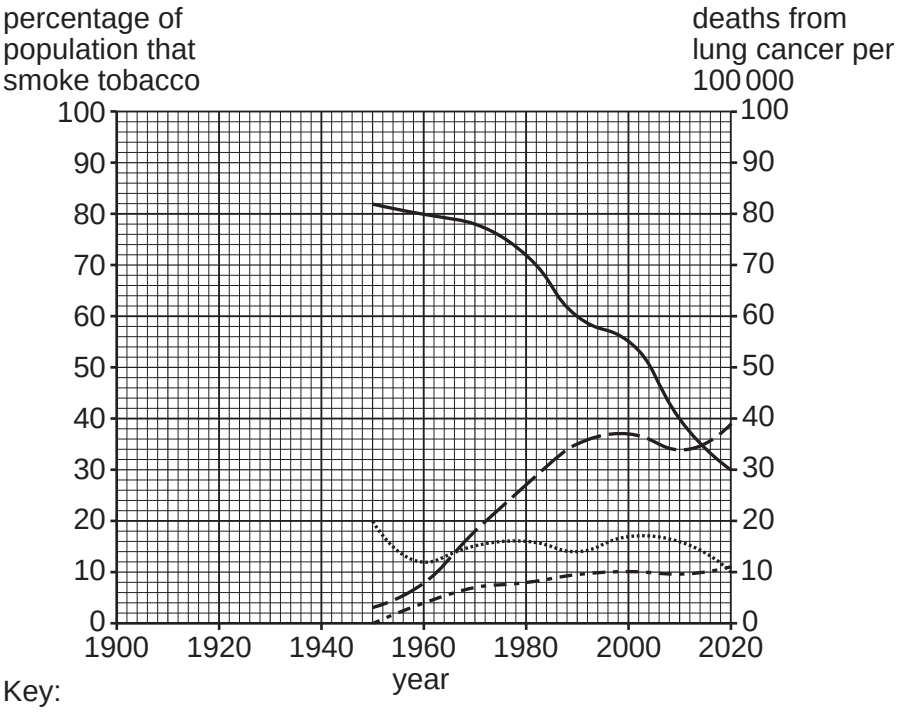

Fig. 4.2

Discuss the evidence **for** and **against** this statement:

'The changes in the percentage of the population that smoke tobacco, and the deaths from lung cancer per 100 000, follow the same trends in males and in females.'

Use the information for country **A** in Fig. 4.1 and country **B** in Fig. 4.2 in your answer.

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..... [6]

[Total: 19]

2 Microbiologists test strains of bacteria for antibiotic resistance.

They do this by soaking paper discs in antibiotics and placing them on bacteria growing in Petri dishes.

The paper discs in the centre of Petri dishes **E** and **F** in Fig. 2.1 have been soaked in penicillin.

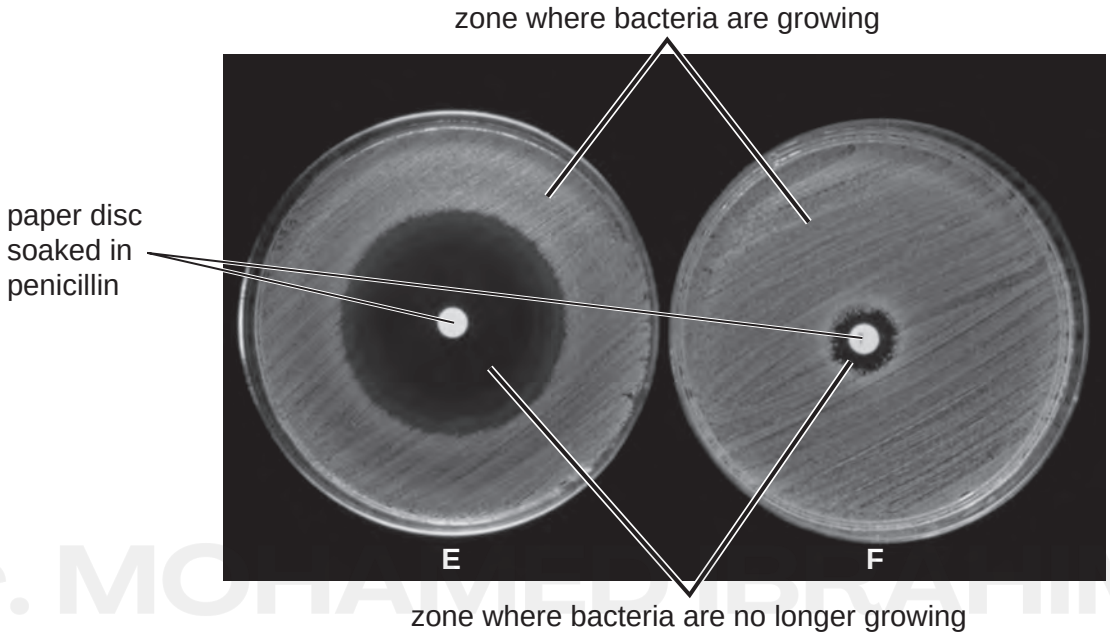

Fig. 2.1

(a) State the **type** of microorganism that produces penicillin.

.....[1]

(b) State **and** explain the evidence from Fig. 2.1 that suggests that the bacteria in dish **F** are resistant to penicillin.

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.....[2]

(c) **(i)** Explain how bacteria become resistant to antibiotics **and** how humans can reduce the problem of antibiotic resistance.

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.....[6]

(ii) Explain why viral infections cannot be treated with antibiotics.

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.....[1]

(b) State **one** similarity between the structure of bacteria and the structure of viruses.

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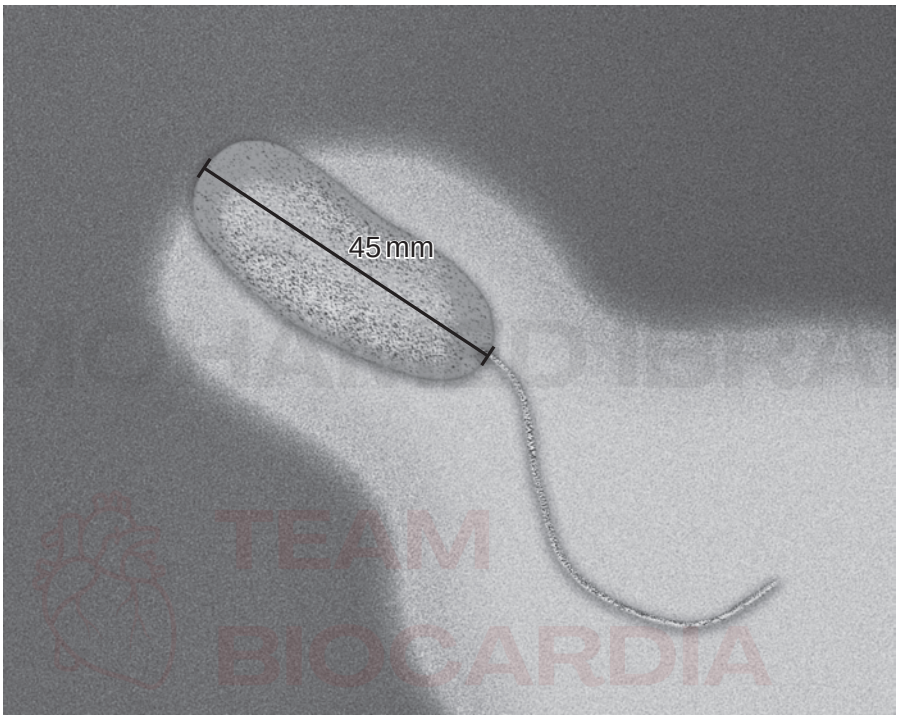
.....

.....[1]

(c) Fig. 1.3 is a photomicrograph of *Vibrio cholerae*, the bacterium that causes cholera.



magnification ×17 300

Fig. 1.3

(i) Write the formula that would be used to calculate the actual length of the bacterium (not including the flagellum) in Fig. 1.3.

[1]

(ii) The actual length of the bacterium shown in Fig. 1.3 is 0.0026 mm.

Convert this value to micrometres (μm).

Space for working.

..... μm [1]

(d) (i) Describe **and** explain the effects of cholera bacteria on the gut.

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.....[4]

(ii) Suggest **one** treatment for cholera.

.....[1]

[Total: 14]

2 A study estimated the number of people with chronic obstructive pulmonary disease (COPD) in India. Data were collected from two groups of people, those who lived in cities and those who lived in villages.

Fig. 2.1 shows the results.

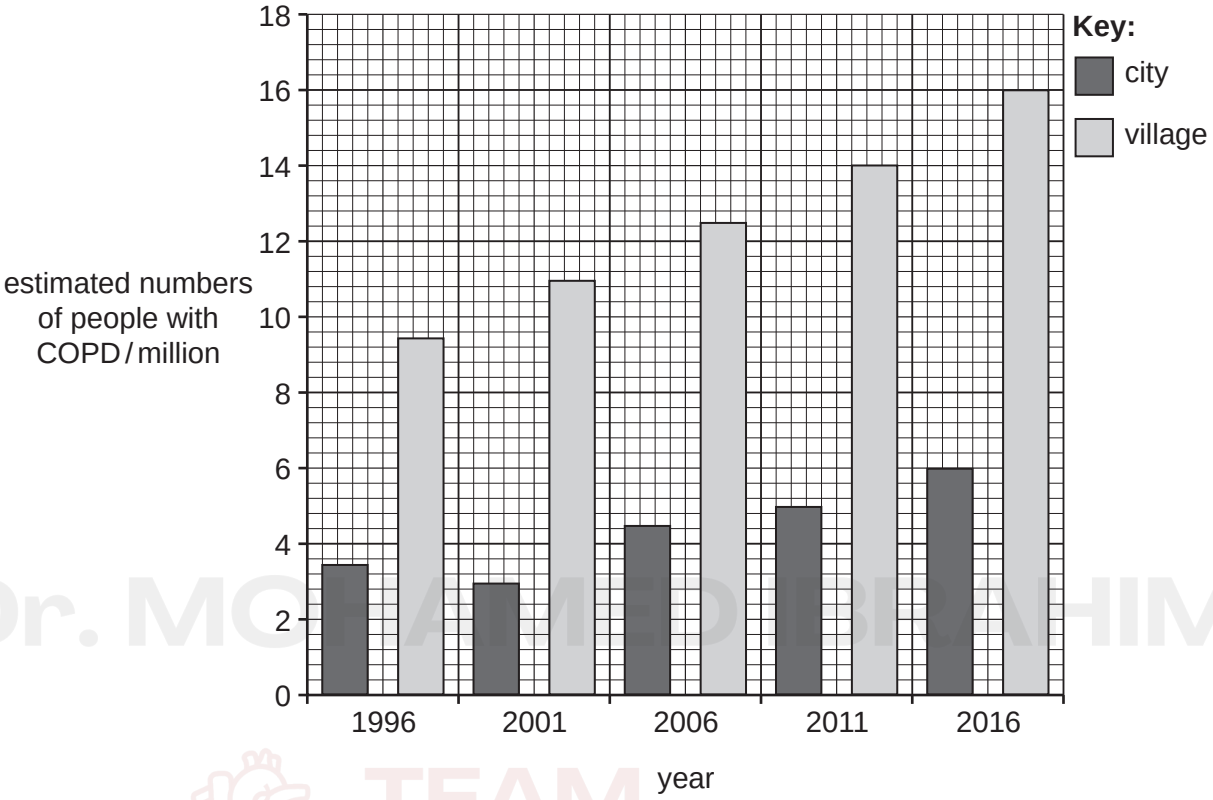

Fig. 2.1

(a) Compare the number of people with COPD in cities with the number of people with COPD in villages **and** suggest reasons for the differences.

Use the data in Fig. 2.1 to support your answer.

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.....[6]

(c) Chlamydia is a sexually transmitted infection (STI).

Fig. 4.2 shows the number of reported cases of chlamydia in females in each age group in one country.

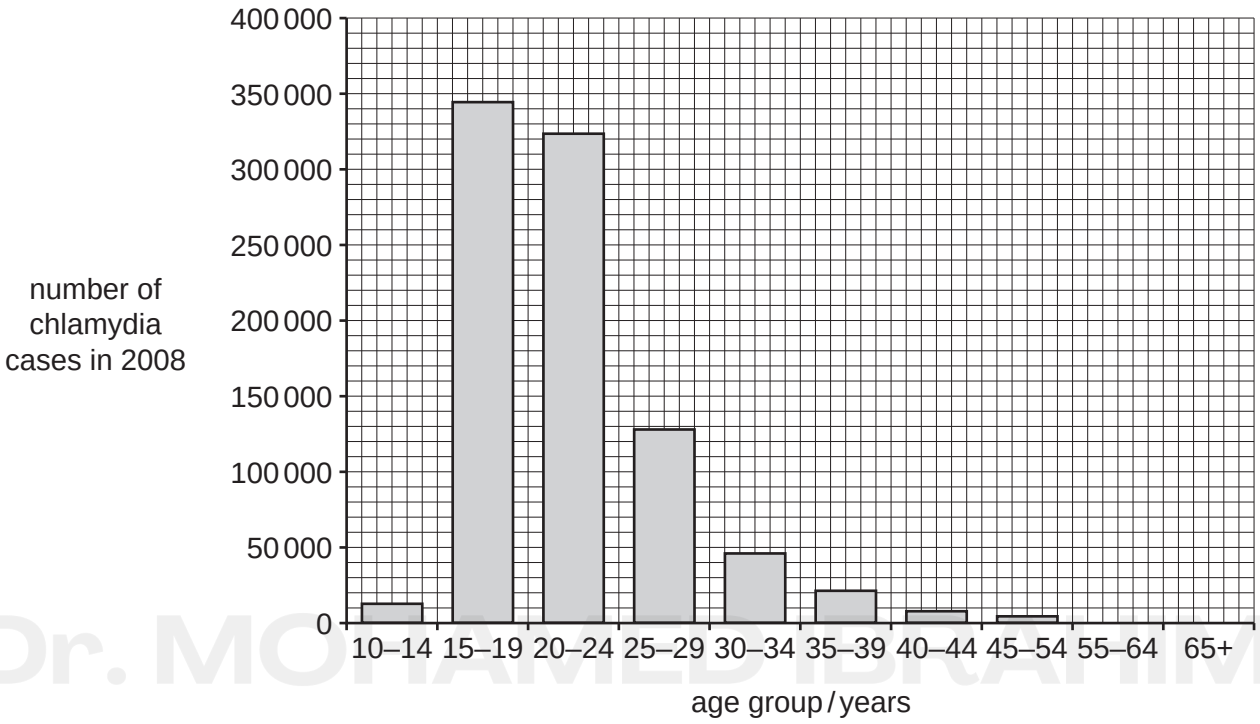

Fig. 4.2

Describe the results shown by the data in Fig. 4.2.

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.....[3]

(d) Chlamydia is caused by a bacterium.

(i) Suggest a treatment for chlamydia.

.....[1]

(ii) State the name of **one other** STI.

.....[1]

(c) *Penicillium* is a mould fungus that is used to make antibiotics.

(i) Describe how *Penicillium* is used to make the antibiotic penicillin.

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.....[3]

(ii) Explain why antibiotics can be used to treat bacterial infections but not viral infections.

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.....[1]

(d) Some fungi are human pathogens.

Describe how the human body prevents pathogens from entering.

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.....[3]

[Total: 14]

5 Fig. 5.1 shows the bacterium *Helicobacter pylori*, which is a human pathogen.

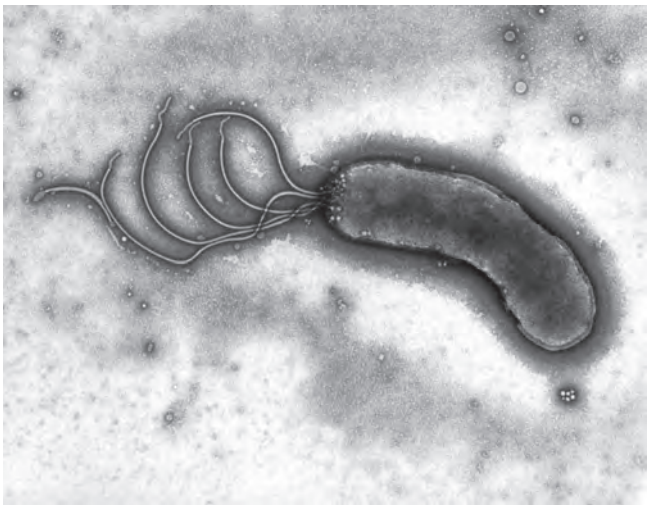

Fig. 5.1

(c) (i) *H. pylori* can cause infections in the stomach.

Suggest how this infection could be treated.

.....[1]

(ii) State **one** natural body defence that is found in the stomach.

.....[1]

(d) The immune system is not very effective against pathogens, such as *H. pylori*, that live inside the alimentary canal. This means that active immunity and passive immunity do not provide complete protection against *H. pylori* infections.

Explain how active immunity differs from passive immunity.

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.....[4]

[Total: 9]

6 Viruses can cause diseases.

(a) **(i)** State **two** other features of all viruses.

1 .....

2 .....
[2]

(ii) Describe how vaccination can prevent the spread of disease.

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.....[5]

(b) Fig. 6.1 shows four different viruses.

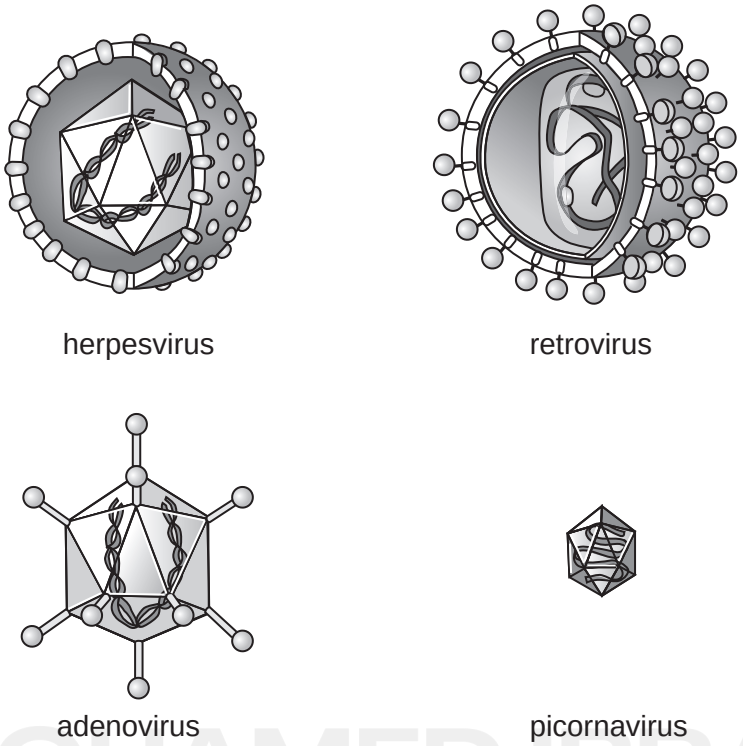

Fig. 6.1

Suggest **one** feature that could be used to classify viruses into groups.

.....

.....[1]

[Total: 8]

6 Fig. 6.1 is a flow diagram that shows what happens at the start of a bacterial infection.

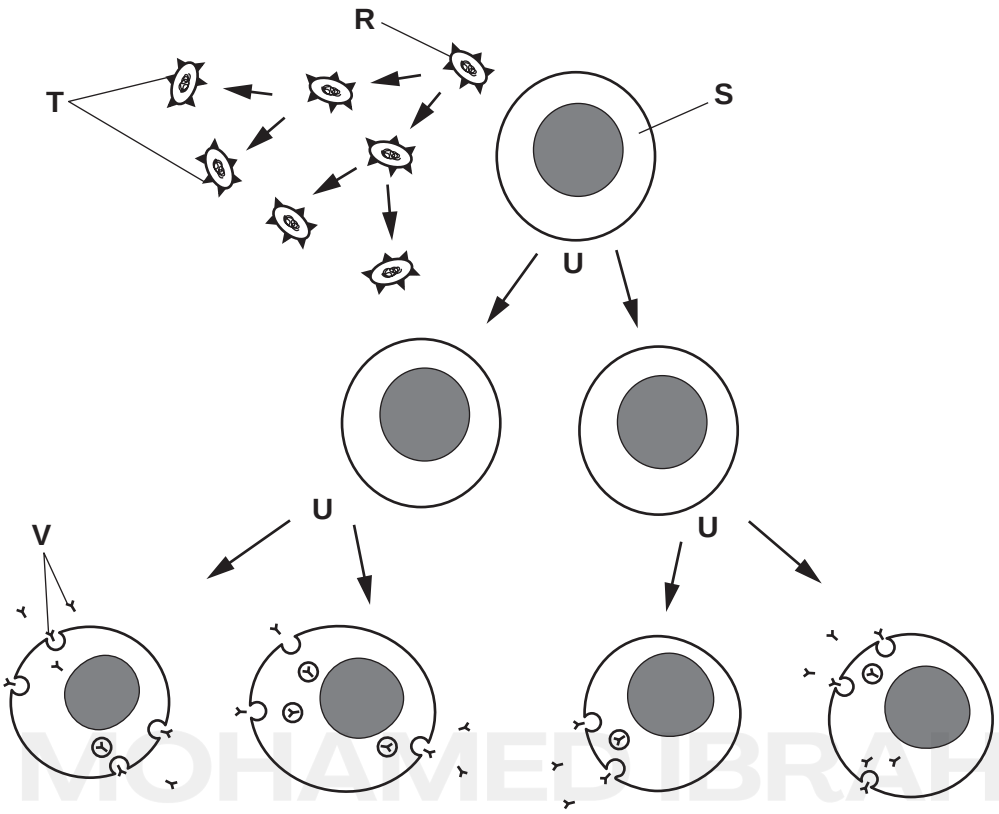

Fig. 6.1

(a) Cell **R** is a prokaryote and cell **S** is a lymphocyte.

(i) State the names of **two** cellular structures that would be found in **both** prokaryotes and white blood cells.

1 .....

2 .....

[2]

(ii) Describe how the cellular structure of white blood cells differs from the cellular structure of prokaryotes.

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.....

.....[3]

(b) Cell **R** is a pathogen that has structures **T** on its surface. These structures are recognised by cell **S**. Cell **S** is a lymphocyte and it produces structures **V**. Cell **R** reproduces by binary fission and cell **S** divides by process **U**.

Identify **T** to **V** from the passage and Fig. 6.1.

T .....

U .....

V .....

[3]

(c) Cell **W** in Fig. 6.2 also responds to pathogens.

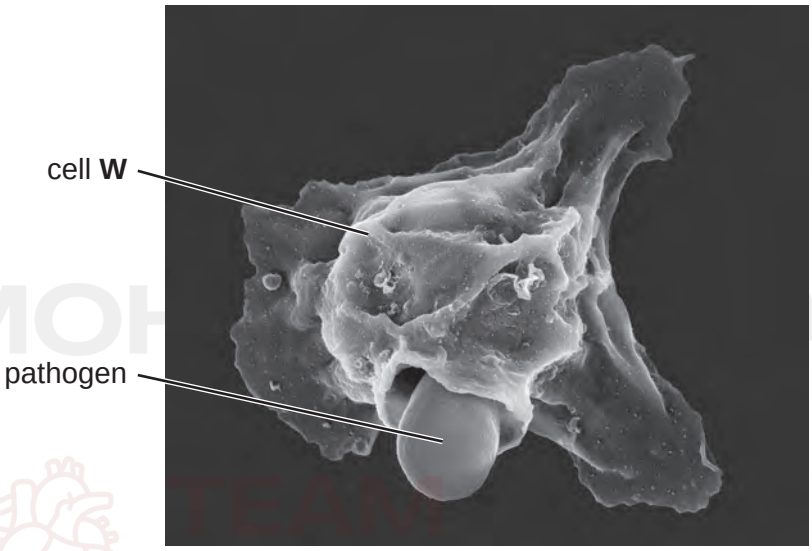

Fig. 6.2

(i) State the name of the process shown in Fig. 6.2.

.....[1]

(ii) Describe what happens to the pathogen during the process shown in Fig. 6.2.

.....

.....

.....[1]

2 The genes for antibodies are only active in lymphocytes.

(b) Lymphocytes produce antibodies.

Outline the role of antibodies in the defence of the body against pathogens.

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.....[4]

(c) Fig. 2.1 is a drawing made from an electron micrograph of a lymphocyte that produces antibodies.

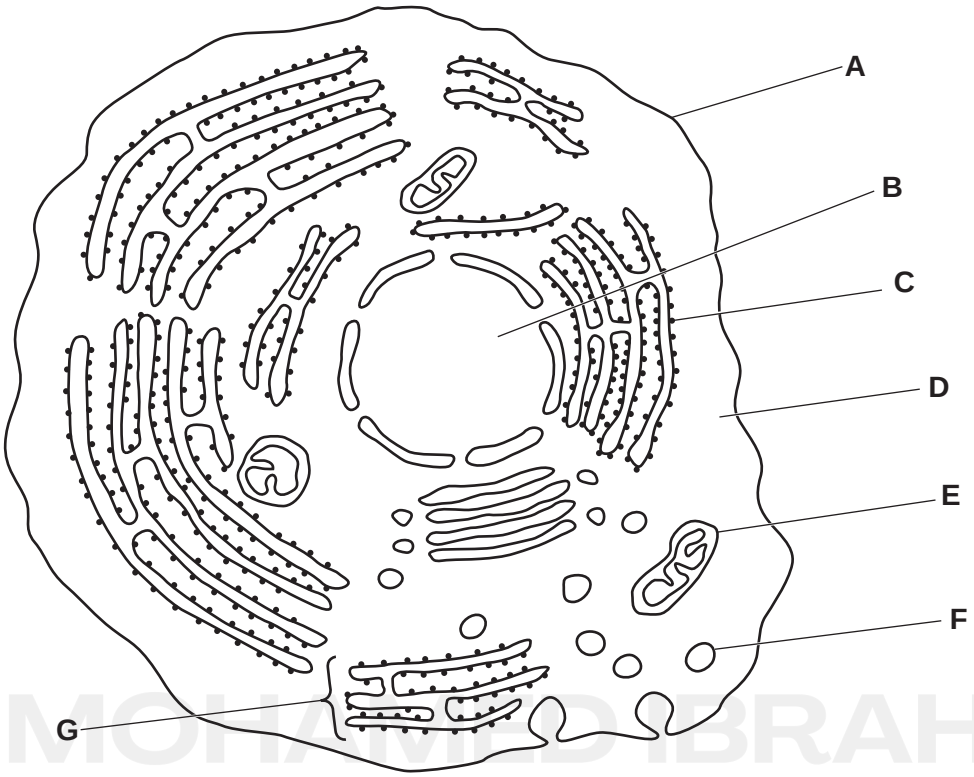

Fig. 2.1

Table 2.1 contains statements about the structures visible in Fig. 2.1.

Complete Table 2.1 by

- naming the structure
- identifying the letter that labels the structure.

The first one has been done for you.

Table 2.1

function	name of structure	letter from Fig. 2.1
absorption of amino acids used in making antibodies	cell membrane	**A**
stores genetic information as DNA		
provides energy for making antibodies		
site of production of antibodies		
transport of antibody molecules for release into blood		

[4]

(d) State the name of **one** type of cell, other than a lymphocyte, that is involved in the defence of the body against pathogens and describe its role.

name.....

role.....

.....
[2]

[Total: 12]

2 Bacteria are classified as belonging to the Prokaryote kingdom.

MRSA is a type of bacterium that is resistant to antibiotics. The number of cases of MRSA identified in hospitals in the USA between 1995 and 2005 was recorded.
Fig. 2.1 shows these data.

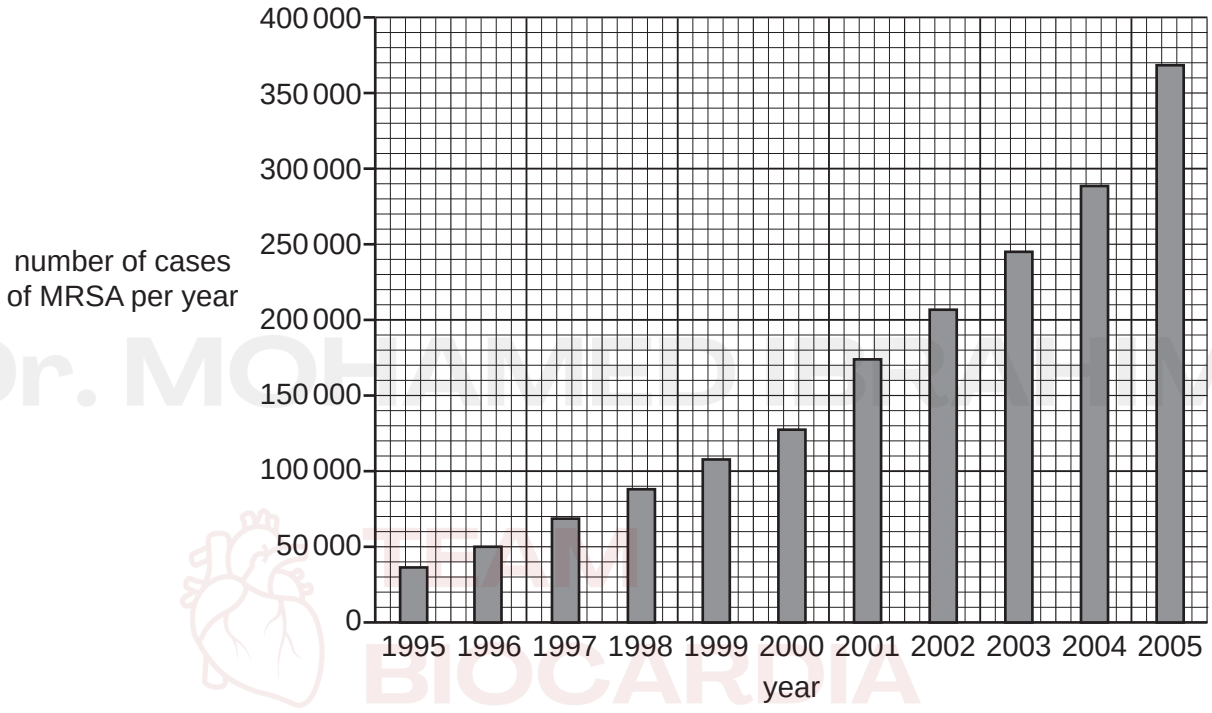

Fig. 2.1

(b) **(i)** Describe the results shown in Fig. 2.1.

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.....[2]

(ii) Explain how bacteria become resistant to antibiotics.

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.....[4]

(c) The number of cases of MRSA has decreased since 2005.

Suggest reasons for this decrease.

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.....[2]

[Total: 10]

(c) A study compared the percentages of men and women aged between 35 and 54 years who smoked cigarettes. The annual death rate caused by lung cancer was also recorded.

The results are shown in the two graphs in Fig. 4.1.

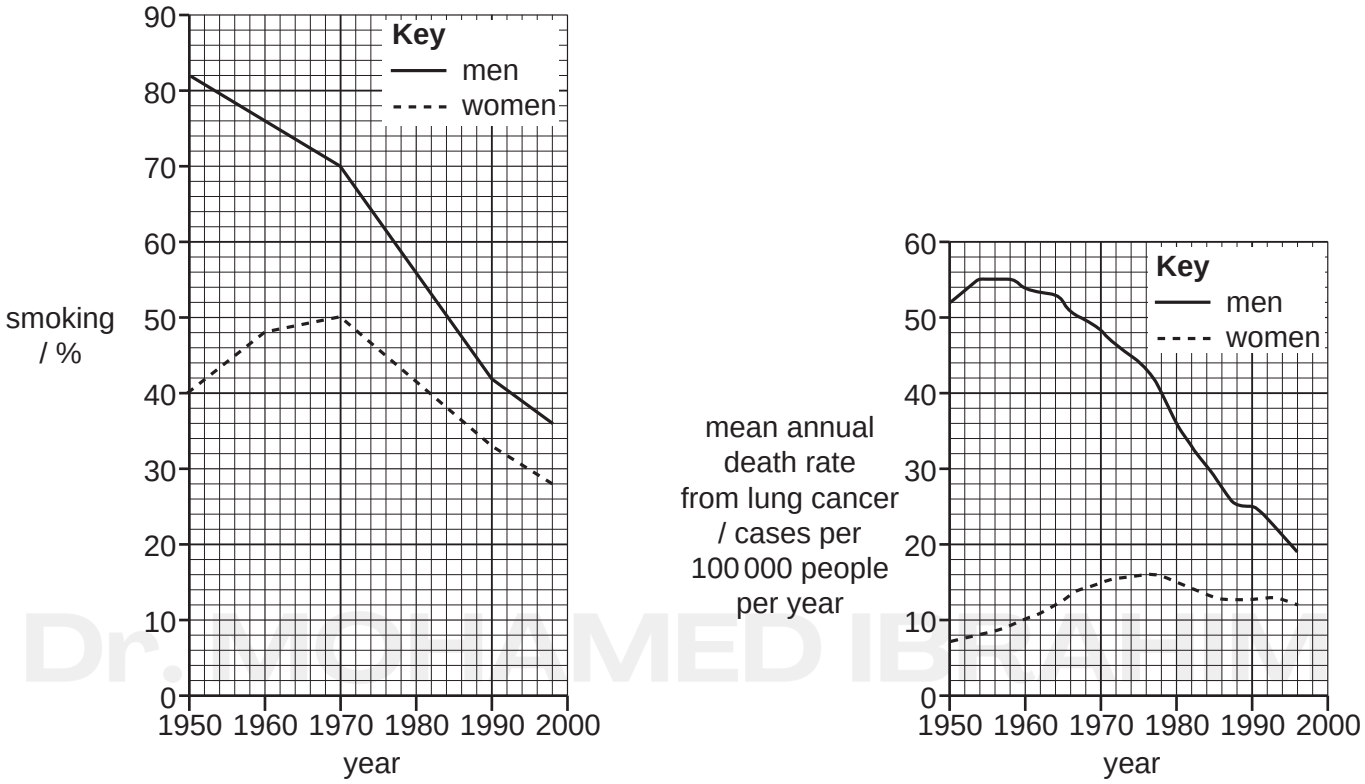

Fig. 4.1

(i) Use the data shown in Fig. 4.1 to compare the percentages of men and women who smoked cigarettes between **1950** and **1998**.

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.....[4]

(ii) Use the information from **both** graphs in Fig. 4.1 to discuss the link between smoking and lung cancer.

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.....

.....[4]

5 The numbers of different cells in a blood sample were counted. The results are shown in Table 5.1.

Table 5.1

cell type	number / per mm^3	percentage
red blood cells	4 820 000	94.91
lymphocytes	1 900	0.04
phagocytes	6 000	0.12
platelets	250 000	
total	5 077 900	100.00

(a) Complete the table by calculating the percentage of platelets. Write your answer in Table 5.1 to two decimal places. [1]

(b) State the role of platelets in the blood **and** describe the process they are involved in.

.....

.....

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.....

.....

..... [4]

(c) Lymphocytes are white blood cells that are produced in bone marrow. Lymphocytes travel in the blood from bone marrow to lymph nodes throughout the body.

If a pathogen infects the body, some of these lymphocytes are activated.

State the role of lymphocytes in defence against pathogens.

..... [1]

(d) During a second infection of the same pathogen the response by lymphocytes is much faster. Explain how this happens.

.....

.....

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.....

.....

..... [2]

(e) HIV invades specific lymphocytes that coordinate immune responses.

Fig. 5.1 shows the change in numbers of these lymphocytes following an HIV infection that has not been treated.

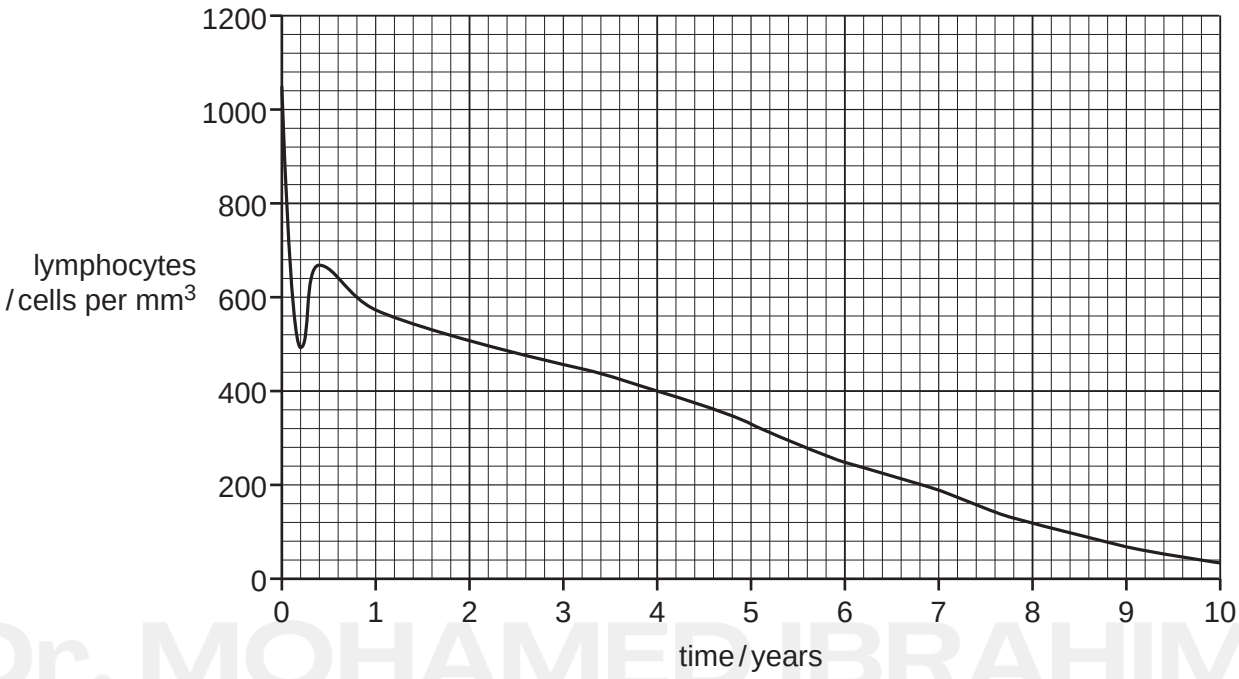

Fig. 5.1

(i) Describe the changes in lymphocyte numbers following HIV infection.

.....

.....

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.....

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..... [3]

(ii) Describe the effects on the body of an untreated HIV infection as shown in Fig. 5.1.

.....

.....

.....

.....

.....

..... [3]

[Total: 14]

1 Penicillin is an antibiotic.

(a) **(i)** Explain why doctors give antibiotics to people who are ill.

.....

.....

.....

.....[2]

(ii) Explain why it is important to complete a full treatment of antibiotics.

.....

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.....[3]

(b) Penicillin was discovered in 1928 by Alexander Fleming.

Name the type of microorganism that produces the antibiotic penicillin.

.....[1]

(c) Penicillin is produced commercially in fermenters as shown in Fig. 1.1.

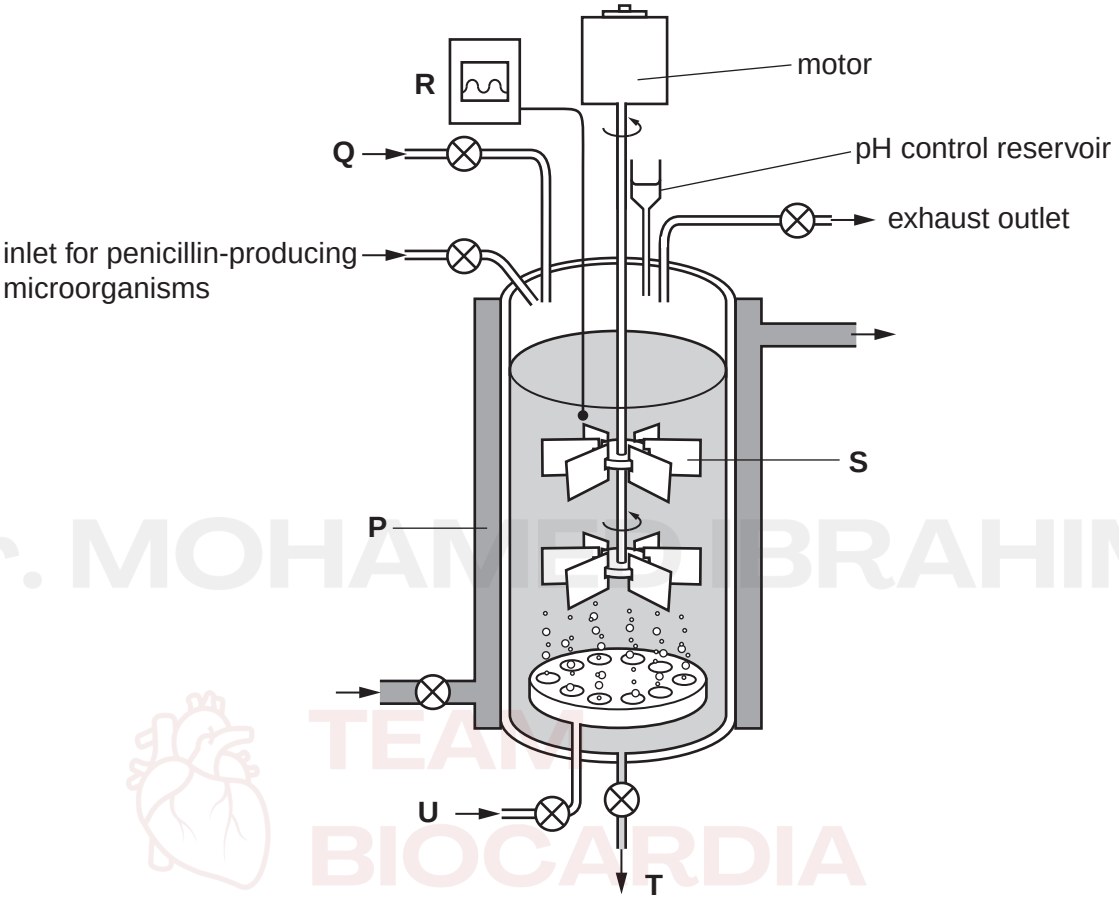

Fig. 1.1

(i) Describe how a fermenter can be sterilised.

.....

.....

.....[2]

(ii) Table 1.1 shows some names of the parts of the fermenter and their functions.

Complete Table 1.1.

One row has been done for you.

Table 1.1

letter from Fig. 1.1	name	function
	water jacket	
S		
	nutrient inlet	
R		
	air supply	
T	outlet	allows collection of the liquid containing penicillin after fermentation

[5]

(d) Describe what happens to the liquid containing penicillin after it is collected from the fermenter.

.....

.....[1]

[Total: 14]

(b) *V. cholerae* is the pathogen that causes cholera. Vaccination is used to control the spread of cholera during an outbreak.

Explain how vaccination can control the spread of diseases.

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..... [4]

(c) Many years ago scientists discovered that *V. cholerae* secretes a toxin. Fig. 2.2 shows the results of an experiment to measure the flow of chloride ions out of human cells with and without the toxin.

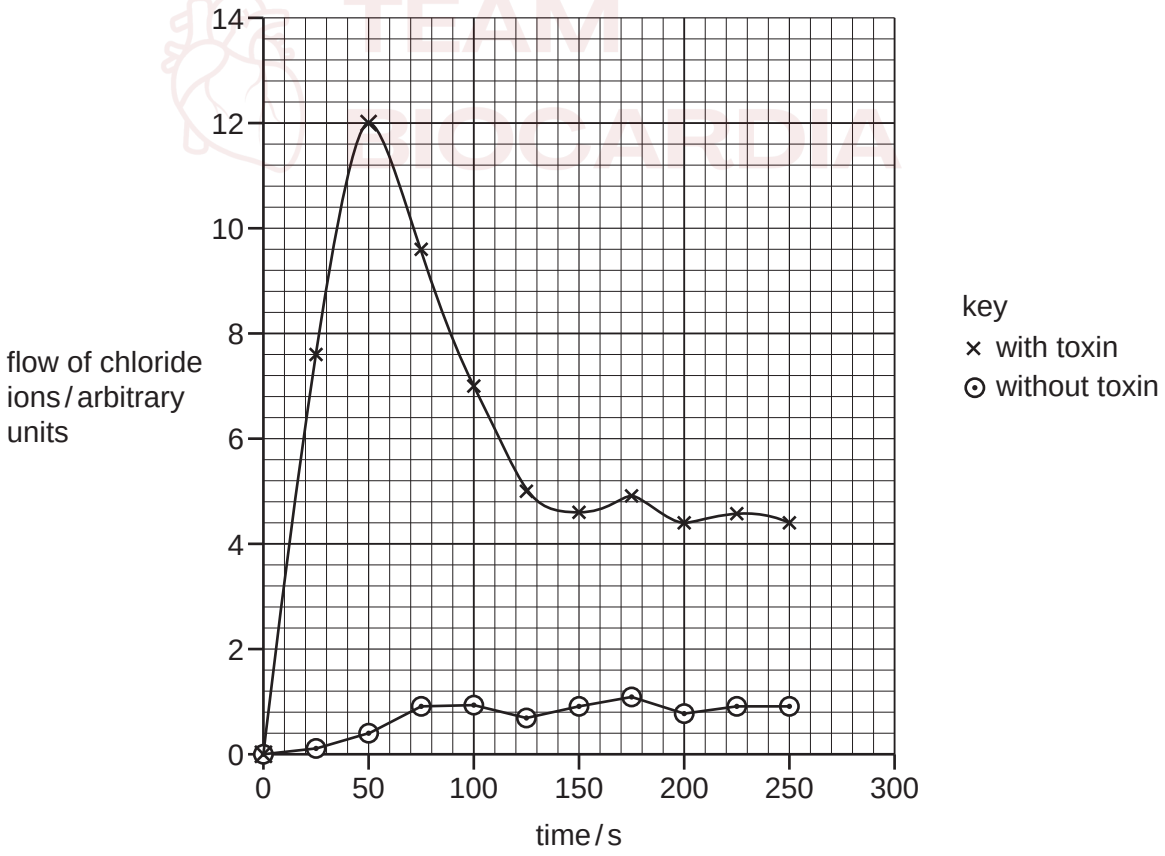

Fig. 2.2

(i) Calculate the difference in flow of chloride ions between the cells with the toxin and the cells without the toxin at 50 seconds.

Show your working and state the units in your answer.

..... [2]

(ii) Use the data in Fig. 2.2 to describe the effect of the toxin on the flow of chloride ions out of the cells.

.....

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..... [3]

(iii) Chloride ions cannot move out of cells by simple diffusion.

Suggest **and** describe how chloride ions could move out of cells.

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..... [3]

(d) The loss of chloride ions from cells causes diarrhoea and dehydration in patients with cholera.

(i) State which organ in the alimentary canal is affected by the cholera toxin.

..... [1]

(ii) Describe the treatment for cholera.

.....

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.....

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..... [2]

[Total: 18]

Inheritance

(b) **(i)** Describe how the pollen that is carried by an insect to another flower results in the formation of a plant embryo.

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..... [5]

(ii) Describe the advantages of cross-pollination.

.....

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.....

..... [2]

(c) Some people are concerned that genetically modified plants might cross-pollinate with wild varieties of plants.

(i) Suggest how farmers could prevent cross-pollination between genetically modified plants and wild varieties of plants.

.....

.....

..... [1]

(ii) State **two** advantages of genetically modified crops.

1 .....

2 .....

[2]

[Total: 16]

(c) Scientists published the results of an investigation into the DNA of cats with and without polydactyly. They compared the base sequence from a particular region of DNA that controls the development of the limbs.

Table 3.1 shows the base sequences.

Table 3.1

cats without polydactyly	AGA CAC AGA AAT GAG
Hemingway's cats with polydactyly	AGA CAC GGA AAT GAG
cats with polydactyly from Oregon and Missouri in the USA	AGA CAC GGA AAT GAG
cats with polydactyly from the UK	AGA CAC AGT AAT GAG

(i) Describe how the base sequences of the cats with polydactyly differ from the base sequence of cats without polydactyly.

.....

.....

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..... [2]

(ii) State the name of the process by which base sequences in DNA are changed.

..... [1]

(iii) The base sequences in Table 3.1 provide evidence that indicates which country the male cat given to Hemingway in the 1930s came from.

Suggest which country this cat came from **and** give a reason for your choice.

.....

.....

.....

.....

..... [2]

(v) When the king cheetah was first discovered it was thought that it was a new species.

Pedigree diagrams of cheetahs proved it was not a new species.

Suggest **one** type of evidence, other than pedigree diagrams, that can be used to determine how closely related organisms are.

.....

.....

..... [1]

(c) Discuss the advantages of sexual reproduction to a wild population of flowering plants such as Johnson grass.

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..... [5]

(d) Sexual reproduction requires energy.

State **three** uses of energy in organisms **other than in reproduction**.

1 .....

2 .....

3 .....

[3]

[Total: 21]

(d) Black stem rust is a disease of wheat that is caused by a fungus.

Plant breeders used two varieties of wheat to produce a variety of wheat that is both rust-resistant and has a high yield.

Fig. 5.2 shows the breeding programme that was used.

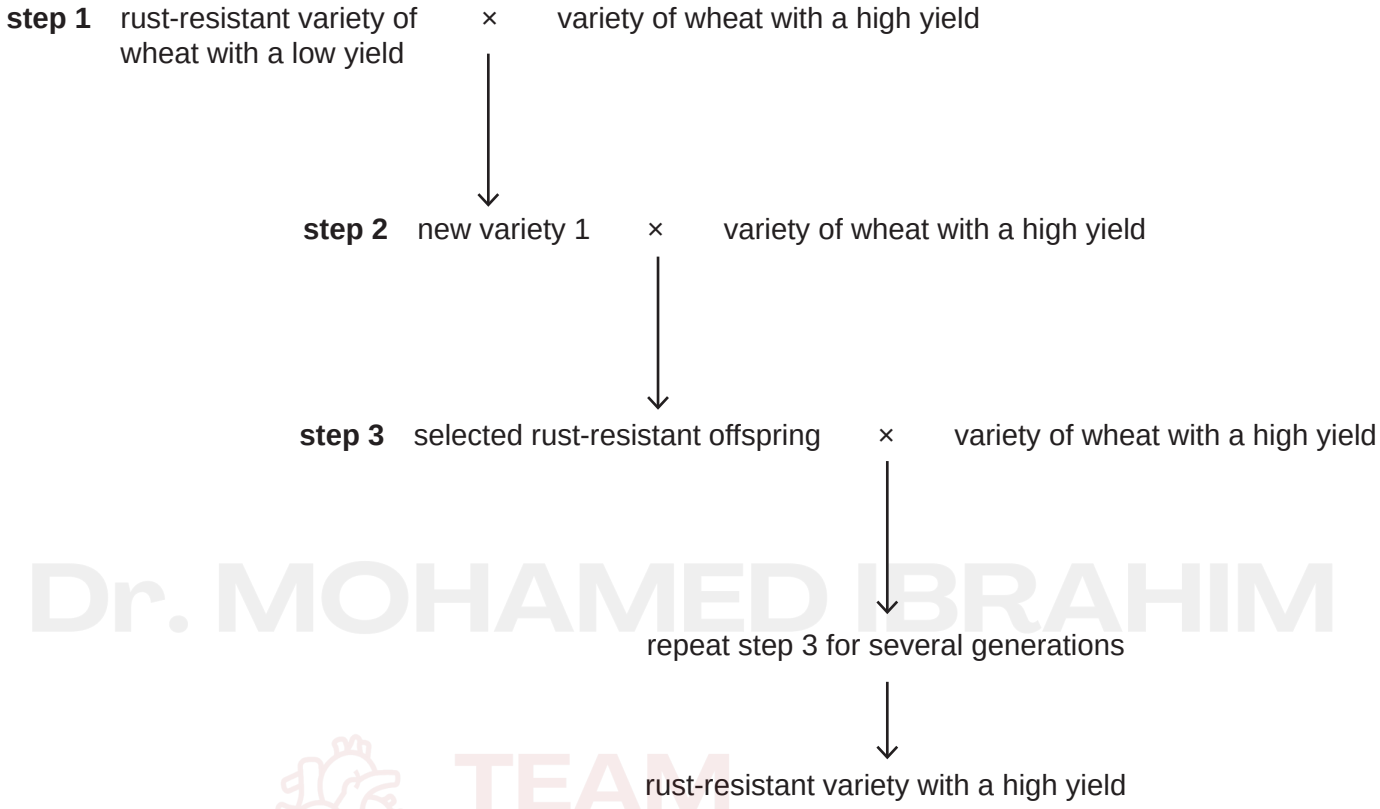

Fig. 5.2

(i) Suggest how plant breeders make sure that the plants that they use for step 3 are rust-resistant.

.....

.....

.....

.....

..... [2]

(ii) Suggest why step 3 is repeated for many generations before the new rust-resistant variety is made available for farmers to grow.

.....

.....

..... [1]

(b) Some people who have sickle-cell anaemia have parents who do not have sickle-cell anaemia.

Explain how people with sickle-cell anaemia inherit the disease.

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..... [4]

(b) Petal colour in the flowers of snapdragon plants shows co-dominance.

The gene for petal colour has two co-dominant alleles:

- C^R for red petals
- C^W for white petals

Table 2.1 shows the genotypes and phenotypes of snapdragon plants with different petal colours.

Table 2.1

genotype	phenotype
C^RC^R	red
C^WC^W	white
C^RC^W	pink

(i) Explain the term *co-dominance*.

.....

.....

.....

.....

..... [2]

(ii) A botanist crossed two snapdragon plants with pink flowers.

Complete the genetic diagram to show the ratio of expected phenotypes in the offspring.

parental phenotypes pink flower × pink flower

parental genotypes C^RC^W × C^RC^W

gametes ....

offspring genotypes ....

offspring phenotypes ....

phenotypic ratio .....

[4]

(iii) The botanist wanted to produce a generation of snapdragons that all had pink flowers.

State the phenotypes of the parent plants that the botanist would need to cross.

Explain your answer.

parent phenotypes .....

explanation .....

.....

.....

[2]

[Total: 13]

(ii) Explain the **disadvantages** of the type of reproduction shown in Fig. 2.3.

.....

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.....

.....

.....

.....

..... [3]

[Total: 12]

(ii) A farmer wanted to do a test cross to identify the genotype of disease-resistant apple trees. This would tell him whether his trees were either homozygous dominant or heterozygous.

Determine the phenotypes of the offspring if the unknown parent apple tree was heterozygous.

Complete the genetic diagram:

parental phenotypes	disease-resistant	×	not disease-resistant
parental genotypes	.....	×	.....
gametes	..... , ...	×	..... , ...

offspring genotype .....

offspring phenotype .....

[5]

(b) The farmer wanted to breed disease-resistant apple trees.

(i) He decided **not** to use heterozygous disease-resistant apple trees in his selective breeding programme.

Explain why.

.....

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.....

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.....

.....

.....[2]

(c) Following fertilisation, seeds will form.

In pea plants there are two alleles for height:

- tall (**T**)
- dwarf (**t**)

(i) Define the term *allele*.

.....

.....

.....[1]

(ii) A farmer wanted to identify the genotype of tall pea plants as either homozygous dominant or heterozygous.

He used a homozygous recessive dwarf pea plant to determine the genotype of the tall pea plants.

State the name of this type of genetic cross.

.....[1]

(iii) Complete the genetic diagram to determine the genotype of the parent plant if all the offspring from the cross are tall plants.

parental phenotypes	tall	×	dwarf
parental genotypes	.....	×	.....
gametes	....	+	....

offspring genotype .....

offspring phenotype .....

[4]

(iv) Another farmer wants to produce pure-breeding dwarf pea plants.

State the genotypes of both of the parent pea plants the farmer should use.

Give a reason for your choice.

genotypes .....

reason .....

.....

[2]

[Total: 16]

2 Many researchers are studying the structure and function of genes.

(a) Define the term *gene*.

.....

.....

.....[2]

(b) Every living cell is able to make proteins.

The process begins in the nucleus.

Describe how proteins are made in a cell.

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.....[4]

(c) Fig. 2.1 is a diagram of a protein used to move ions across membranes in root hair cells.

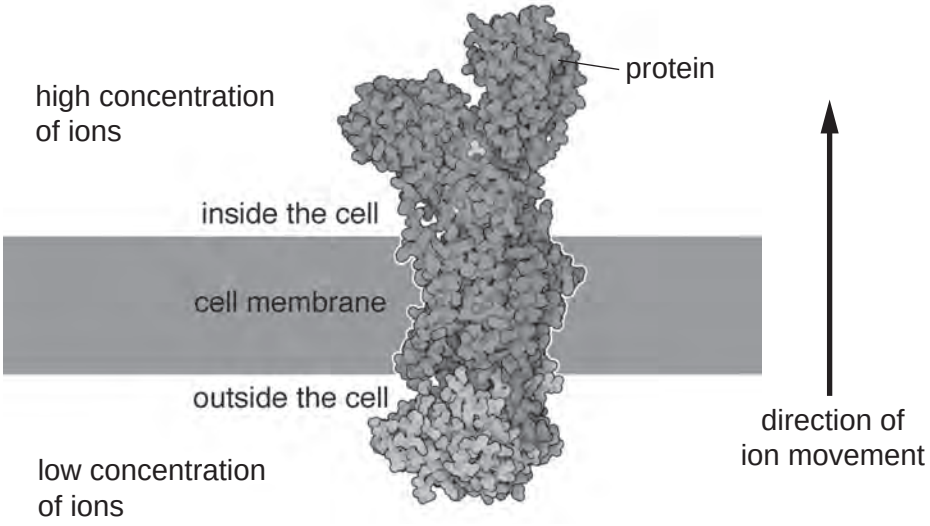


Fig. 2.1

(i) State the name of the process that moves mineral ions into root hair cells through cell membrane proteins.

.....[1]

(ii) Explain how protein molecules move ions across a membrane during this process.

.....

.....

.....

.....

.....

.....

.....[3]

(d) Proteins are also found in the blood.

State the names of **two** proteins found in the blood.

1 .....

2 .....

[2]

[Total: 12]

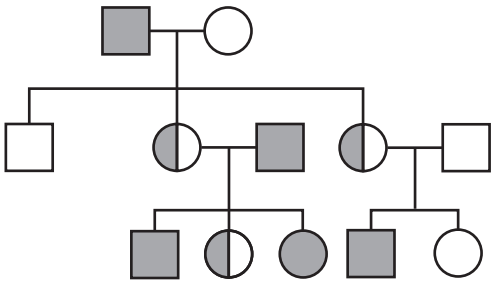
(c) Colour blindness is a sex-linked characteristic.

The gene for colour vision is on the X chromosome.

There are two alleles of this gene:

- **B** is the allele for normal colour vision
- **b** is the allele for colour blindness.

Fig. 3.2 is a pedigree chart showing the inheritance of colour blindness in a family. The key shows the sex chromosomes and the alleles of the gene for colour vision.



Key

male with normal colour vision	X^BY
colour-blind male	X^bY
female with normal colour vision	X^BX^B
carrier female with normal colour vision	X^BX^b
colour-blind female	X^bX^b

Fig. 3.2

Describe evidence from Fig. 3.2 that shows that colour blindness is a sex-linked characteristic.

.....

.....

.....

.....

.....[2]

(d) A man with normal colour vision (X^BY) and a woman who is colour-blind (X^bX^b) have a baby.

Complete the genetic diagram to predict the probability that the baby is colour-blind.

parental phenotypes	male with normal colour vision	x	colour-blind female
parental genotypes	X^BY	x	X^bX^b
parental gametes	....		....
offspring genotypes	....		....
offspring phenotypes	....		....

probability that the baby is colour-blind:

.....

[4]

[Total: 14]

5 **(a)** **(i)** Describe the structure of a DNA molecule.

.....

.....

.....

.....

.....

.....

.....[3]

(ii) State the function of a gene.

.....

.....[1]

(b) Molecular biologists identified a gene found in all species of bacteria and in mitochondria.

State the function of mitochondria.

.....

.....[2]

DNA can be used to distinguish between different species of bacteria.

Molecular biologists compared the DNA sequences of the gene in mitochondria and six species of bacteria. They counted the number of differences.

Table 5.1 shows the number of differences between the DNA sequences.

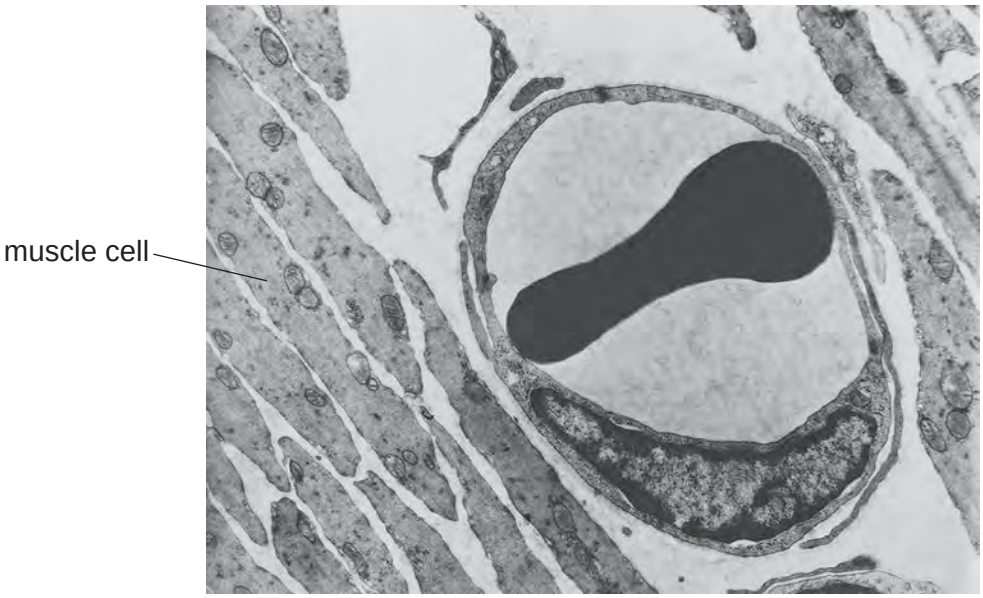
Table 5.1

	mitochondria **A**	species **B**	species **C**	species **D**	species **E**	species **F**	species **G**
mitochondria **A**		29	26	34	25	3	23
species **B**			18	12	17	26	24
species **C**				19	10	19	14
species **D**					28	29	30
species **E**						19	6
species **F**							16
species **G**							

The most closely related species have:

- the least number of differences between their DNA sequences
- the shortest distance from a branching point on a classification tree.

(b) Fig. 4.2 is an electron micrograph of a red blood cell within a capillary.



magnification ×6500

Fig. 4.2

(i) Molecules of carbon dioxide that are produced in muscle cells are transported to the blood.

Describe the pathway taken by these molecules of carbon dioxide.

.....

.....

.....

.....

..... [3]

(ii) Explain how capillaries are adapted for their functions.

.....

.....

.....

.....

.....

..... [3]

(ii) Describe how DNA can be used to classify organisms.

.....

.....

.....

.....[2]

(c) DNA controls cell function by controlling the production of proteins.

(i) Proteins are coded for by a length of DNA.

What is the name given to the length of DNA which codes for a protein?

.....[1]

(ii) Describe the role of mRNA in protein synthesis.

.....

.....

.....

.....

.....

.....[3]

[Total: 10]

Variation, Mutation & Natural Selection

(b) Methicillin-resistant *Staphylococcus aureus* (MRSA) is a type of bacterium that is resistant to some antibiotics.

Fig. 5.1 shows how a population of bacteria may develop antibiotic resistance and how the antibiotic resistance can be passed from one strain of bacterium to another.

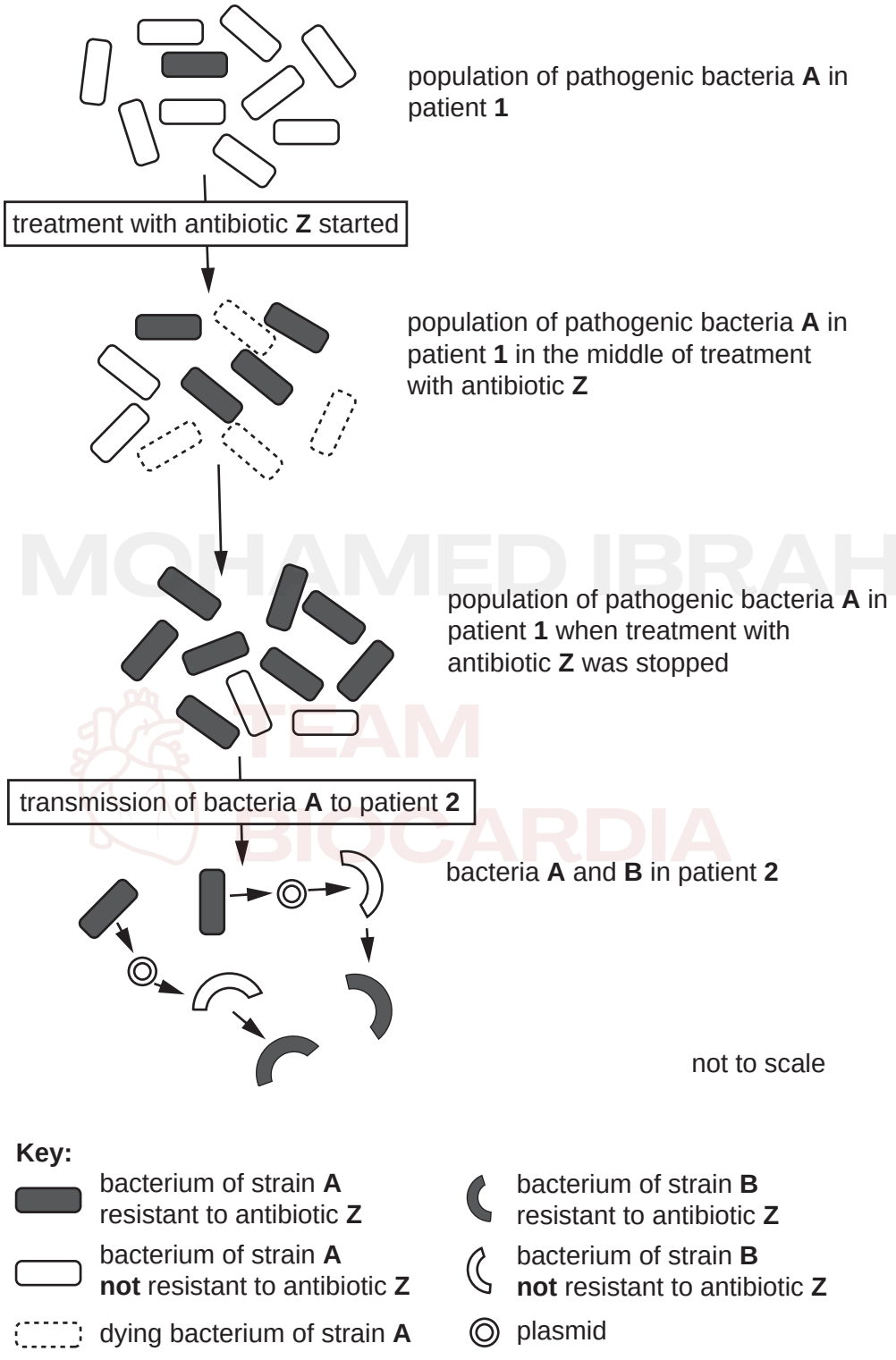


Fig. 5.1

Explain how resistance to an antibiotic develops in a population of bacteria and spreads in the human population.

....

....

....

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....

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....

....

.... [6]

(c) Explain how the development of resistant bacteria, such as MRSA, can be minimised.

....

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....

....

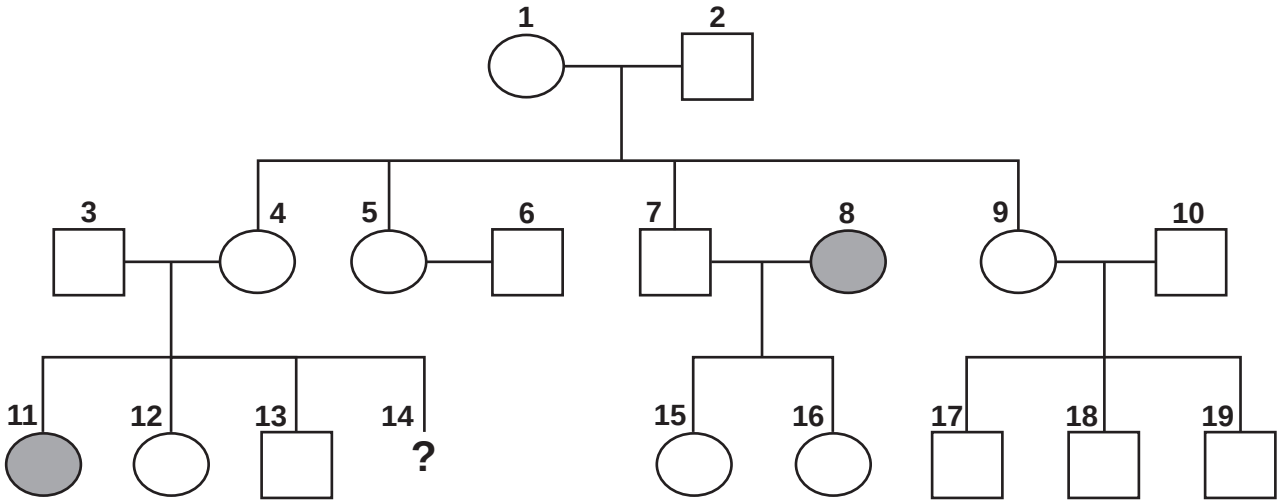
....

....

.... [3]

[Total: 11]

Fig. 3.3 shows a pedigree diagram of a population of cheetahs.



Key:

female king cheetah

female cheetah with spots

male king cheetah

male cheetah with spots

Fig. 3.3

(ii) Deduce the genotype of cheetah **11**.

..... [1]

(iii) Predict the probability of cheetah **14** being a king cheetah.

..... [1]

(iv) Describe how a breeder could determine the genotype of cheetah **17**.

.....

.....

.....

.....

..... [2]

4 Johnson grass, *Sorghum halepense*, is wind-pollinated.

(a) Fig. 4.1 shows some Johnson grass flowers.

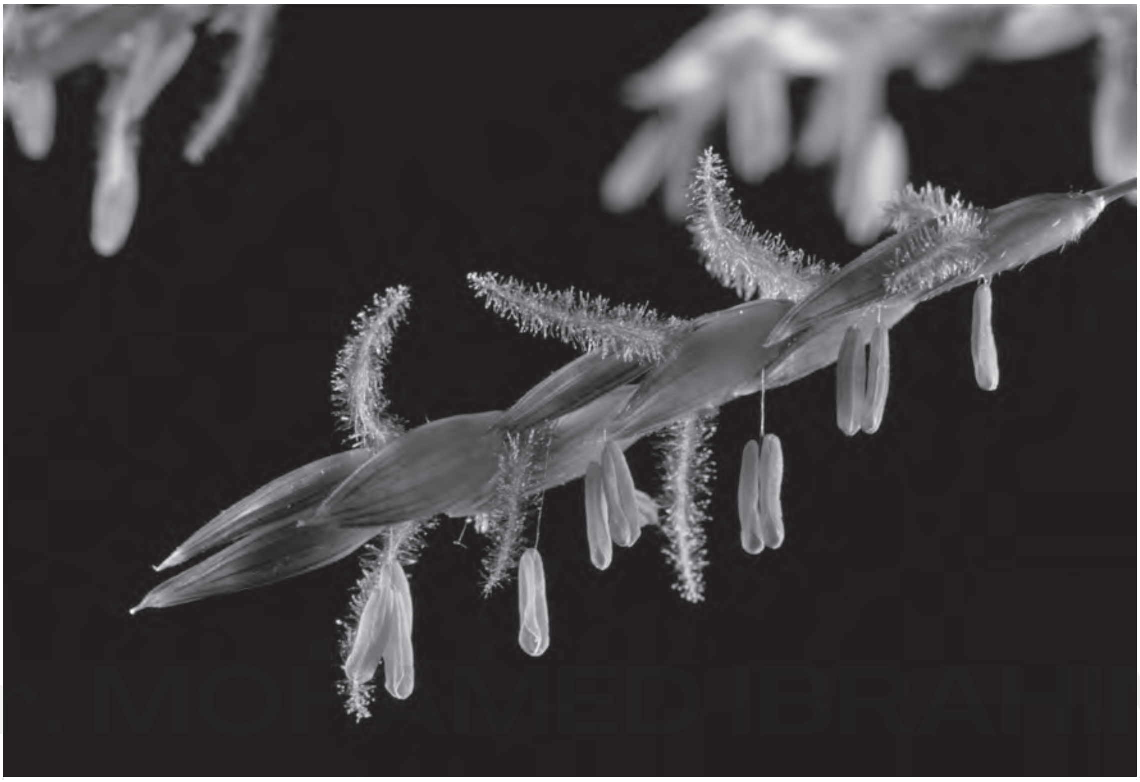


Fig. 4.1

(i) State the genus of Johnson grass.

.... [1]

(ii) Describe **two** features **visible in Fig. 4.1** that show that Johnson grass flowers are adapted for wind-pollination.

1 ....

....

2 ....

....
[2]

(ii) Complete the sentences:

Pollen grains are formed in anthers. During their formation the number of chromosomes in the nuclei is halved by the process of ..... . This means the male nucleus **A** in the pollen tube is described as a ..... nucleus. When nucleus **A** ..... with nucleus **B**, the chromosome number doubles to form a ..... nucleus. The name of this process is ..... . Then the ..... divides by the process of ..... to form an embryo.

[7]

(b) The Hawaiian happy-face spider, *Theridion grallator*, is found on several of the Hawaiian islands. Some of the spiders have a very distinctive pattern on their bodies as shown in Fig. 1.3.

Fig. 1.3

(i) State **one** feature, visible in Fig. 1.3, that identifies *T. grallator* as an arachnid.

..... [1]

(ii) Scientists think that the pattern on the bodies of the spiders is an adaptive feature.

Explain the term *adaptive feature* with reference to this pattern.

.....

.....

.....

.....

.....

.....

..... [3]

(d) Black stem rust is a disease of wheat that is caused by a fungus.

Plant breeders used two varieties of wheat to produce a variety of wheat that is both rust-resistant and has a high yield.

Fig. 5.2 shows the breeding programme that was used.

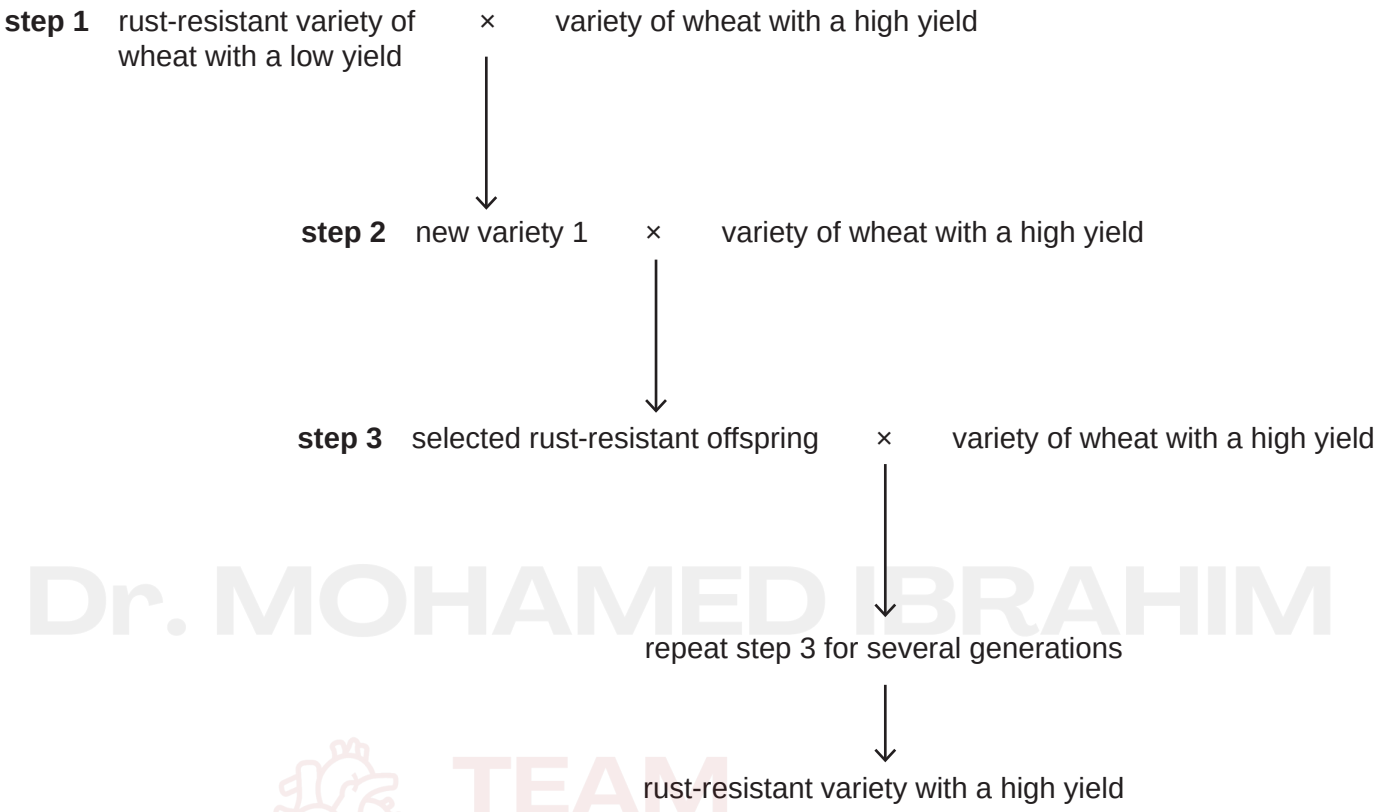


Fig. 5.2

(i) Suggest how plant breeders make sure that the plants that they use for step 3 are rust-resistant.

.....

.....

.....

.....

..... [2]

(ii) Suggest why step 3 is repeated for many generations before the new rust-resistant variety is made available for farmers to grow.

.....

.....

..... [1]

5 Sickle-cell anaemia is an inherited disease.

Fig. 5.1 is a photomicrograph of some blood cells from a person who has sickle-cell anaemia.

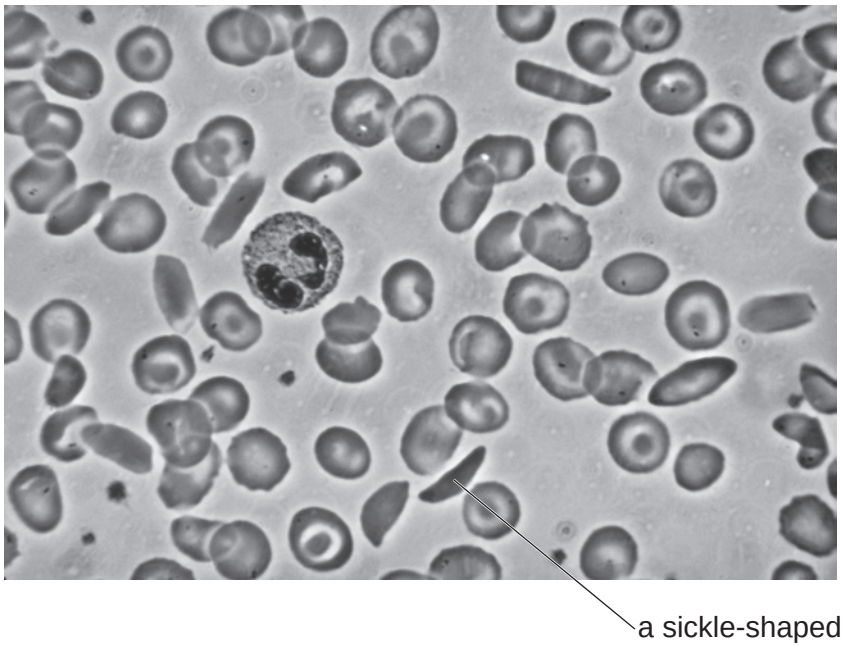


Fig. 5.1

(a) Explain how red blood cells become sickle-shaped.

.....

.....

.....

.....

.....

.....

..... [3]

2 Fig. 2.1 shows an Arctic wolf, *Canis lupus*. These wolves are one of the few mammals adapted to the extreme cold of the tundra in the Canadian Arctic and in Alaska.

Fig. 2.1

(a) (i) State **two** features, **visible** in Fig. 2.1, that identify Arctic wolves as mammals.

1 .....

2 .....

[2]

(ii) Arctic wolves show many adaptive features to a cold environment.

Explain what is meant by the term *adaptive feature*.

.....

.....

.....

.....

.....

.....[3]

(c) One group of students recorded the change in temperature as the seeds germinated in five insulated flasks, labelled **A** to **E**.

(i) Suggest why germinating seeds increase in temperature.

.....

.....

.....[2]

(ii) The students sterilised the seeds before their investigation.

Their teacher told them to use a sterilising solution to wash the seeds because steam would kill the seeds and prevent the seeds from germinating.

Explain why steam sterilisation would prevent seed germination.

.....

.....[1]

The results from this group of students are shown in Table 5.1.

Table 5.1

flask	pH	group 1
		temperature of seeds after 72 hours / °C
A	2.0	20.6
B	3.5	20.3
C	4.0	21.2
D	5.5	34.1
E	7.0	46.2

(iii) Describe the results obtained by group 1.

.....

.....

.....

.....

.....[2]

(d) The second group of students placed 100 seeds in each of five Petri dishes, labelled **1** to **5**.

Group 2 used the same range of pH values as group 1.

They recorded the percentage of seeds that had germinated after 72 hours.

Their results are shown in Table 5.2.

Table 5.2

Petri dish	pH	group 2
		percentage of seeds germinated after 72 hours
1	2.0	20
2	3.5	82
3	4.0	19
4	5.5	65
5	7.0	87

The teacher thought that group 2 had forgotten to add the sulfuric acid to one of their Petri dishes.

Suggest which Petri dish was not set up correctly.

.....[1]

[Total: 15]

2 Bacteria are classified as belonging to the Prokaryote kingdom.

(a) State **two** features of **all** prokaryotes.

1 .....

2 .....
[2]

MRSA is a type of bacterium that is resistant to antibiotics. The number of cases of MRSA identified in hospitals in the USA between 1995 and 2005 was recorded.
Fig. 2.1 shows these data.

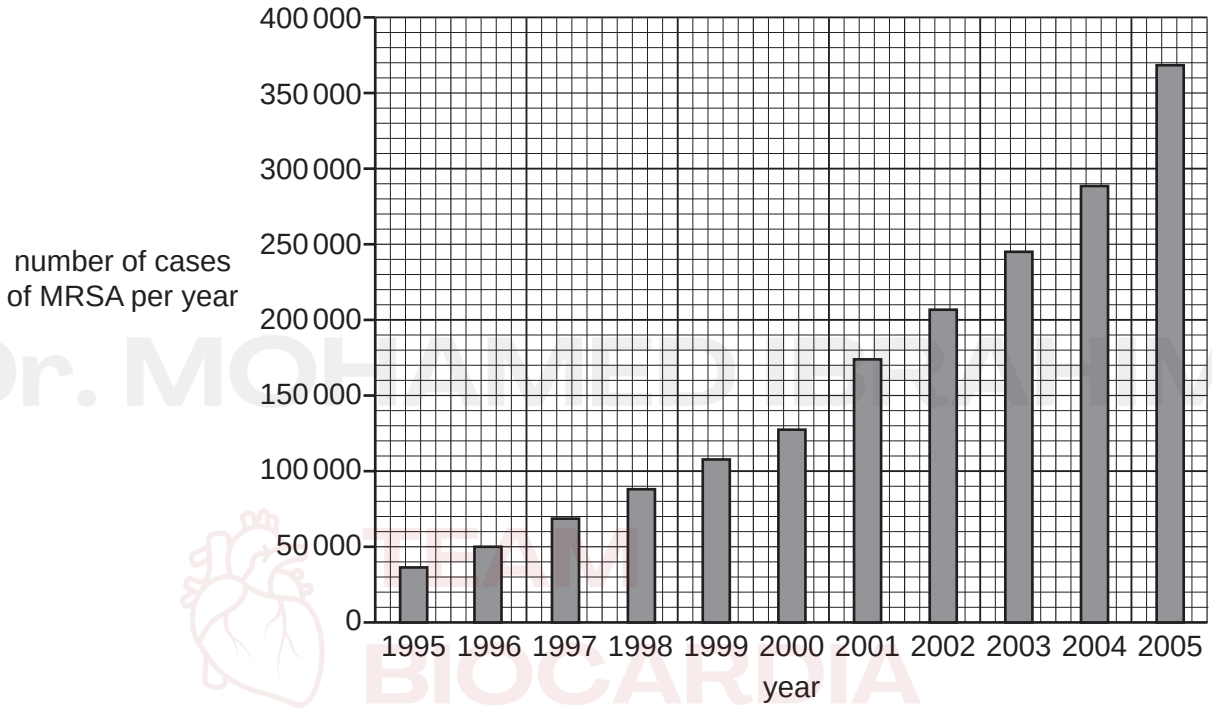


Fig. 2.1

(b) **(i)** Describe the results shown in Fig. 2.1.

.....

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.....

.....

.....[2]

(ii) Explain how bacteria become resistant to antibiotics.

.....

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.....[4]

(c) The number of cases of MRSA has decreased since 2005.

Suggest reasons for this decrease.

.....

.....

.....

.....

.....[2]

[Total: 10]

(c) Fig. 4.2 shows a section through the leaf of a water lily.

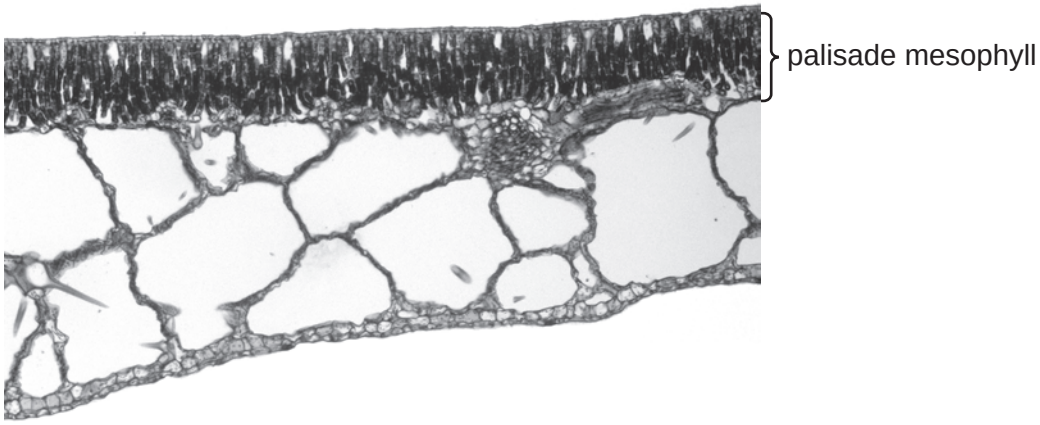

Fig. 4.2

(i) State why the palisade mesophyll is a tissue.

.....

..... [1]

(ii) Name **two** other tissues that are present in the leaf in Fig. 4.2.

1 .....

2 .....
[2]

(d) The large air spaces are an adaptation of water lily leaves. Suggest why.

.....

.....

.....

.....

..... [2]

(e) Hydrophytes are adapted to aquatic habitats.

State the name used for plants that are adapted to dry habitats.

..... [1]

(f) Explain what is meant by the term *adaptive feature*.

.....

.....

.....

.....

..... [2]

[Total: 11]

Biotechnology & Genetic Modification

(b) Yeast is used in the production of ethanol to manufacture a type of biofuel.

Fig. 4.2 is a flow chart of the process.

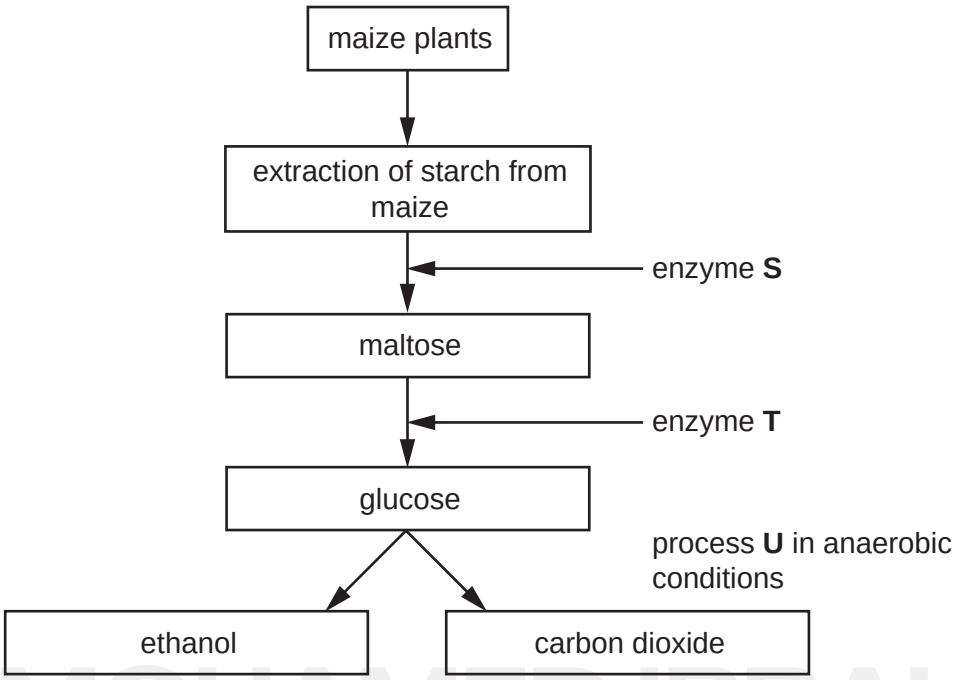

Fig. 4.2

(i) State the names of enzymes **S** and **T**.

S .....

T .....

[2]

(ii) Yeast is used in process **U**. Complete the balanced chemical equation for anaerobic respiration in yeast.

..... ⟶ .....C_2H_5OH + ...

[2]

(iii) Suggest the advantages of using biofuels instead of fossil fuels.

.....

.....

.....

.....

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.....

..... [3]

(c) Fig. 5.1 shows a flow diagram for the production of lactose-free milk.

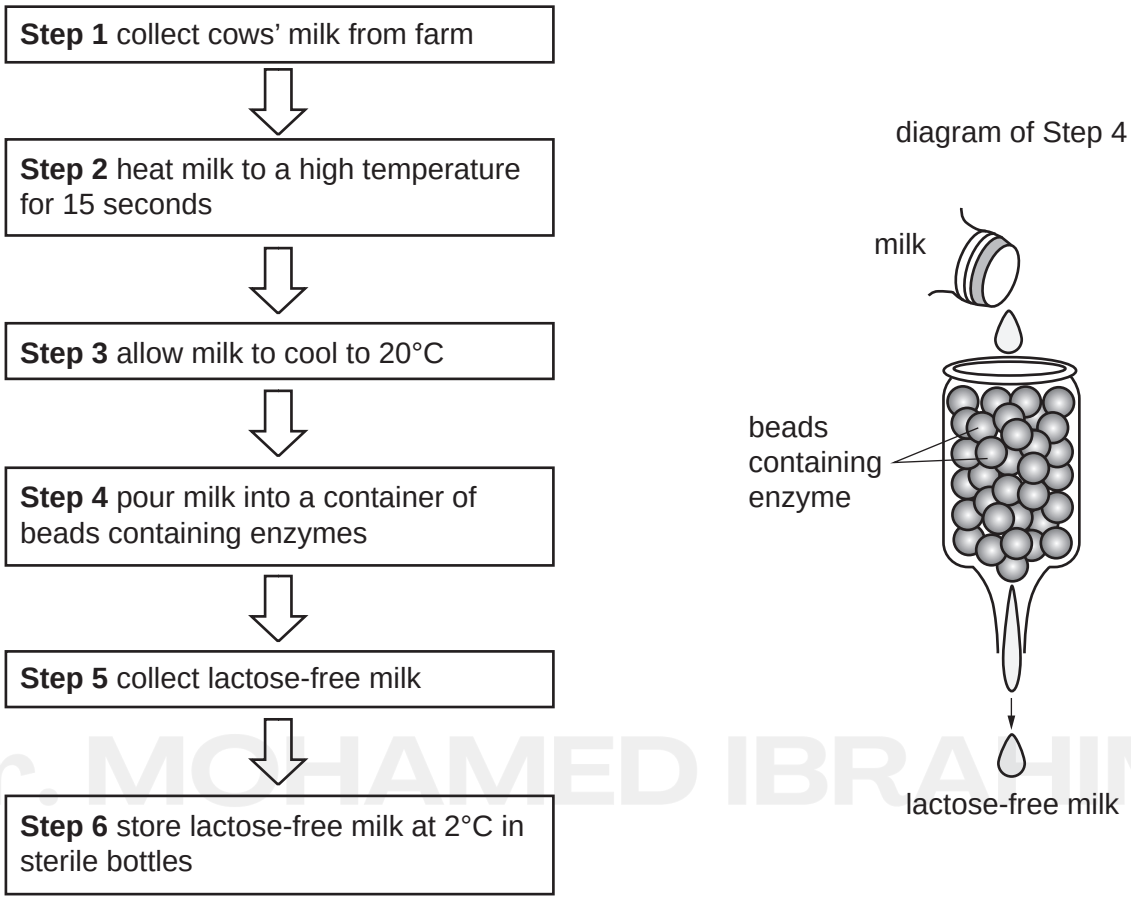

Fig. 5.1

(i) Explain how heating the milk in **step 2** in Fig. 5.1 ensures the hygienic preparation of lactose-free milk.

.....

.....

..... [1]

(ii) Explain why the milk must be cooled in **step 3** before it makes contact with the enzymes.

.....

.....

.....

.....

..... [2]

(iii) State the name of the enzyme used to make lactose-free milk in **step 4**.

..... [1]

(iv) Suggest why the enzymes are kept in the beads in **step 4** rather than mixed as an enzyme solution with the milk.

.....

.....

..... [1]

1 Bacteria are classified in the Prokaryote kingdom.

(a) State **two** features of animal cells that are **not** found in bacteria.

1 .....

2 .....
[2]

(b) The bacterium *Bacillus megaterium* was grown in the laboratory fermenter shown in Fig. 1.1.

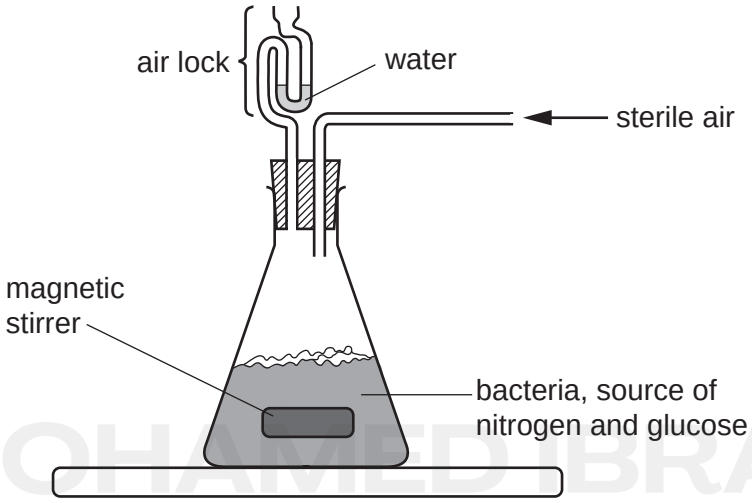

Fig. 1.1

(i) Explain why a source of nitrogen and glucose were added to the fermenter.

nitrogen .....

.....

glucose .....

.....
[2]

(ii) Suggest why it is important to stir the contents of the fermenter continuously.

.....

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.....

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..... [3]

(c) Samples were taken from the fermenter at frequent intervals and the number of live bacteria was determined. The results are shown in Fig. 1.2.

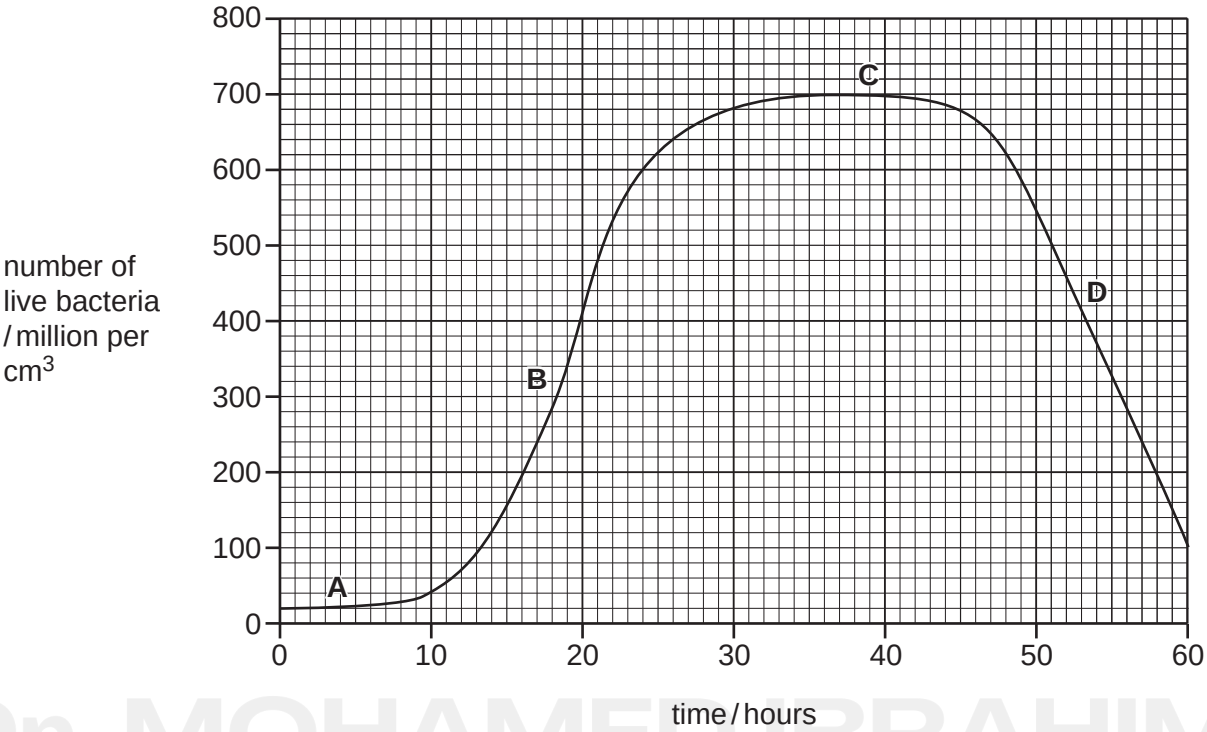

Fig. 1.2

Describe **and** explain what happens to the number of live bacteria shown in the stages labelled **A**, **B**, **C** and **D** in Fig. 1.2.

.....

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.....

..... [6]

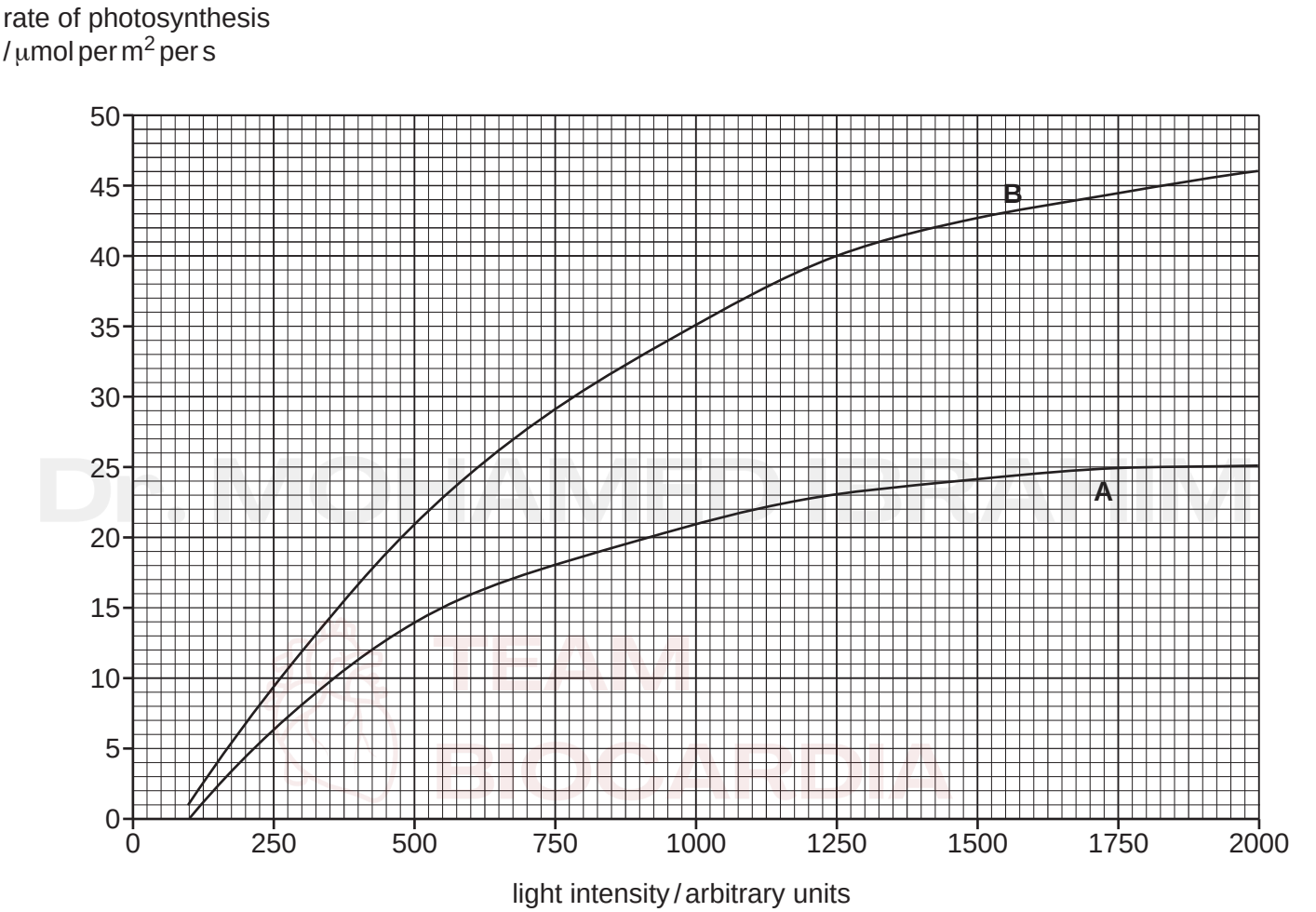
[Total: 13]

2 **(a)** State the **word** equation for photosynthesis.

..... [2]

(b) Scientists investigated the effect of light intensity on the rate of photosynthesis in the leaves of eucalyptus trees at two different concentrations of carbon dioxide, **A** and **B**.

The results are shown in Fig. 2.1.



Key:

A carbon dioxide concentration 140 ppm

B carbon dioxide concentration 1000 ppm

Fig. 2.1

(c) **(i)** Explain how bacteria become resistant to antibiotics **and** how humans can reduce the problem of antibiotic resistance.

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.....[6]

(ii) Explain why viral infections cannot be treated with antibiotics.

.....

.....[1]

(d) Some bacteria and viruses cause disease but many are useful to the biotechnology industry.

Explain why bacteria are useful in biotechnology.

.....

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.....

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.....[3]

[Total: 13]

(b) An experiment to test the effect of the size of apple pieces on the activity of pectinase was performed by a group of students. Some of their apparatus is shown in Fig. 2.1.

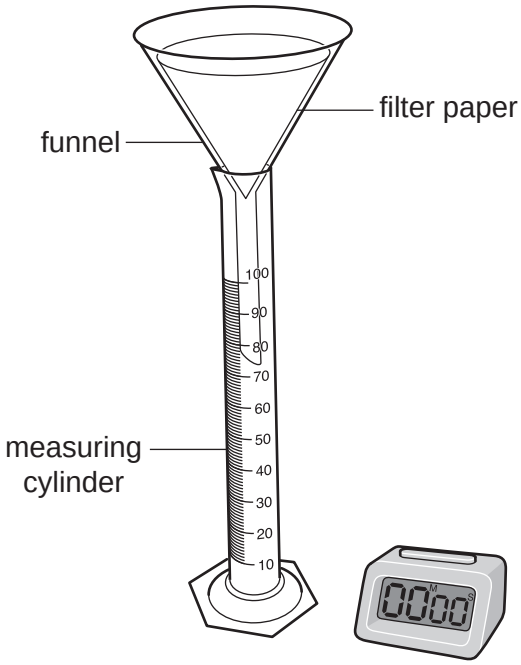

Fig. 2.1

Describe how the students should use the measuring cylinder to obtain **accurate** measurements of volume.

.....

.....

.....

.....

.....[2]

(c) The students added 1.5 cm^3 of pectinase solution to pieces of apple in a beaker.

They then poured the mixture into the funnel.

They found that it took 10 minutes to collect 19 cm^3 of juice.

(i) Calculate the rate of the enzyme reaction.

Show your working.

Write your answer to the nearest whole number.

..... cm^3 per min [2]

(ii) The students performed four experiments using different ways to prepare the apples.

The same total mass and type of apple was used each time.

A 0.5 cm^3 apple cubes

B 1.0 cm^3 apple cubes

C whole peeled small apples

D whole unpeeled small apples

Predict **and** explain which experiment (**A**, **B**, **C** or **D**) would result in the fastest rate of reaction.

.....

.....

.....

.....

.....[2]

[Total: 12]

1 Penicillin is an antibiotic.

(a) **(i)** Explain why doctors give antibiotics to people who are ill.

.....

.....

.....

.....[2]

(ii) Explain why it is important to complete a full treatment of antibiotics.

.....

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.....[3]

(b) Penicillin was discovered in 1928 by Alexander Fleming.

Name the type of microorganism that produces the antibiotic penicillin.

.....[1]

(c) Penicillin is produced commercially in fermenters as shown in Fig. 1.1.

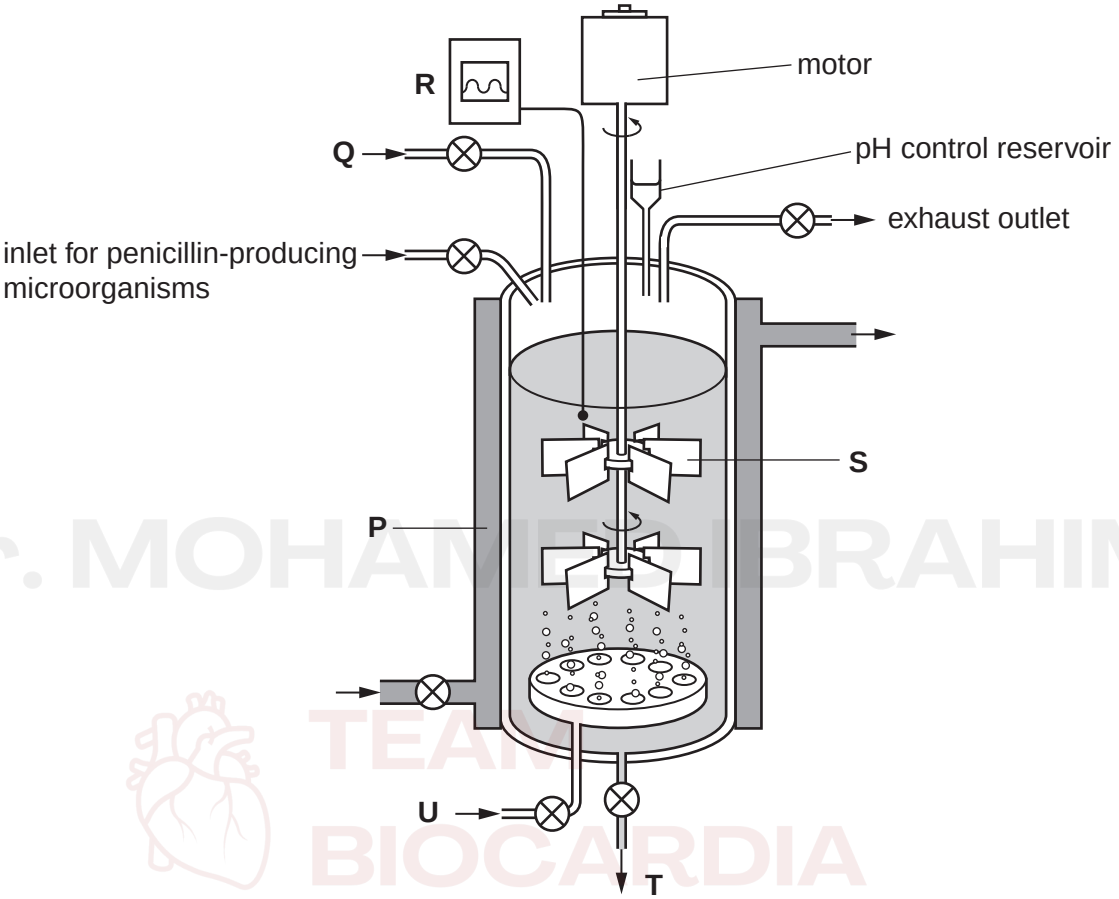

Fig. 1.1

(i) Describe how a fermenter can be sterilised.

.....

.....

.....[2]

(ii) Table 1.1 shows some names of the parts of the fermenter and their functions.

Complete Table 1.1.

One row has been done for you.

Table 1.1

letter from Fig. 1.1	name	function
	water jacket	
S		
	nutrient inlet	
R		
	air supply	
T	outlet	allows collection of the liquid containing penicillin after fermentation

[5]

(d) Describe what happens to the liquid containing penicillin after it is collected from the fermenter.

.....

.....[1]

[Total: 14]

Ecology

(b) Fields of crop plants were sprayed with two herbicides. A farmer measured the concentration of the two herbicides, **A** and **B**, in a lake near the fields.

The water in the lake was sampled at intervals for two weeks.

Fig. 4.2 shows the results.

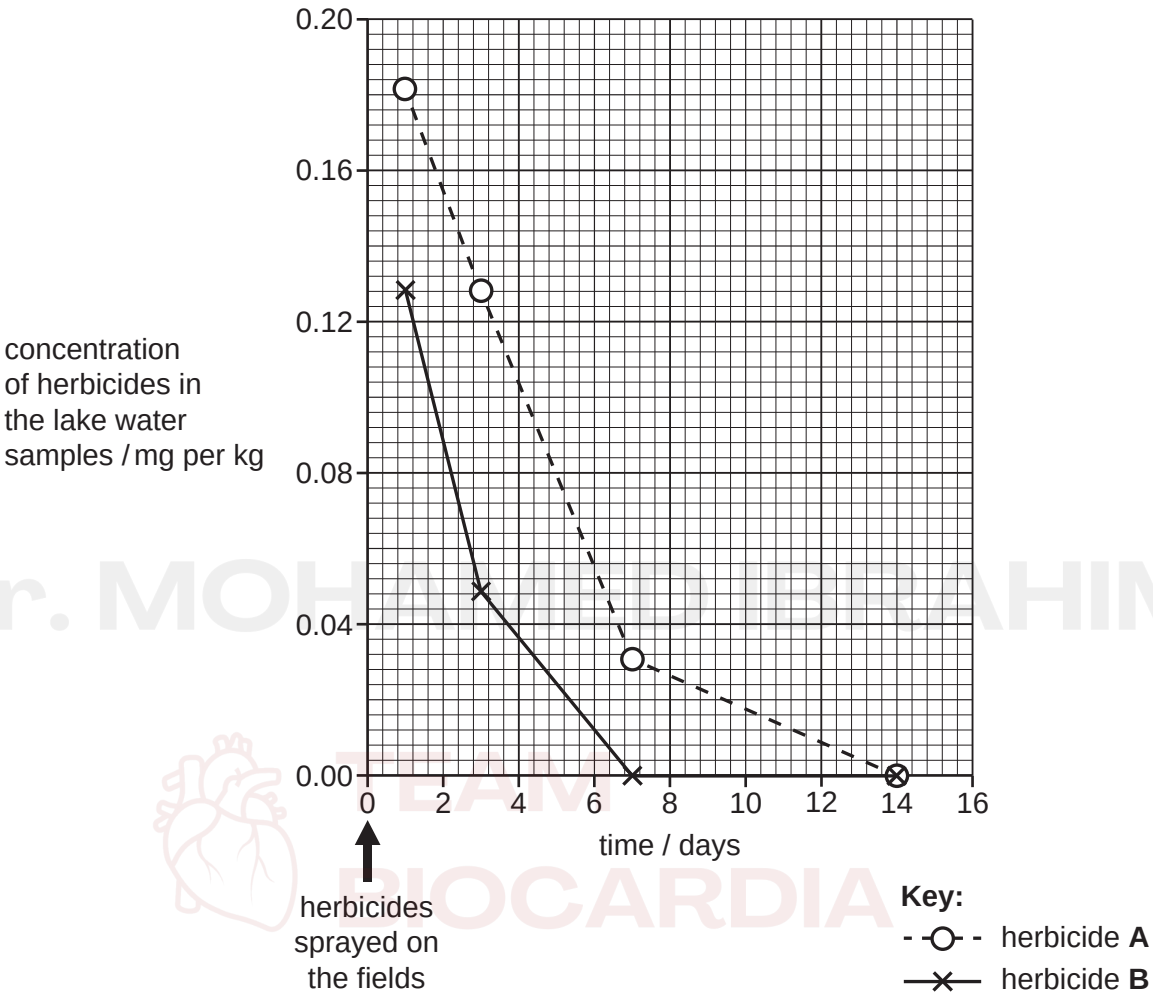

Fig. 4.2

(i) Compare the concentrations of herbicide **A** and herbicide **B** in the lake.

Use the information in Fig. 4.2 to support your answer.

.....

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..... [3]

(ii) Suggest how herbicides damage ecosystems in a lake.

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..... [4]

(b) Lugworms live in sand on coastal beaches and are eaten by wading birds. Lugworms feed on diatoms. Diatoms are photosynthetic protoctists that require ammonium ions as a source of nitrogen. Beach sand contains ammonium ions.

(i) Construct a food chain for these marine organisms.

[2]

5 **(a)** Yeast can respire aerobically and anaerobically.

State the balanced chemical equation for aerobic respiration by yeast.

.....[2]

(b) When yeast respires anaerobically, ethanol is released.

Ethanol is a type of sustainable resource that can be produced from a wide range of crops. It can be used as a biofuel.

Table 5.1 summarises some information about crops that are used to make biofuel.

Table 5.1

crop	biofuel produced	energy yield / GJ per ha	optimum growth temperature / °C	optimum annual rainfall range / mm
wheat	ethanol	53–84	24	800–1200
corn	ethanol	63–76	18	360–1000
sugar beet	ethanol	110–122	18	360–1000
sugar cane	ethanol	110–140	28	800–1200
oil palm	oil	150–166	28	1100–2500

(i) Uruguay has an average temperature range of 12 °C to 24 °C and an average annual rainfall of 1000 mm.

Suggest **and** explain which crop would be the **most** suitable crop to grow for producing biofuel in Uruguay.

Use the information in Table 5.1 to justify your choice.

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.....[3]

(ii) Sugar cane requires soil with high concentrations of nitrogen and potassium.

Describe how the lack of nitrate ions would affect the production of sugar cane.

.....

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.....[3]

(iii) Researchers in Brazil are considering using microscopic algae that live in water to produce biofuels. They have found that algae can produce a maximum amount of energy of 200 GJ per m^2.

$1\,m^2 = 0.0001$ ha

Convert the production of biofuel from algae into GJ per ha.

Space for working.

..... GJ per ha [1]

(iv) Suggest why people who are concerned about the environment want countries to produce more biofuel from algae rather than the crops listed in Table 5.1.

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.....[3]

(e) Many biologists think that it is better to conserve ecosystems rather than individual species, such as parrots.

Explain the advantages of conserving ecosystems.

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.....

.....[3]

[Total: 13]

5 An investigation studied the effect of fertilisers on grass yield and species diversity in a grassland ecosystem.

Some plots within the grassland were treated with fertilisers containing nitrogen, magnesium and phosphate.

The control plots did not have any added fertiliser.

The average yields were:

- plots with fertiliser 1733 g m^{-2} $year^{-1}$
- plots without fertiliser (control plots) 1009 g m^{-2} $year^{-1}$

(a) **(i)** Calculate the difference between the average yields of the two plots within the field as a percentage of the average yield of the control plots.

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

..... %
[2]

(ii) Explain why the average yield increased as a result of adding the fertiliser.

.....

.....

.....

.....

.....

.....

.....[3]

(iii) State the name of the process that occurs when fertiliser washes off land into rivers and causes an algal bloom.

.....[1]

The researchers counted the number of different plant species in each of the plots in the grassland to determine species diversity. Counting started at the beginning of the growing season and was repeated every three weeks.

The average number of plant species in each type of plot is shown in Fig. 5.1.

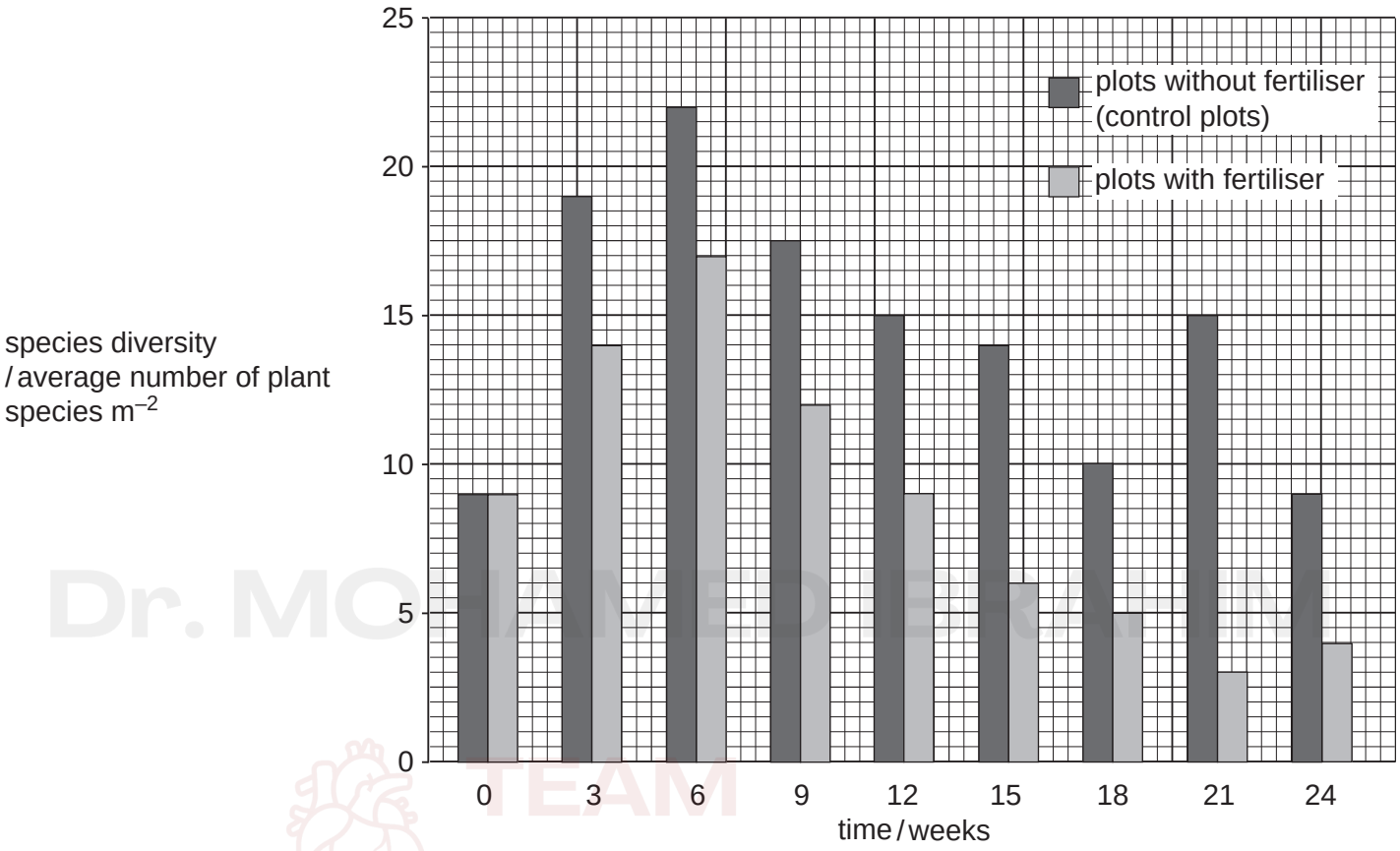

Fig. 5.1

(b) Describe the effect of fertiliser on the plant species diversity shown in Fig. 5.1.

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.....[3]

5 Acid rain has negative effects on many ecosystems.

(a) Describe the negative effects of acid rain on freshwater ecosystems, such as streams, rivers and lakes.

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.....[5]

(b) Two groups of students were asked to investigate the effects of acid rain on the germination of pine tree seeds.

(i) Both groups of students decided to use sulfuric acid rather than hydrochloric acid to represent acid rain in their investigation.

Suggest why.

.....

.....[1]

(ii) State how the students could have measured the pH of the sulfuric acid.

.....

.....[1]

(iii) The students provided the environmental conditions that seeds need to germinate.

State **two** of these environmental conditions.

1 .....

2 .....

[2]

5 The giant quiver tree, *Aloe pillansii*, shown in Fig. 5.1, is an endangered species.

These long-lived trees grow in harsh environments. Some populations of *A. pillansii* are found within the Richtersveld National Park, but one population is found just outside on a mountain called Cornell's Kop in southern Africa.

Fig. 5.1

(a) (i) State the genus of the giant quiver tree.

.....[1]

(ii) Explain why the *A. pillansii* trees on Cornell's Kop represent a population.

.....

.....

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.....

.....[3]

(b) Suggest **three** reasons why the giant quiver tree is an endangered species.

1.....

.....

2.....

.....

3.....

.....

[3]

(c) It was estimated in 2005 that the total number of giant quiver trees in the wild was less than 3000, which is considered to be very low compared with other tree species.

Explain the risks to a plant species of having very small numbers.

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.....[3]