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Answer **all** questions in the spaces provided.

1 (a) (i) What is atheroma?

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(2 marks)

(Extra space) .....

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1 (a) (ii) Atheroma makes it more likely that a blood clot will form. Describe how a blood clot may lead to a myocardial infarction.

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(3 marks)

(Extra space) .....

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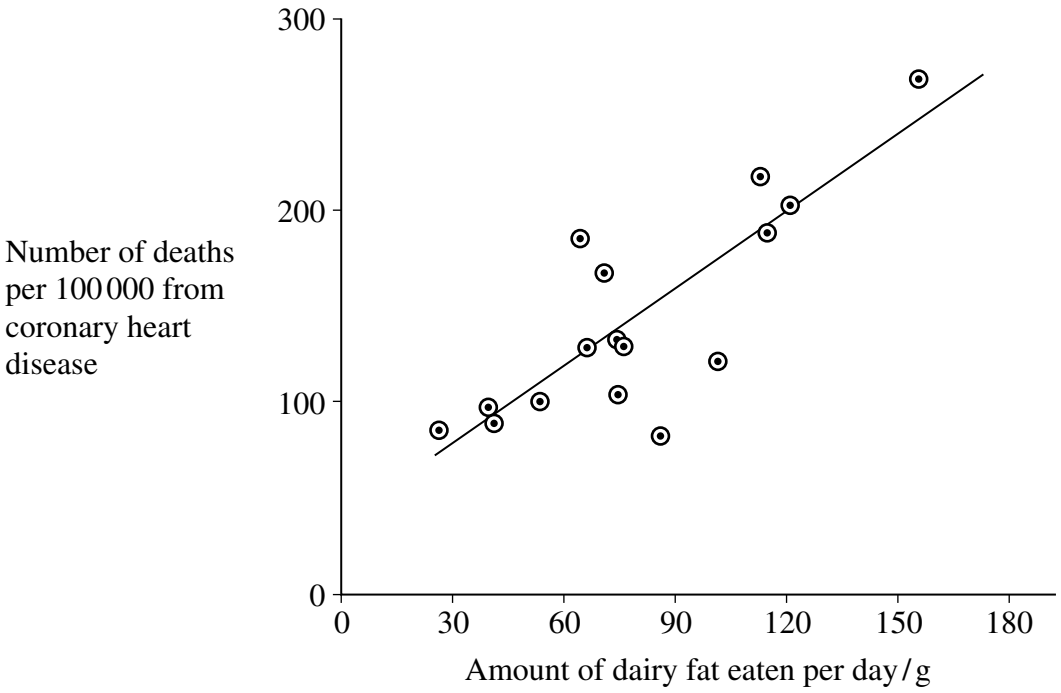
1 (b) The graph shows the relationship between the amount of dairy fat eaten and the deaths from coronary heart disease (CHD) in different countries.



1 (b) (i) The number of deaths is given per 100 000 people. Explain why.

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(2 marks)

1 (b) (ii) Does the evidence from the graph show that eating dairy fat causes coronary heart disease? Explain your answer.

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(2 marks)

9

2 (a) Sucrose, maltose and lactose are disaccharides.

2 (a) (i) Sucrase is an enzyme. It hydrolyses sucrose during digestion. Name the products of this reaction.

..... and .....

(2 marks)

2 (a) (ii) Sucrase does **not** hydrolyse lactose. Use your knowledge of the way in which enzymes work to explain why.

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(2 marks)

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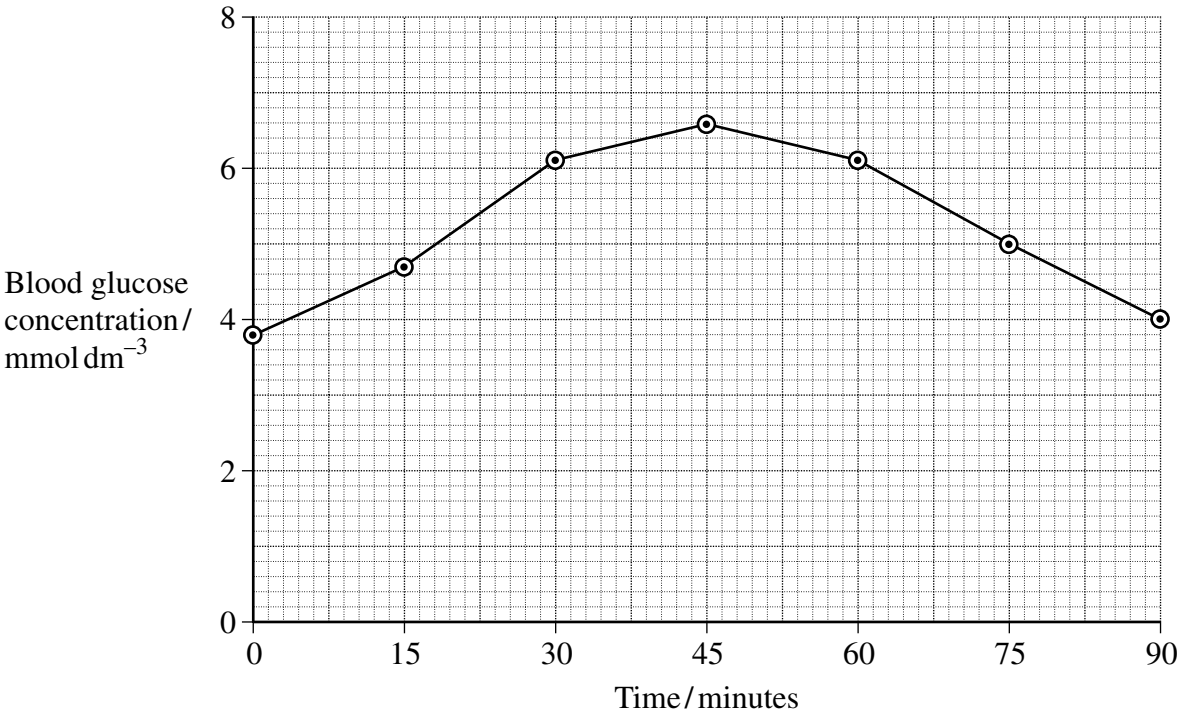
2 (b) A woman was given a solution of sucrose to drink. Her blood glucose concentration was measured over the next 90 minutes. The results are shown on the graph.



2 (b) (i) Describe how the woman's blood glucose concentration changed in the period shown in the graph.

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(2 marks)

2 (b) (ii) Explain the results shown on the graph.

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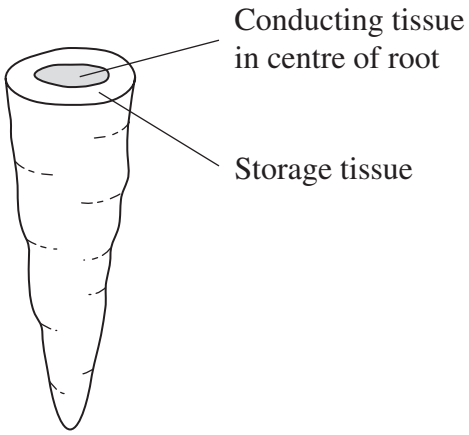
(2 marks)

2 (b) (iii) This woman was lactose intolerant.

On the graph, sketch a curve to show what would happen to her blood glucose concentration if she had been given a solution of lactose to drink instead of a sucrose solution. *(1 mark)*

9

3 The diagram shows a carrot.



A group of students investigated the effect of sucrose concentration on the length of cylinders cut from a carrot.

3 (a) The students used a cork borer to cut cylinders from the carrot. Describe how the students should cut these cylinders to make sure that this was a fair test and would produce reliable results.

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(2 marks)

3 (b) They measured the initial length of each cylinder then placed the cylinders into test tubes containing different concentrations of sucrose solution. Bungs were placed in the tubes and the tubes were left overnight. Explain why the bungs were placed in the tubes.

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(2 marks)

3 (c) The students then measured the final lengths of the carrot cylinders. Their results are shown in the table.

Concentration of sucrose / mol dm^{-3}	**$\frac{\text{Final length}}{\text{Initial length}}$**
0.0	1.4
0.2	1.4
0.4	1.2
0.6	1.1
0.8	0.9

3 (c) (i) The students used these results to find the concentration of sucrose that has the same water potential as the carrot cylinders. Describe how they could have done this.

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(2 marks)

(Extra space) .....

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3 (c) (ii) Was it important in this investigation that the carrot cylinders had the same initial length? Explain your answer.

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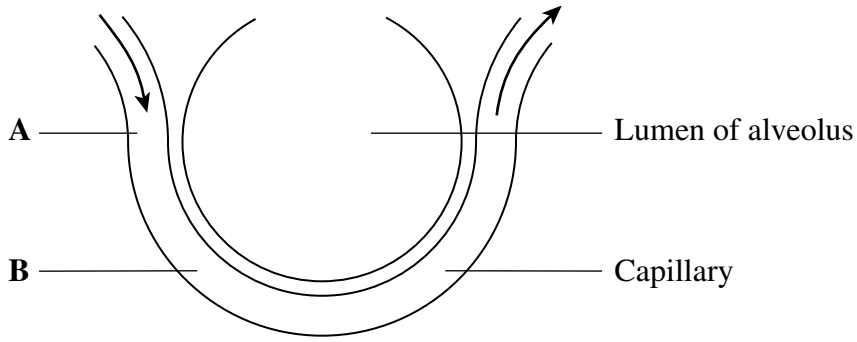
(1 mark)

7

4 The diagram shows part of an alveolus and a capillary.



10 µm

4 (a) The rate of blood flow in the capillary is $0.2\,mm\,s^{-1}$.
Calculate the time it would take for blood in the capillary to flow from point **A** to point **B**. Show your working.

Answer ..... seconds
(2 marks)

4 (b) The rate of diffusion of oxygen is affected by the difference between its concentration in the alveolus and its concentration in the blood.

4 (b) (i) Circulation of the blood helps to maintain this difference in oxygen concentration. Explain how.

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(1 mark)

4 (b) (ii) During an asthma attack, less oxygen diffuses into the blood from the alveoli. Explain why.

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(2 marks)

(Extra space) .....

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4 (c) Scientists investigated a new drug to treat asthma. People with asthma took part in a trial. They were divided into two groups, an experimental group and a control group.

4 (c) (i) It was important to have a control group in this trial. Explain why.

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(1 mark)

4 (c) (ii) People in the experimental group were given the drug in an inhaler. Describe how the control group should have been treated.

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(2 marks)

(Extra space) .....

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8

5 (a) Phagocytes and lysosomes are involved in destroying microorganisms. Describe how.

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(3 marks)

(Extra space) .....

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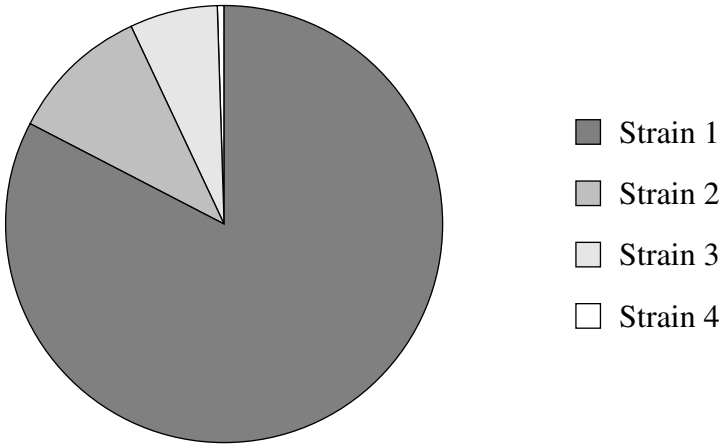
5 (b) The pie chart shows the proportions of people infected with four different strains of influenza virus early in 2004.



5 (b) (i) A person may develop influenza twice within a short time. Use information from the pie chart to explain why.

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(2 marks)

5 (b) (ii) The information in the pie chart is valuable to companies who make influenza vaccines. Use your knowledge of antigens to explain why.

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(2 marks)

7

6 Read the following passage.

Campylobacter jejuni is a bacterium. It is one of the commonest causes of diarrhoea in humans. The illness that it causes does not usually last very long and many sufferers do not even go to the doctor. The only treatment required is the use of oral rehydration solutions to replace the water lost by diarrhoea. In 1998, laboratory tests confirmed 60 000 cases of diarrhoea caused by this bacterium in the UK. The bacterium was more frequently found in males than in females with a ratio of 1.5 : 1.

In rare cases, the nervous system may be affected. Scientists are now beginning to understand the cause of this. Sugars in the antigens on the surface of the bacteria are identical to some of the sugars on the surface of nerve cells. Antibodies produced against the bacteria may therefore attack the body's nerve cells. There can be serious problems if this leads to paralysis of the diaphragm. Breathing difficulties result and the patient may die.

Use information in the passage and your own knowledge to answer the following questions.

6 (a) (i) The number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in the UK in 1998 was 60 000 (lines 4–5). Explain why the true number of cases is thought to be more than this.

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(1 mark)

6 (a) (ii) Calculate the number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in men in 1998.

Answer .....

(1 mark)

6 (b) Explain how an oral rehydration solution (ORS) replaces water lost by diarrhoea (lines 3–4).

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(3 marks)

(Extra space) .....

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6 (c) Explain why antibodies produced against *Campylobacter jejuni* also attack nerve cells (lines 9–10).

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(3 marks)

(Extra space) .....

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6 (d) Explain how paralysis of the diaphragm leads to breathing difficulties (line 11).

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(2 marks)

10

7 (a) The structure of a cholera bacterium is different from the structure of an epithelial cell from the small intestine. Describe how the structure of a cholera bacterium is different.

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(5 marks)

(Extra space) .....

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7 (b) Scientists use optical microscopes and transmission electron microscopes (TEMs) to investigate cell structure. Explain the advantages and the limitations of using a TEM to investigate cell structure.

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(5 marks)

(Extra space) .....

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10

END OF QUESTIONS

Answer **all** questions in the spaces provided.

1 (a) Name the process in which cells become adapted for different functions.

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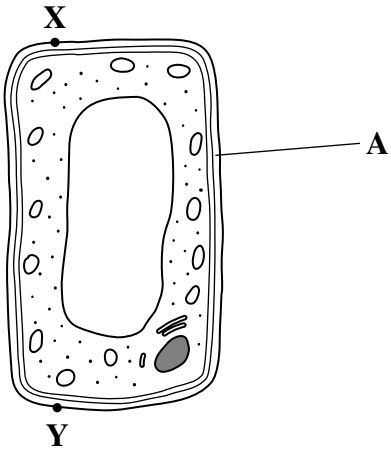
(1 mark)

1 (b) Palisade cells are found in leaves. The diagram shows a palisade cell.



1 (b) (i) Name structure **A**.

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(1 mark)

1 (b) (ii) The real length of this cell between **X** and **Y** is 20 micrometres (μm). By how many times has it been magnified? Show your working.

Answer .....

(2 marks)

1 (b) (iii) Explain **one** way in which this cell is adapted for photosynthesis.

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(1 mark)

5

2 In 2002, biologists identified a new group of insects. They called these insects gladiators.

2 (a) (i) *Mantophasma zephyra* is one species of gladiator. Complete the table to show how this species is classified.

Kingdom	Animalia
	Arthropoda
	Insecta
	Notoptera
Family	Mantophasmatodae
Species	

(2 marks)

2 (a) (ii) This system of classification consists of a hierarchy. Explain what is meant by a hierarchy.

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(2 marks)

2 (b) In 2002, very few gladiators were available for identification. Scientists around the world used photographs to establish the relationship of gladiators to other insects. Explain how.

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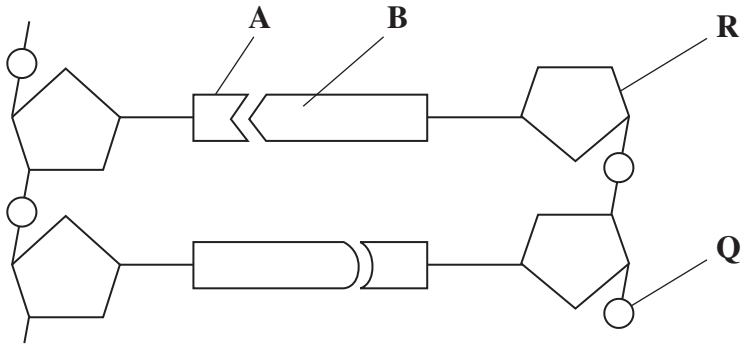
(1 mark)

5

3 **Figure 1** shows a short section of a DNA molecule.

Figure 1



3 (a) Name parts **R** and **Q**.

3 (a) (i) **R** .....

3 (a) (ii) **Q** .....

(2 marks)

3 (b) Name the bonds that join **A** and **B**.

.....

(1 mark)

3 (c) Ribonuclease is an enzyme. It is 127 amino acids long.

What is the minimum number of DNA bases needed to code for ribonuclease?

(1 mark)

3 (d) **Figure 2** shows the sequence of DNA bases coding for seven amino acids in the enzyme ribonuclease.

Figure 2

G T T T A C T A C T C T T C T T C T T T A

The number of each type of amino acid coded for by this sequence of DNA bases is shown in the table.

Amino acid	Number present
Arg	3
Met	2
Gln	1
Asn	1

Use the table and **Figure 2** to work out the sequence of amino acids in this part of the enzyme. Write your answer in the boxes below.

Gln						

(1 mark)

3 (e) Explain how a change in a sequence of DNA bases could result in a non-functional enzyme.

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(3 marks)

(Extra space) .....

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8

4 (a) An increase in respiration in the tissues of a mammal affects the oxygen dissociation curve of haemoglobin. Describe and explain how.

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(2 marks)

4 (b) There is less oxygen at high altitudes than at sea level.

4 (b) (i) People living at high altitudes have more red blood cells than people living at sea level. Explain the advantage of this to people living at high altitude.

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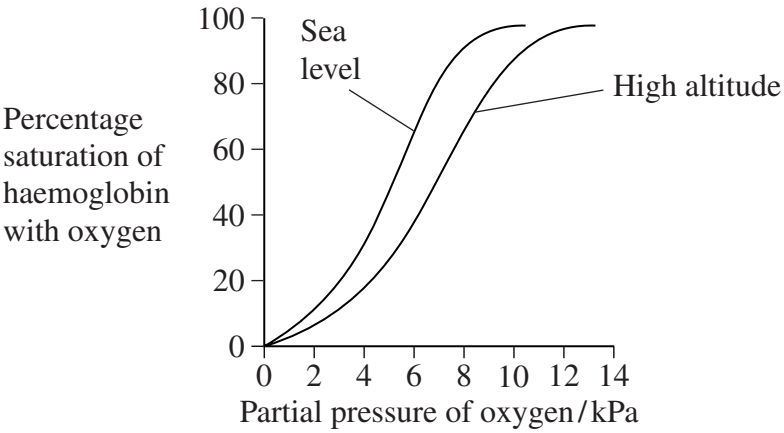
(2 marks)

4 (b) (ii) The graph shows oxygen dissociation curves for people living at high altitude and for people living at sea level.



Explain the advantage to people living at high altitude of having the oxygen dissociation curve shown in the graph.

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(2 marks)

6

5 A student found the number of stomata per cm^2 on the lower surface of a daffodil leaf. He removed a small, thin piece of lower epidermis and mounted it on a microscope slide. He examined the slide using an optical microscope.

5 (a) Explain why it was important that the piece of the epidermis that the student removed was thin.

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(2 marks)

5 (b) Suggest how the student could have used his slide to find the number of stomata per cm^2.

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(3 marks)

(Extra space) .....

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5 (c) The stomata on the leaves of pine trees are found in pits below the leaf surface. Explain how this helps to reduce water loss.

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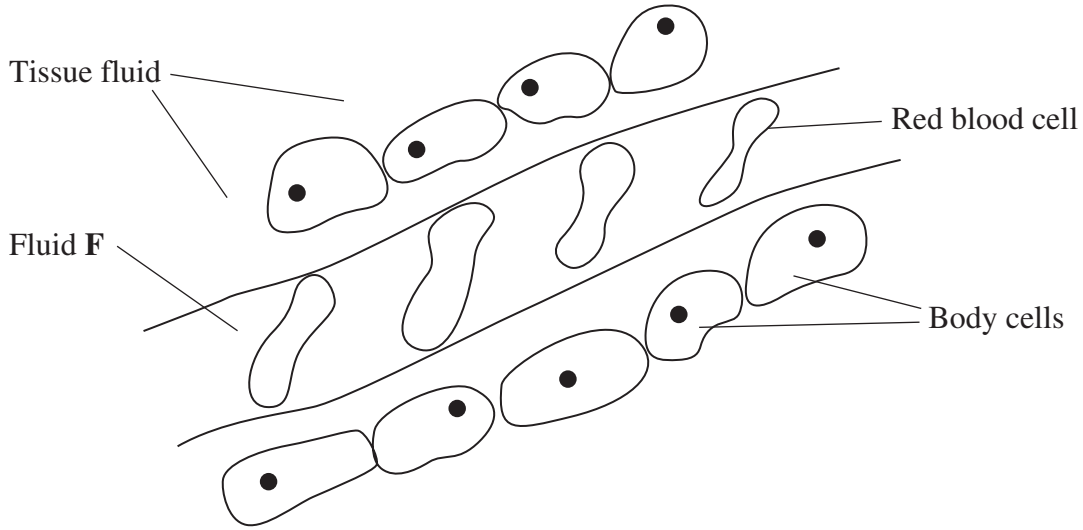
(2 marks)

7

6 The diagram shows tissue fluid and cells surrounding a capillary.



6 (a) Name fluid **F**.

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(1 mark)

6 (b) Give **one** way in which fluid **F** is different from tissue fluid.

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(1 mark)

6 (c) (i) The blood pressure is high at the start of the capillary. Explain how the left ventricle causes the blood to be at high pressure.

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(1 mark)

6 (c) (ii) The blood pressure decreases along the length of the capillary. What causes this decrease in pressure?

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(1 mark)

6 (d) In children, some diets may result in a low concentration of protein in fluid **F**. This can cause the accumulation of tissue fluid. Explain the link between a low concentration of protein in fluid **F** and the accumulation of tissue fluid.

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(3 marks)

(Extra space) .....

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7

Turn over for the next question

7 (a) Heath is a community of plants and animals. A student investigated the species diversity of plants in this community. The table shows her results.

Plant species	Number of plants per m^2
Heath rush	1
Bilberry	1
Sheep's sorrel	5
Ling	2
Bell heather	1
Heath bedstraw	8
Mat-grass	11

7 (a) (i) The index of diversity can be calculated from the formula

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species.

Use this formula to calculate the index of diversity for the plants on the heath. Show your working.

Answer .....

(2 marks)

7 (a) (ii) Explain why it may be more useful to calculate the index of diversity than to record only the number of species present.

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(2 marks)

7 (b) The demand for increased food production has led to areas of heath being used to grow wheat. Explain the effect of this on

7 (b) (i) the species diversity of plants

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(2 marks)

7 (b) (ii) the species diversity of animals.

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(2 marks)

8

8 (a) Gas exchange in fish takes place in gills. Explain how **two** features of gills allow efficient gas exchange.

1 .....

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2 .....

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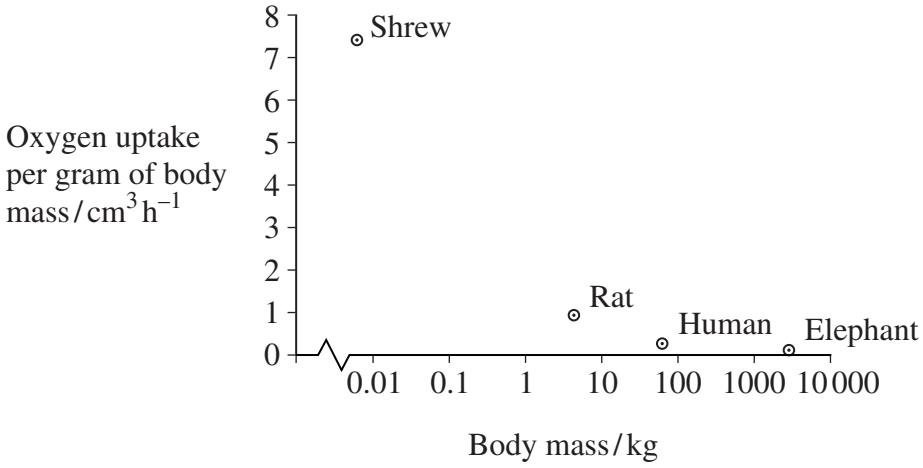
(2 marks)

8 (b) A zoologist investigated the relationship between body mass and rate of oxygen uptake in four species of mammal. The results are shown in the graph.



8 (b) (i) The scale for plotting body mass is a logarithmic scale. Explain why a logarithmic scale was used to plot body mass.

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(1 mark)

8 (b) (ii) Describe the relationship between body mass and oxygen uptake.

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(1 mark)

8 (b) (iii) The zoologist measured oxygen uptake per gram of body mass. Explain why he measured oxygen uptake per gram of body mass.

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(2 marks)

8 (b) (iv) Heat from respiration helps mammals to maintain a constant body temperature. Use this information to explain the relationship between body mass and oxygen uptake shown in the graph.

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(3 marks)

(Extra space) .....

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9

9 Taxol is a drug used to treat cancer. Research scientists investigated the effect of injecting taxol on the growth of tumours in mice. Some of the results are shown in **Figure 3**.

Figure 3

Number of days of treatment	Mean volume of tumour / mm^3	
	Control group	Group injected with taxol in saline
1	1	1
10	7	2
20	21	11
30	43	20
40	114	48
50	372	87

9 (a) Suggest how the scientists should have treated the control group.

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(2 marks)

9 (b) Suggest and explain **two** factors which should be considered when deciding the number of mice to be used in this investigation.

1 .....

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2 .....

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(2 marks)

9 (c) The scientists measured the volume of the tumours. Explain the advantage of using volume rather than length to measure the growth of tumours.

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(1 mark)

9 (d) The scientists concluded that taxol was effective in reducing the growth rate of the tumours over the 50 days of treatment. Use suitable calculations to support this conclusion.

(2 marks)

9 (e) In cells, taxol disrupts spindle activity. Use this information to explain the results in the group that has been treated with taxol.

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(3 marks)

(Extra space) .....

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Question 9 continues on the next page

9 (f) The research scientists then investigated the effect of a drug called OGF on the growth of tumours in mice. OGF and taxol were injected into different mice as separate treatments or as a combined treatment. **Figure 4** and **Figure 5** show the results from this second investigation.

Figure 4

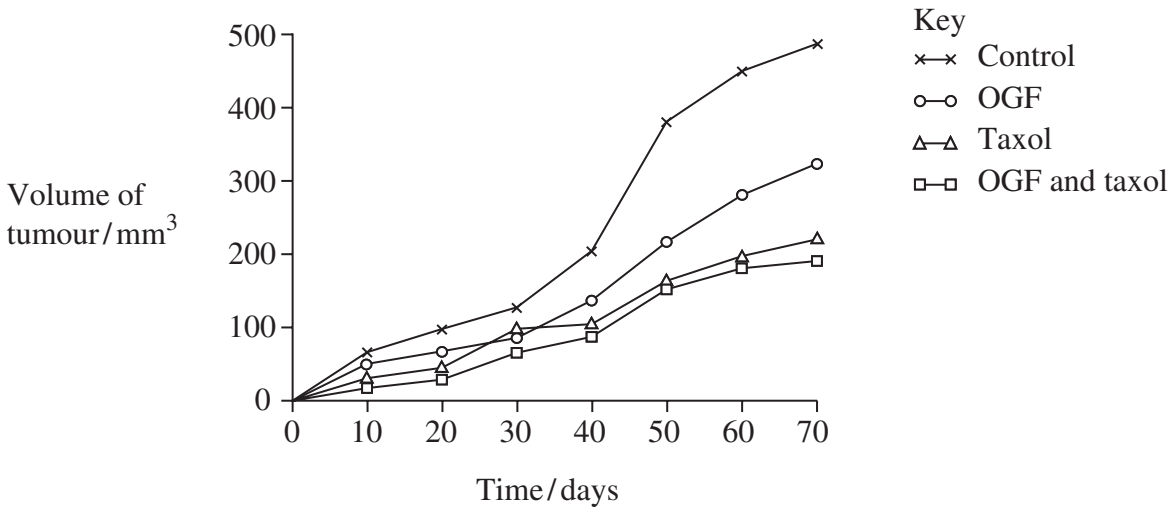

Figure 5

Treatment	**Mean volume of tumour following 70 days treatment / mm^3 (± standard deviation)**
OGF	322 (± 28.3)
Taxol	207 (± 22.5)
OGF and taxol	190 (± 25.7)
Control	488 (± 32.4)

9 (f) (i) What information does standard deviation give about the volume of the tumours in this investigation?

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(1 mark)

9 (f) (ii) Use **Figure 4** and **Figure 5** to evaluate the effectiveness of the two drugs when they are used separately and as a combined treatment.

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(4 marks)

(Extra space) .....

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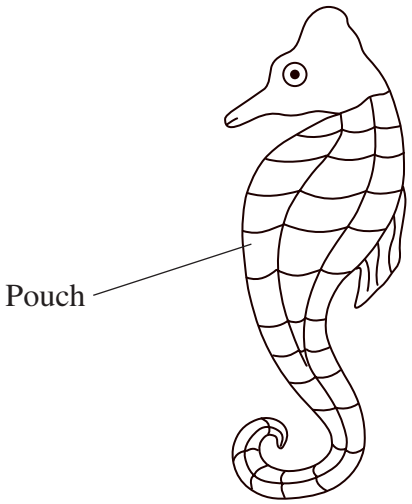
15

10 The diagram shows a seahorse. A seahorse is a fish. Mating in seahorses begins with courtship behaviour. After this, the female transfers her unfertilised eggs to the male's pouch.
Most male fish fertilise eggs that have been released into the sea. However, a male seahorse fertilises the eggs while they are inside his pouch. The fertilised eggs stay in the pouch where they develop into young seahorses.



10 (a) Give **two** ways in which courtship behaviour increases the probability of successful mating.

1 .....

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2 .....

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(2 marks)

10 (b) Give **one** way in which reproduction in seahorses increases the probability of

10 (b) (i) fertilisation

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(1 mark)

10 (b) (ii) survival of young seahorses.

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(1 mark)

Scientists investigated the effect of total body length on the selection of a mate in one Australian species of seahorse. The scientists used head length as a measure of total body length.

10 (c) (i) Use the diagram to suggest why the scientists measured head length rather than total body length.

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(1 mark)

10 (c) (ii) Suggest why the scientists were able to use head length as a measure of total body length.

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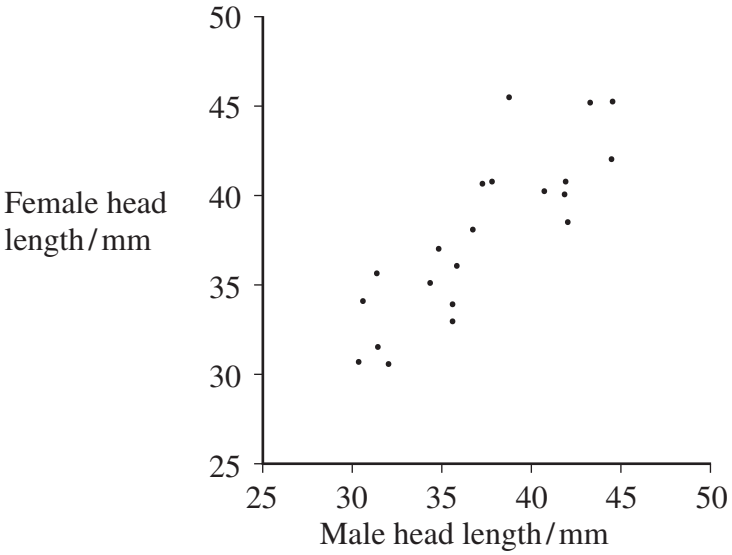
(1 mark)

The scientists measured the head lengths of the female and male of a number of pairs. The results are shown in the graph.



10 (d) The scientists concluded that total body length affects the selection of a mate. Explain how the results support this conclusion.

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(1 mark)

Question 9 continues on the next page

10 (e) A female with a head length of 50 mm selected a mate. Explain how you could use the graph to predict the total head length of the mate selected.

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(2 marks)

10 (f) Scientists studied two species of North American seahorse. They thought that these two species are closely related. Describe how comparisons of biological molecules in these two species could be used to find out if they are closely related.

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(6 marks)

(Extra space) .....

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END OF QUESTIONS

15

1 **(a)** Human populations have herded cattle for milk for around 9000 years. Artificial selection over this time has resulted in the modern dairy cow.

(i) State **three** phenotypic traits (characteristics) that have been selected for in dairy cows.

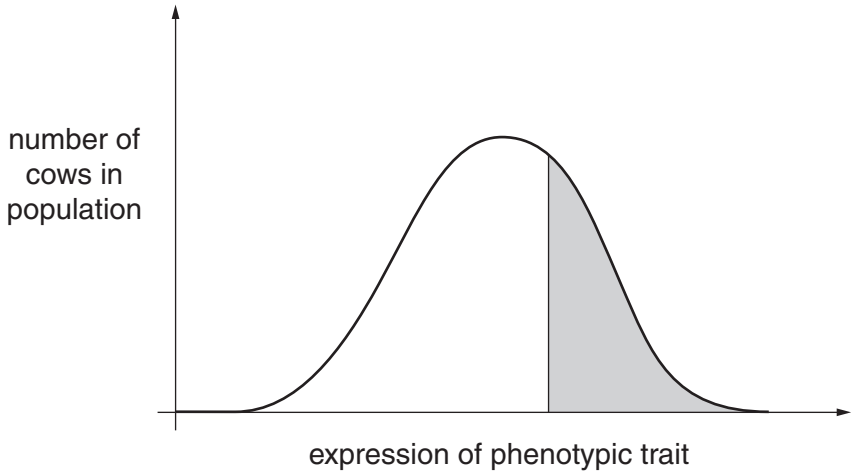
1 .....

2 .....

3 ..... **[3]**

(ii) Fig. 1.1 shows the pattern of variation of a phenotypic trait in a herd of dairy cows. The shaded part of the graph indicates those cows that are chosen to breed.

Draw, **on Fig. 1.1**, a second curve to show the pattern of variation in the next generation.



[2]

Fig. 1.1

(iii) In recent years, artificial selection of dairy cows has been helped by modern reproductive technology.

Name **two** modern techniques or procedures that can be used in the selective breeding of dairy cows.

1 .....

2 ..... **[2]**

(b) Lactase is an enzyme that is necessary to digest lactose sugar in milk.

In some parts of the world, animals are not farmed for milk and no dairy products are eaten. Adult humans that are native to these parts of the world do not produce lactase.

In areas where animals are farmed for milk, native adult humans do produce lactase. In these populations, a new allele has arisen by gene mutation.

(i) State what is meant by gene mutation.

.....

..... **[1]**

(ii) Over time, the frequency of this new allele increased in the gene pool of the human populations whose diet included milk.

Name the process by which this increase occurred.

..... **[1]**

(c) (i) All human babies produce the enzyme lactase. The genetic change that allows adults to produce this enzyme is thought to involve a mutation in a regulatory gene. This mutation causes the structural gene to be expressed in adults.

Distinguish between the terms 'regulatory gene' and 'structural gene'.

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..... **[2]**

(ii) Adult humans who cannot produce the enzyme lactase are described as lactose-intolerant and cannot drink milk without experiencing health problems. However, lactose-intolerant people can safely eat yogurt.

Yogurt is produced from milk that is fermented by bacteria. These bacteria perform anaerobic respiration, using carbohydrate as their respiratory substrate.

Suggest why yogurt is a suitable food for lactose-intolerant people.

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..... **[2]**

(d) The control of the expression of the *lac* operon genes, which allow uptake and digestion of lactose in the bacterium *Escherichia coli*, is well known.

Fig. 1.2 shows the arrangement of the elements of the *lac* operon.

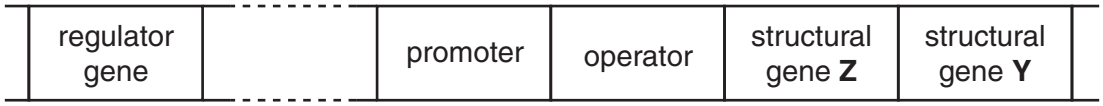

Fig. 1.2

Describe how genes **Z** and **Y** are switched on in bacteria that are moved to a nutrient medium that contains lactose.

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..... **[3]**

[Total: 16]

2 This question is about types of muscle and how the nervous system and hormones control their activity.

(a) There are three types of muscle within the human body. These differ in their cellular structure and in their function.

Complete Table 2.1 to show how each type of muscle **differs from the other two** types.

Table 2.1

	voluntary (skeletal) muscle	involuntary (smooth) muscle	cardiac muscle
cellular structure			
function			

[6]

(b) The human thorax is the area between the base of the neck and the base of the rib cage. All three types of muscle can be found within this area.

For each type of muscle, identify where **in the thorax** this type of muscle may be found.

voluntary .....

involuntary .....

cardiac ..... **[3]**

(c) Fig. 2.1 shows a vertical section through the human brain.

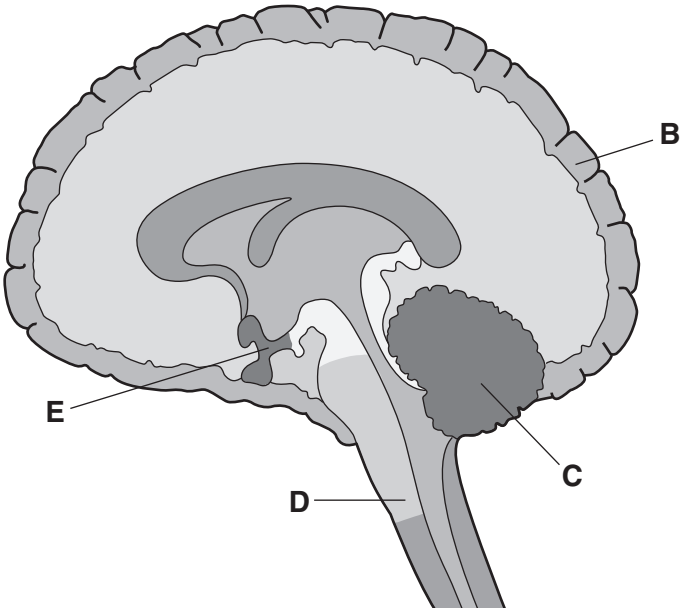

Fig. 2.1

Use Fig. 2.1 to state the letter (**B** to **E**) of the part of the brain that would be involved in the following:

adjusting the rate of contraction of cardiac muscle .....

clapping the hands together .....

automatically correcting balance when riding a bicycle ..... **[3]**

(d) Movement disorders are conditions in which people lose the ability to control their body movements.

Scientists have discovered that inserting electrodes to stimulate parts of the brain can help to cure some movement disorders. This discovery has resulted from experimental work with monkeys, which has made the research controversial.

Suggest why monkeys rather than other laboratory animals, such as rats, were used for this work **and** comment on whether their use in this way is justified or not.

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..... **[3]**

(e) The 'fight or flight' response to threatening environmental stimuli is coordinated by the nervous and endocrine systems.

Describe and explain how the activation of the 'fight or flight' response affects voluntary, involuntary and cardiac muscle.

In your answer, for each type of muscle, you should give a named structure in which it is found and explain how the nervous and endocrine systems affect its response.

.... **[9]**

[Total: 24]

3 Total plant growth within an ecosystem depends on the light intensity, temperature and the supply of water and inorganic minerals to the ecosystem.

Table 3.1 shows the net primary production by plants in four different ecosystems.

Table 3.1

ecosystem	net primary production ($kJ\,m^{-2}\,year^{-1}$)
temperate grassland	9240
temperate woodland	11340
tropical grassland	13440
tropical rainforest	36160

(a) Discuss possible reasons for the differences in net primary production in these ecosystems.

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..... **[4]**

(b) To calculate the net primary production figures in Table 3.1 in $kJ\,m^{-2}\,year^{-1}$, it is necessary to measure the energy content of the primary producers.

Outline how the energy content, in kJ, of a primary producer such as grass can be measured in the laboratory.

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..... **[2]**

(c) The efficiency with which consumers convert the food they eat into their own biomass is generally low.

Table 3.2 compares the energy egested, absorbed and respired in four types of animal.

Table 3.2

animal	percentage of energy consumed that is:			
	egested	absorbed	respired	converted to biomass
grasshopper, a herbivorous insect	63	37	24	13
perch, a carnivorous fish	17	83	61	
cow, a herbivorous mammal	60	40	39	
bobcat, a carnivorous mammal	17	83	77	6

(i) **Complete Table 3.2** to show the percentage of energy consumed that is converted into biomass in the perch and the cow.

You may use the space below for your working.

[2]

(ii) Describe **and** explain, using the data from Table 3.2, how the trophic level of a **mammal** affects the percentage of its food energy that it is able to convert to biomass.

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..... **[3]**

(iii) Using the data from Table 3.2 and your knowledge of energy flow through food chains, suggest which of these four animals could be farmed to provide the maximum amount of food energy in $kJ\,m^{-2}\,year^{-1}$ for humans.

Explain the reasons for your choice.

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..... **[3]**

[Total: 14]

4 The antibiotic penicillin is produced by batch culture of the fungus *Penicillium chrysogenum*.

(a) Fig. 4.1 shows the concentration of penicillin, lactose and ammonia as well as the fungal biomass over time when penicillin is being produced by batch culture.

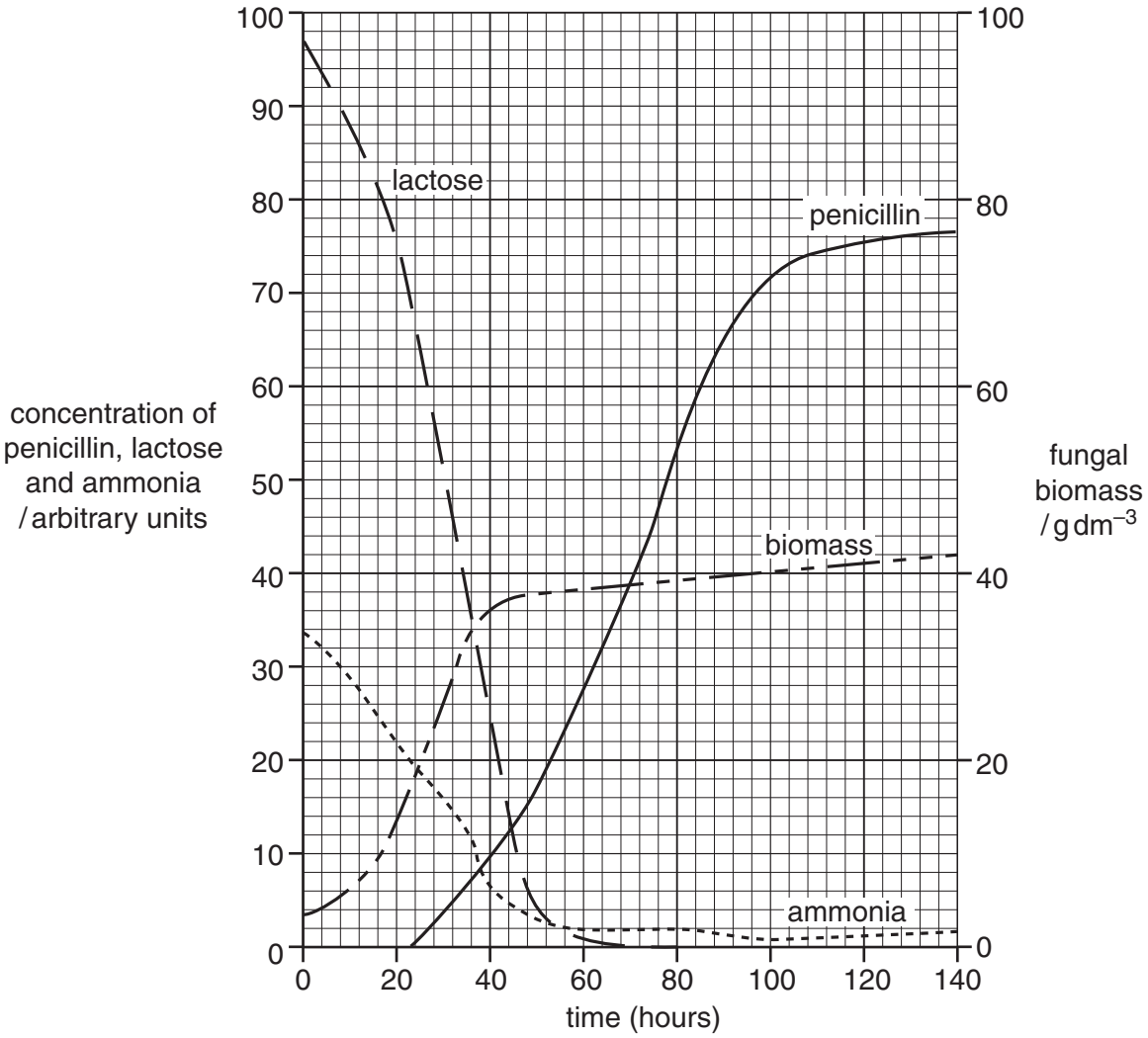

Fig. 4.1

(i) With reference to Fig. 4.1, describe and explain the changes in concentration of lactose **and** ammonia.

description .....

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explanation .....

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..... **[4]**

(ii) A student incorrectly suggested that penicillin might be produced by continuous culture fermentation instead of by batch culture.

Suggest how the curves for lactose, ammonia and biomass on Fig. 4.1 might differ in continuous culture.

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..... **[2]**

(iii) A second student said that continuous culture would not be suitable, as penicillin is a secondary metabolite.

What evidence is there in Fig. 4.1 that penicillin is a secondary metabolite?

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..... **[2]**

(b) (i) Explain the importance of maintaining aseptic conditions in manufacturing penicillin by fermentation.

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..... **[3]**

(ii) State **three** physical or chemical factors within the fermenter, other than nutrient levels, that need to be monitored and controlled.

For each factor, explain **why** it must be controlled.

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..... **[3]**

[Total: 14]

5 This question is about genetic engineering and the techniques used for making multiple copies of genes (gene cloning).

(a) Genetic engineering uses the following:

A an enzyme that synthesises new DNA
B an enzyme that cuts DNA at specific sequences
C an enzyme that reseals cut ends of DNA
D small circular pieces of DNA found in bacteria; these pieces of DNA have antibiotic resistance genes
E an enzyme found in some viruses with an RNA genome; this enzyme converts RNA into DNA.

Name **A** to **E**.

A .....

B .....

C .....

D .....

E ..... **[5]**

(b) Genes are cloned for a number of reasons. For example,

- one group of research scientists at a hospital wanted to sequence a disease-causing mutation to learn more about a human disease; these scientists started their research using white blood cells;

- another group of scientists at a biotechnology company wanted to clone the insulin gene in order to manufacture its protein product to treat diabetes; these scientists started their research using cells from the pancreas.

Suggest **and** explain the biological reasons why the two groups each started with a different cell.

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..... **[4]**

(c) A gene can be cloned *in vitro* (in a test-tube) by the polymerase chain reaction (PCR). Alternatively, a gene can be cloned *in vivo* (in living cells) by introducing the gene into bacterial host cells.

Table 5.1 identifies some of the key steps in each process.

Table 5.1

in vitro gene cloning (PCR)	*in vivo* gene cloning
At 95 °C, DNA extracted from a cell separates into two strands.	A library of gene fragments is produced and introduced into host bacteria.
At 50 °C, specially-made primer sequences attach to the ends of the desired gene only.	Bacteria are screened for antibiotic resistance to identify those with recombinant DNA.
At 72 °C complementary copies of both DNA strands are made.	A gene probe is used to select the bacterial colony containing the desired gene.
The cycle of temperature changes is repeated and more copies of the gene are made.	This colony is grown on in nutrient broth and the DNA is then purified.

Compare the two processes of gene cloning by explaining the advantages of each.

In your answer you should ensure that clear comparisons between the two processes are made and explained.

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..... **[8]**

[Total: 17]

6 **(a)** State the term used to describe:

(i) a directional growth response of a plant

..... **[1]**

(ii) a signalling molecule that enables **plants** to respond to environmental change

..... **[1]**

(iii) plants that lose their leaves seasonally

..... **[1]**

(iv) the process of managing an ecosystem sustainably to protect biodiversity

..... **[1]**

(v) organisms that return inorganic minerals from the bodies of dead organisms to the abiotic environment

..... **[1]**

(vi) the conversion of nitrogen gas to ammonium compounds in the soil.

..... **[1]**

(b) Describe briefly **one** example of each of the following types of **animal** behaviour:

(i) habituation

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..... **[3]**

(ii) operant conditioning

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..... **[3]**

(iii) social behaviour in primates and its importance.

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..... **[3]**

[Total: 15]

END OF QUESTION PAPER

1 (a) A balanced diet is essential for good health.

Complete the following passage by using the most appropriate terms from the list to fill the gaps.

Each term **should not** be used more than once.

haemoglobin **iron** **collagen** **obese**

calcium **anorexic** **sodium**

A balanced diet is one which provides an adequate intake of energy and nutrients for the maintenance of our body. If energy intake exceeds energy usage over a period of time, an individual can become ……..... .

The deficiency disease anaemia can be caused by a lack of the mineral ……..... in the diet. As a result of this deficiency, the body is unable to produce sufficient amounts of the protein ……..... in red blood cells. **[3]**

(b) The Body Mass Index (BMI) is one way of determining whether a person is underweight or overweight.

BMI can be calculated using the formula:

$$\text{BMI} = \frac{\text{mass in kg}}{(\text{height in m})^2}$$

Calculate the BMI of a female of mass 69 kg and a height of 1.67 m.

Show your working. Give your answer to **one decimal place**.

Answer = ... **[2]**

(c) Another way of determining whether a person is underweight or overweight is to use a graph showing the relationship between height and body mass.

Fig. 1.1 is an example of this type of graph.

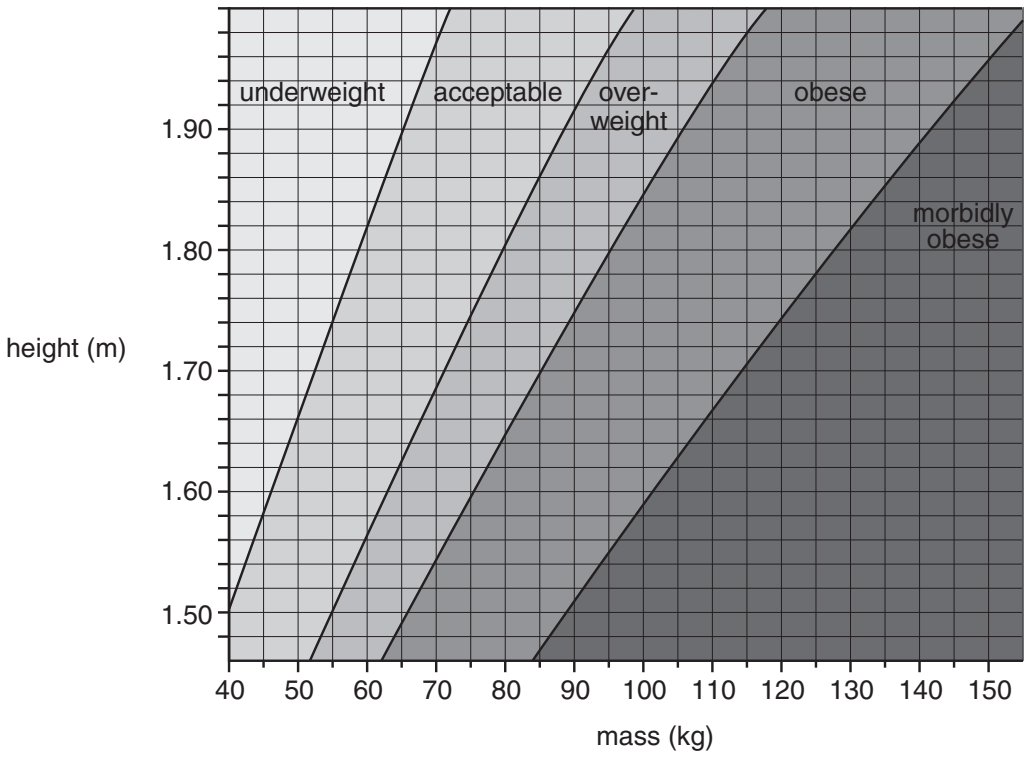

Fig. 1.1

(i) Using Fig. 1.1, state the category into which a female who has a body mass of 69 kg and a height of 1.67 m is placed.

..... **[1]**

(ii) There are many factors that determine the category into which a person is placed. Fig. 1.1 does not take into account all of these factors.

Suggest why the female in **(c)(i)** might be placed in the wrong category.

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..... **[2]**

(d) Name **two** diseases associated with obesity.

1 .....

2 ..... **[2]**

[Total: 10]

Turn over

2 Fig. 2.1 represents a water molecule.

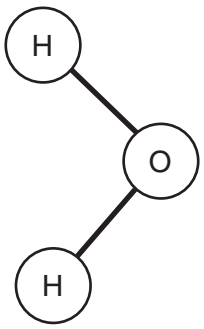

Fig. 2.1

(a) Water molecules are polar. As a result, they attract each other.

Draw a second water molecule on Fig. 2.1.

Your drawing should show:

- the bond(s) between the two molecules
- the name of the bond
- the charges on each atom. **[3]**

(b) Ponds provide a very stable environment for aquatic organisms.

Three properties of water that contribute to this stability are as follows:

- the density of water decreases as the temperature falls below 4 °C so ice floats on the top of the pond
- it acts as a solvent for ions such as nitrates (NO_3^-)
- a large quantity of energy is required to raise the temperature of water by 1 °C.

Explain how these three properties help organisms survive in the pond.

In your answer you should make clear the links between the behaviour of the water molecules and the survival of the organisms.

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..... **[8]**

(c) Water is important in many biological reactions.

Complete Table 2.1 by writing an appropriate term next to each description.

Table 2.1

description	term
the type of reaction that occurs when water is added to break a bond in a molecule	
the phosphate group of a phospholipid that readily attracts water molecules	

[2]

[Total: 13]

3 **(a)** The enzyme DHPS is involved in the production of folic acid in bacteria.

- The substrate for DHPS is a molecule known as PABA.
- The enzyme DHPS is inhibited by the drug sulfonamide.

Fig. 3.1 shows the structure of PABA and that of sulfonamide.

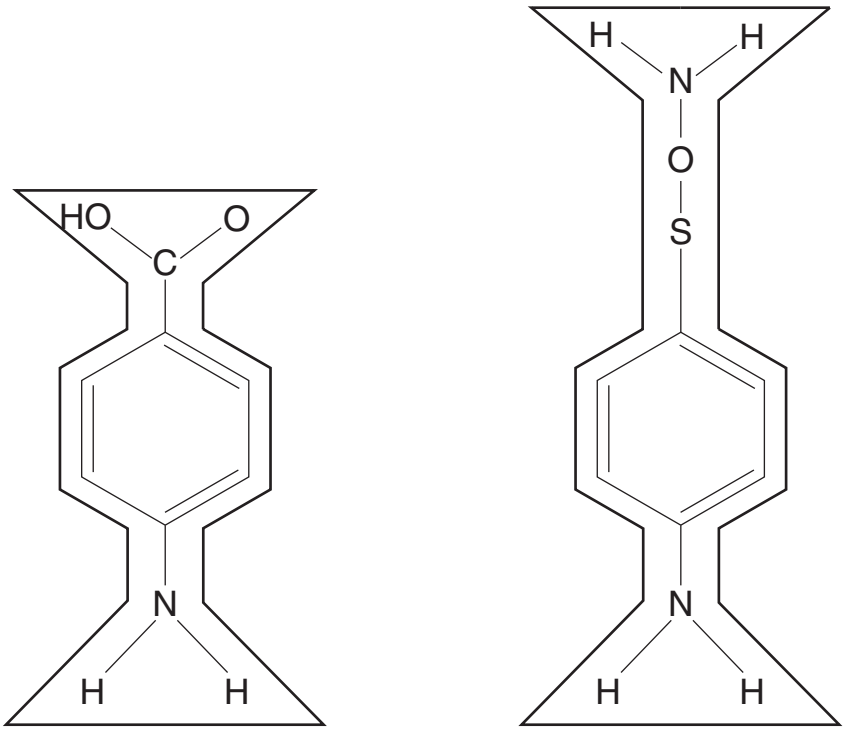
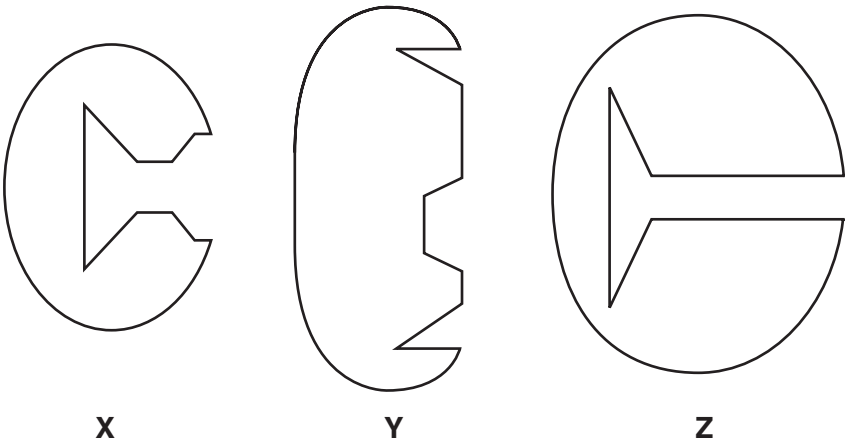


Fig. 3.1

(i) Diagrams **X**, **Y** and **Z** represent these enzyme molecules and their active sites.



State the letter, **X**, **Y** or **Z**, that most accurately represents the enzyme DHPS.

..... **[1]**

(ii) Using the information in Fig. 3.1, explain why sulfonamide acts as a competitive inhibitor of DHPS.

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..... **[3]**

(b) Fig. 3.2 shows the effect of increasing the concentration of the substrate (PABA) on the rate of reaction.

- Curve **A** shows the rate of reaction without the presence of the competitive inhibitor sulfonamide.
- Curve **B** shows the rate of reaction in the presence of the competitive inhibitor sulfonamide.

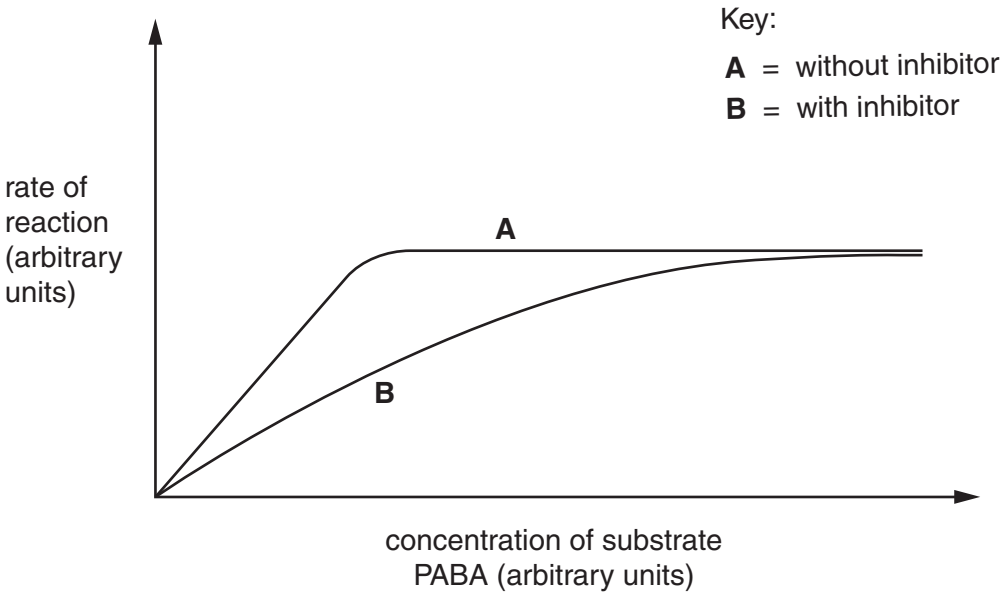

Fig. 3.2

Explain the effect of increasing the concentration of substrate on the rate of reaction;

(i) without inhibitor,

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..... **[3]**

(ii) with inhibitor.

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..... **[2]**

(c) Antibiotic resistance in bacteria is becoming an increasing problem.

Describe how a sulfonamide-resistant population of bacteria could develop.

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..... **[4]**

(d) Hospitals can check to see if a strain of bacteria causing an infection is resistant to a range of antibiotics by using a **multodisc**. A multodisc contains different antibiotics.

- The bacteria are isolated from a patient.
- The bacteria are spread on nutrient agar in a Petri dish.
- The multodisc is placed on the agar.

Fig. 3.3 shows a Petri dish with the bacteria, in which is placed a multodisc containing six different antibiotics.

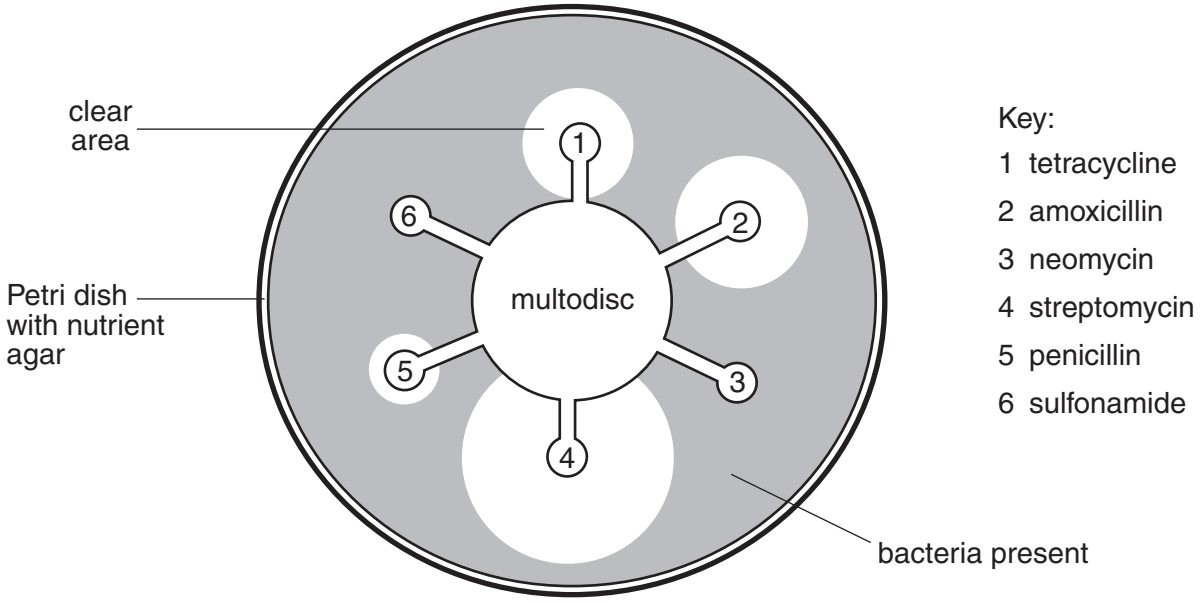

Fig. 3.3

(i) Explain why there are clear areas of agar in the Petri dish.

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..... **[1]**

(ii) Using Fig. 3.3, name the antibiotic that is most effective against the bacteria causing the infection.

..... **[1]**

(iii) Suggest **three** reasons why a hospital might use a multodisc to select the most suitable antibiotic for treating a patient.

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..... **[3]**

(e) Drugs, such as antibiotics, are often first discovered in the natural environment.

Explain why it may become increasingly difficult to discover new drugs in the future.

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..... **[2]**

[Total: 20]

4 **(a)** Amino acids are the basic building blocks for proteins. Fig. 4.1 shows the amino acid cysteine.

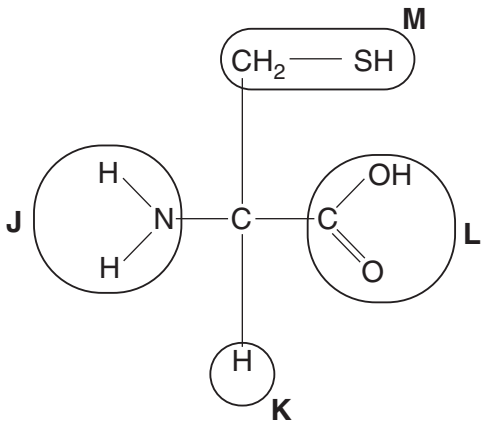

Fig. 4.1

(i) Complete the table by selecting the letter, **J**, **K**, **L** or **M**, that represents the following groups in cysteine.

group	letter
carboxyl	
R group	
amine group	

[3]

(ii) The primary structure of a protein consists of a chain of amino acids.

Describe how a second amino acid would bond to cysteine in forming the primary structure of a protein.

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..... **[3]**

(b) Each amino acid has a different R group.

Describe how these R groups can interact to determine the **tertiary** structure of a protein.

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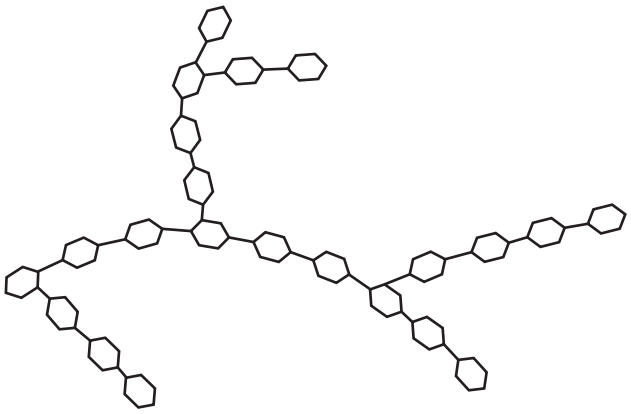
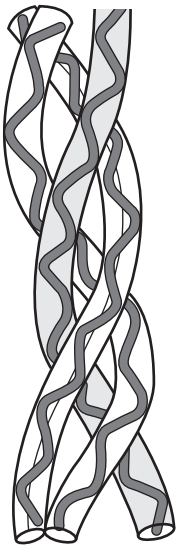
..... **[4]**

(c) Fig. 4.2 shows the structure of two polymers, glycogen and collagen, that are found in mammals.



glycogen



collagen

Fig. 4.2

(i) Complete the table below to give three **differences** between the **structure** of glycogen and collagen.

glycogen	collagen

[3]

(ii) Collagen is found in the ligaments which hold bones together at joints.

State **two** properties of collagen that make it suitable for this purpose.

1 .....

2 ..... **[2]**

[Total: 15]

5 **(a)** Coronary heart disease (CHD) can be described as a multifactorial disease. This means that a number of different risk factors contribute to the development of the disease.

Fig. 5.1 shows the percentage of cases of CHD in a population to which each risk factor contributed.

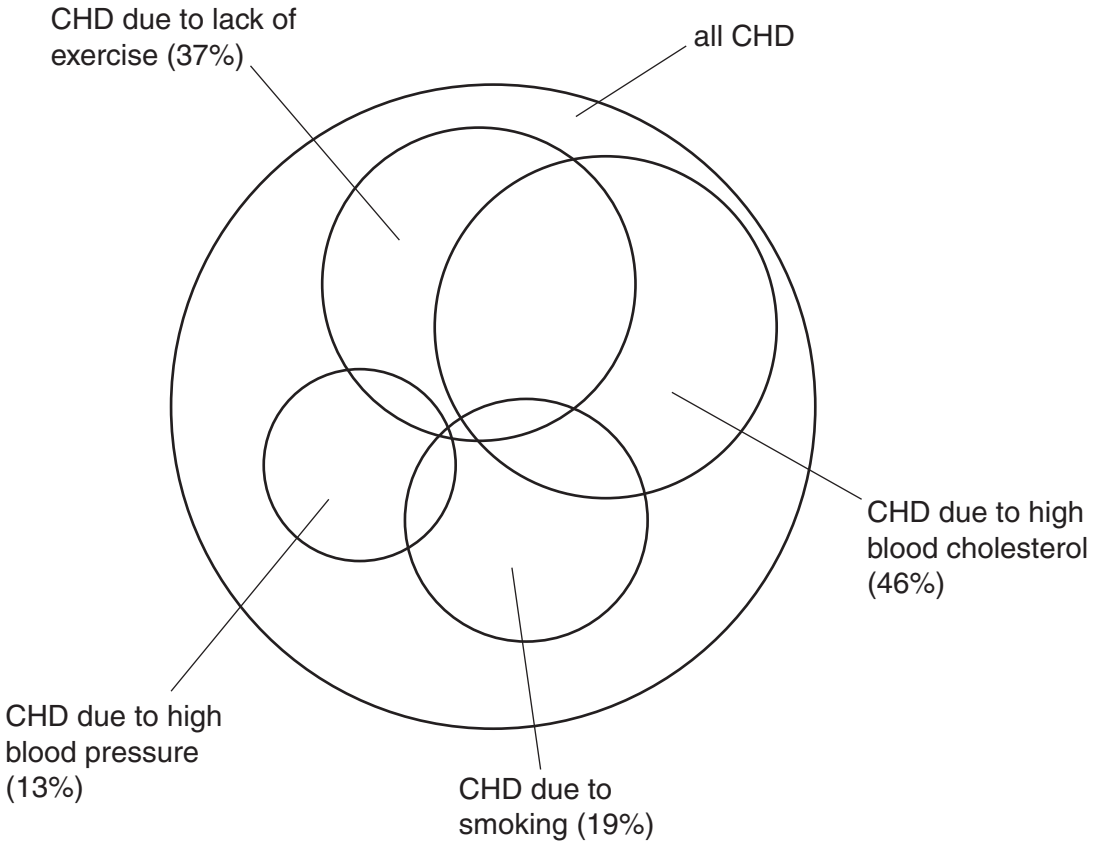


Fig. 5.1

(i) When you add up the different risk factor percentages for the population you find that it is greater than 100%.

Suggest why.

.....

..... **[1]**

(ii) State **two** further risk factors that are **not** shown in Fig. 5.1.

1 .....

2 ..... **[2]**

(iii) Smoking is a contributing factor in 19% of all cases of CHD.

Table 5.1 lists a number of effects of cigarette smoke.

Use a tick (✓) to indicate which component of cigarette smoke causes each effect.

The first row has been done for you.

Table 5.1

effect	nicotine	carbon monoxide
increases heart rate	✓	
constricts arterioles		
damages the lining of arteries		
reduces the ability of haemoglobin to carry oxygen		
makes platelets sticky		

[4]

(b) Cholesterol is transported in the form of lipoproteins. High levels of low density lipoproteins (LDLs) in the blood are a risk factor in heart disease.

Outline the role of LDLs in the formation of an atheroma.

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..... **[2]**

(c) An atheroma can grow to a point where it restricts blood flow in a coronary artery, causing coronary heart disease (CHD).

Fig 5.2 shows a method of reducing the symptoms of CHD.

A stent is a tubular device, containing a 'balloon', which can be inserted into the damaged artery. The stent can be opened up by inflating the balloon.

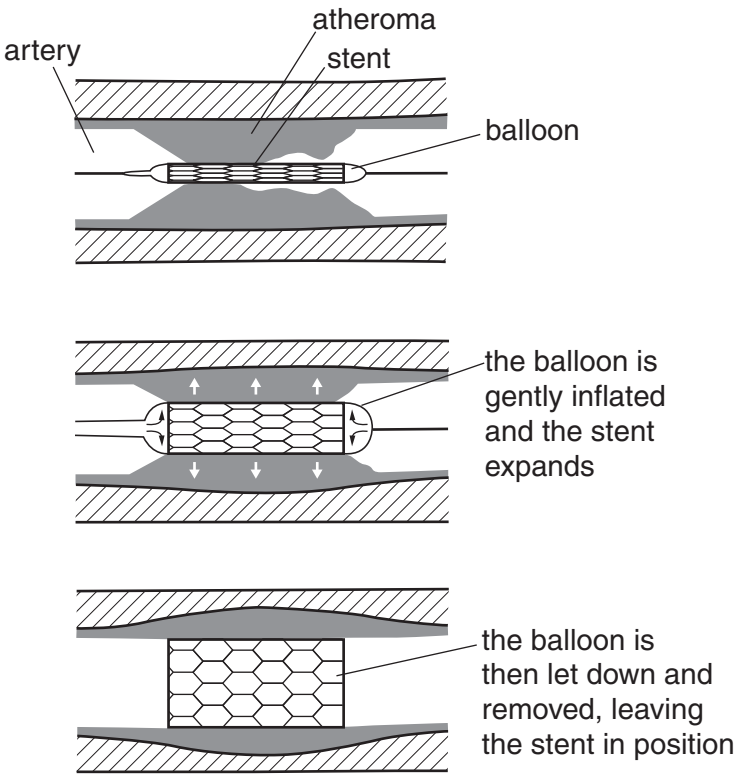

Fig. 5.2

Explain how the inserted stent would reduce the symptoms of CHD.

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..... **[4]**

[Total: 13]

6 DNA and RNA are nucleic acids.

(a) (i) State the components of a **DNA** nucleotide.

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..... **[3]**

(ii) Describe how the structure of RNA differs from that of DNA.

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..... **[2]**

(b) Before a cell divides, the DNA needs to be accurately replicated.

Describe how a DNA molecule is replicated.

In your answer you should make clear how the steps in the process are sequenced.

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(c) (i) State what a gene codes for.

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..... **[1]**

(ii) Suggest how changing the sequence of DNA nucleotides could affect the final product the DNA codes for.

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..... **[2]**

[Total: 15]

7 Fig. 7.1, **on the insert**, shows a photograph of a part of a heathland habitat. A study was carried out on the biodiversity of this habitat.

(a) Define the terms:

habitat .....

.....

.....

biodiversity .....

.....

..... **[3]**

(b) In this study, a student placed his quadrat on areas he considered to have the most biodiversity.

Explain what is wrong with this technique.

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..... **[2]**

(c) The student looked at the abundance of three plants at different distances from the bottom of the slope.

The results table drawn by the student is shown below.

Table 7.1

distance from bottom of slope	percentage cover of each plant species		
	cotton grass	ling	bracken
0 m	76	0	0
10 m	68	0	0
20 m	0	2	0
30 m	0	35	0
40 m	0	50	0
50 m	0	60	7
60 m	0	40	17
70 m	0	10	42
80 m	0	0	68
90 m	0	0	71
100 m	0	0	74

(i) The format of the student's table is incorrect.

Suggest **one** way in which the student could correct the table.

.....

..... **[1]**

Fig. 7.2 is a graph showing the distribution of cotton grass and bracken at different distances from the bottom of the slope.

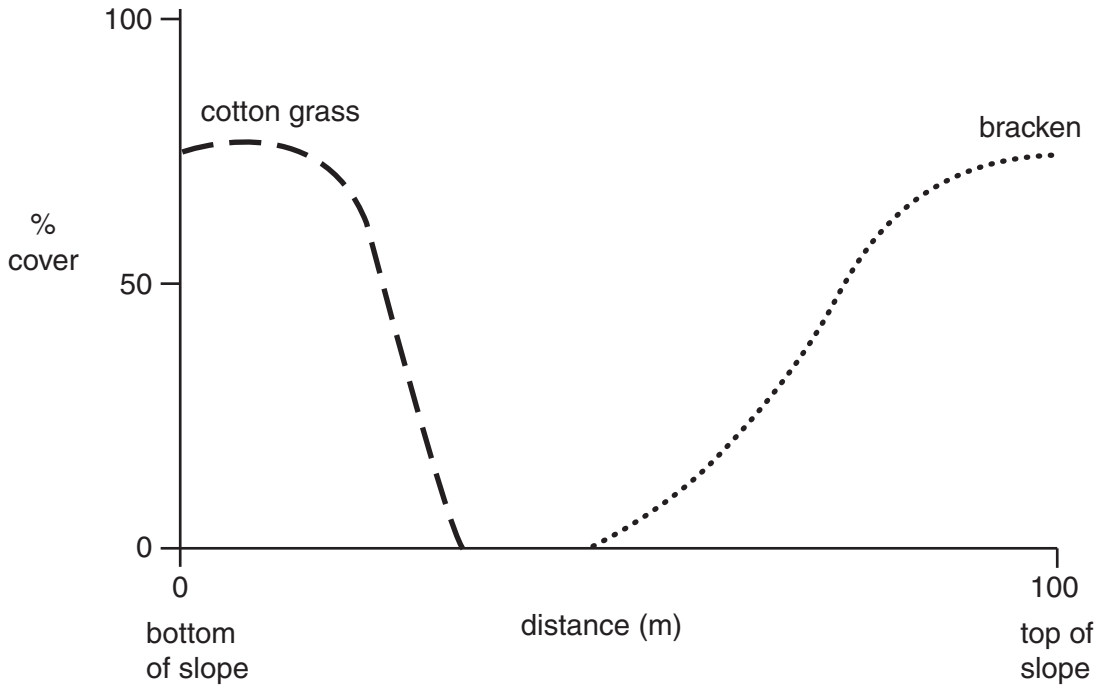

Fig. 7.2

(ii) Using the information in Table 7.1, **sketch on Fig. 7.2** a curve to show the distribution of **ling**. **[3]**

(iii) Describe the distribution of **bracken**.

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..... **[2]**

(d) (i) The student was asked to calculate the biodiversity using Simpson's Index of Diversity.

Suggest what additional data he would need to **collect** in order to calculate Simpson's Index of Diversity in this habitat.

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..... **[2]**

(ii) The student calculated Simpson's Index as 0.2. This is a low value.

State the **significance** of this low value for this habitat.

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..... **[1]**

[Total: 14]

END OF QUESTION PAPER

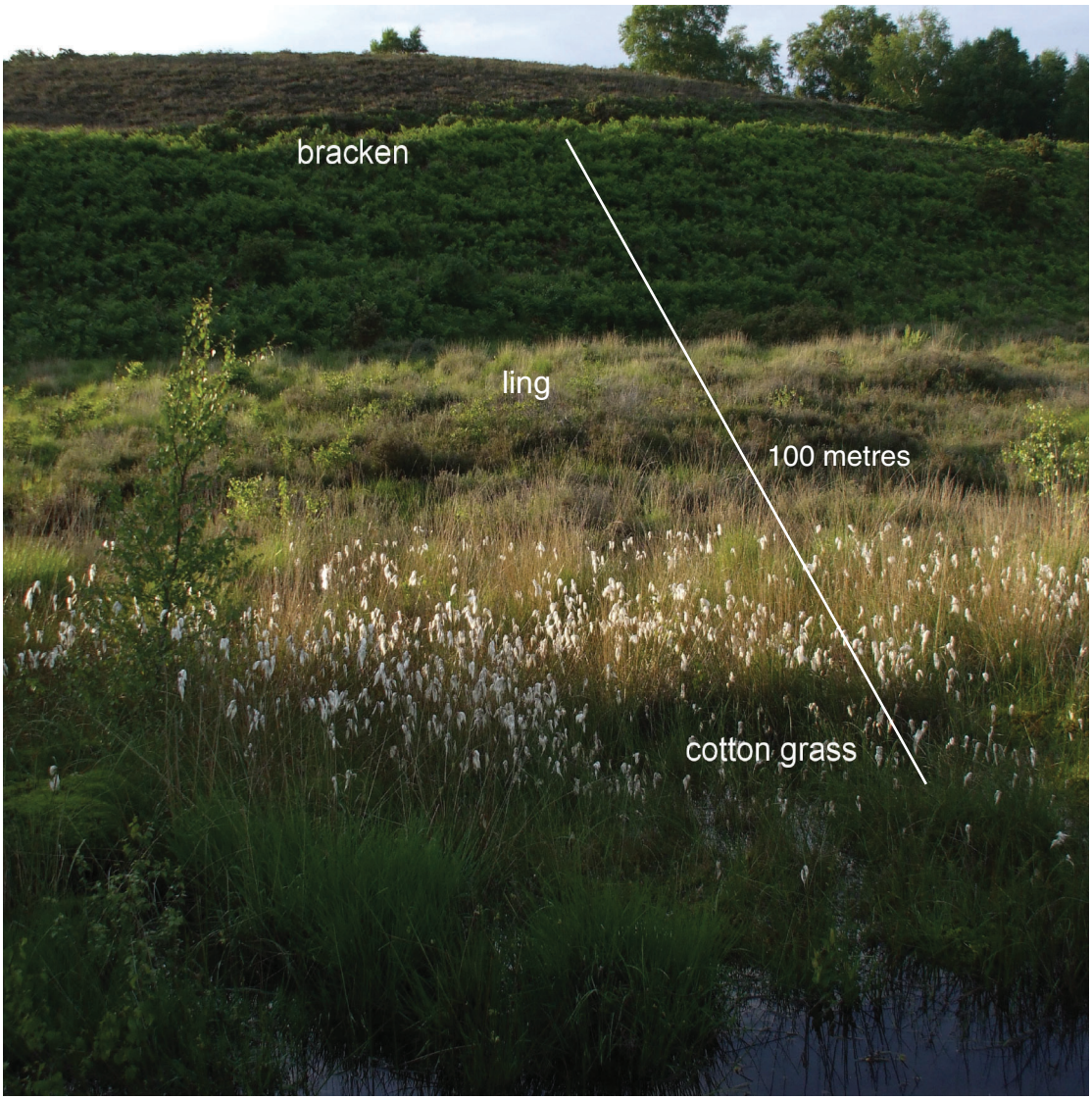
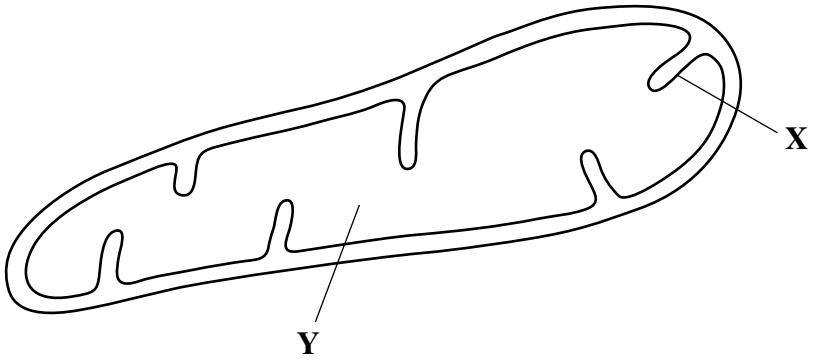


Fig. 7.1

Answer **all** questions in the spaces provided.

1 The diagram shows a mitochondrion.



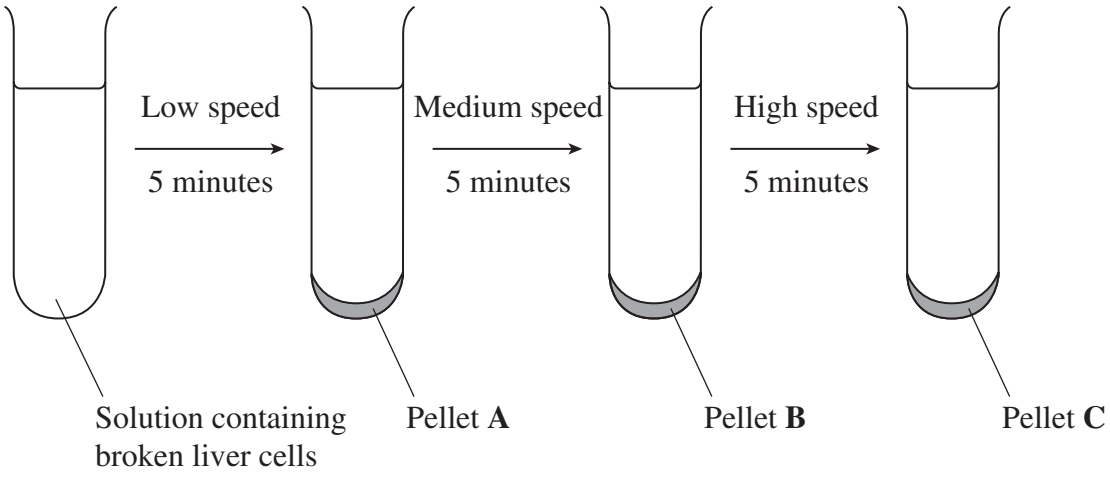
1 (a) Name the parts labelled **X** and **Y**.

1 (a) (i) **X** .....

1 (a) (ii) **Y** .....

(2 marks)

Scientists isolated mitochondria from liver cells. They broke the cells open in an ice-cold, isotonic solution. They then used a centrifuge to separate the cell organelles. The diagram shows some of the steps in the process of centrifugation.



1 (b) Suggest which pellet, **A**, **B** or **C** contained the mitochondria.

(1 mark)

1 (c) Explain why the solution used was

1 (c) (i) ice-cold

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(1 mark)

1 (c) (ii) isotonic.

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(2 marks)

Extra space .....

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1 (d) People with mitochondrial disease have mitochondria that do not function properly. Some people with mitochondrial disease can only exercise for a short time. Explain why a person with mitochondrial disease can only exercise for a short time.

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(2 marks)

Extra space .....

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8

2 (a) The sinoatrial node (SAN) is in the right atrium of the heart. Describe the role of the sinoatrial node.

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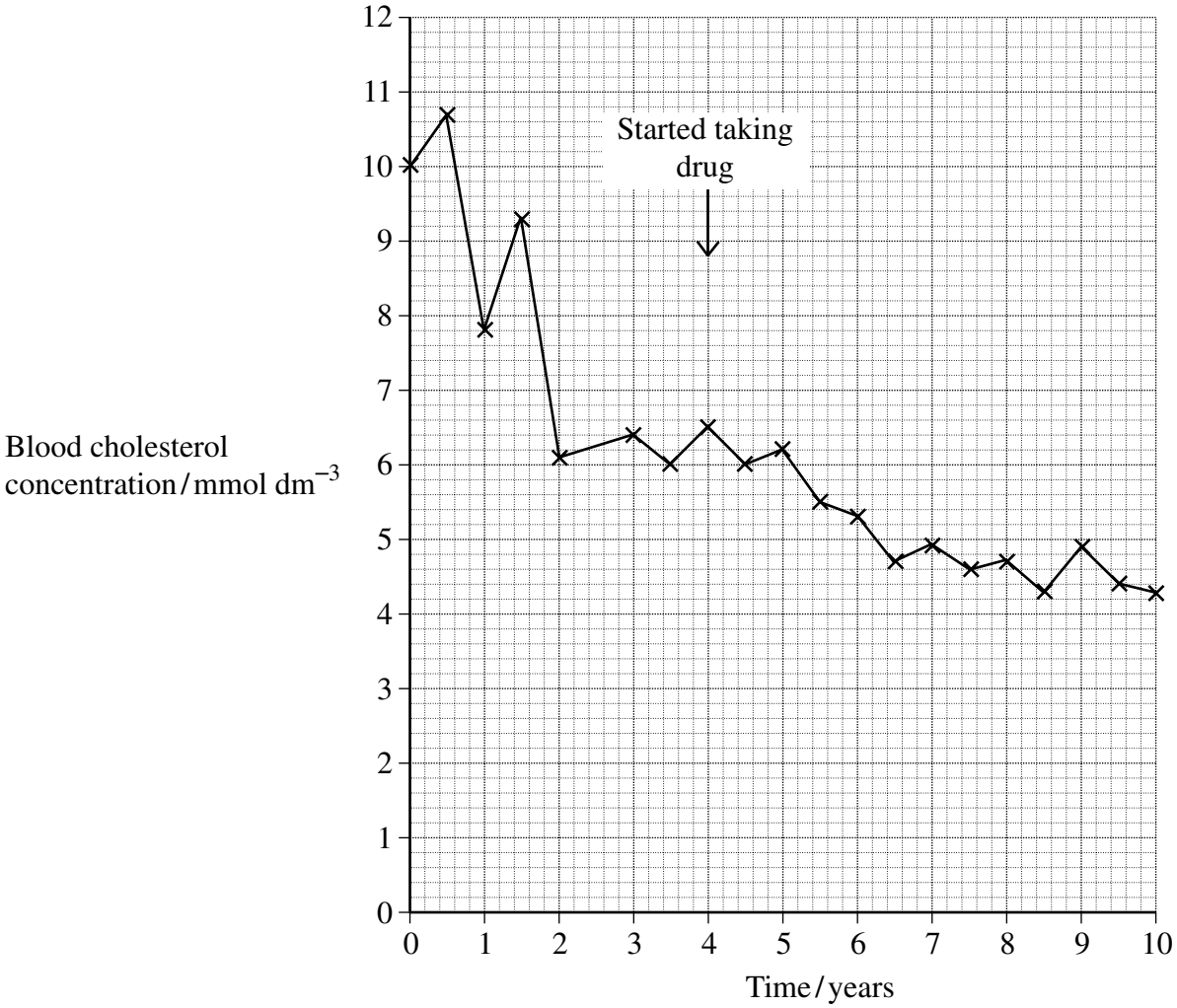
(2 marks)

Ten years ago, a woman was found to have a high concentration of cholesterol in her blood. As a result, she was put on a special diet. She has been on this diet ever since. Four years after starting the diet, she started taking a drug to lower her blood cholesterol. The graph shows the concentration of cholesterol in her blood over the ten-year period.



2 (b) Describe how the concentration of cholesterol in her blood changed over the ten-year period.

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(2 marks)

2 (c) Explain the overall change in cholesterol concentration in the blood in the first two years.

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(2 marks)

2 (d) Use the graph to evaluate the success of the special diet and of the drug in reducing the risk of coronary heart disease.

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(2 marks)

Extra space .....

.....

8

3 A glucose biosensor is an instrument used to measure glucose concentration. It contains an enzyme called glucose oxidase.

3 (a) A glucose biosensor detects only glucose. Use your knowledge of the way in which enzymes work to explain why.

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(3 marks)

(Extra space).....

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3 (b) It is better to use a biosensor than the Benedict's test to measure the concentration of glucose in a sample of blood. Suggest **two** reasons why.

1 .....

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2 .....

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(2 marks)

3 (c) (i) Diabetes mellitus is a disease that can lead to an increase in blood glucose concentration. Some diabetics need insulin injections. Insulin is a protein so it cannot be taken orally. Suggest why insulin cannot be taken orally.

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(1 mark)

3 (c) (ii) A drug company produced a new type of insulin. Scientists from the company carried out a trial in which they gave this new type of insulin to rats. They reported that the results of this trial on rats were positive. A newspaper stated that diabetics would benefit from this new drug. Suggest **two** reasons why this statement should be viewed with caution.

1 .....

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2 .....

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(2 marks)

8

Turn over for the next question

4 (a) Give **two** ways in which pathogens can cause disease when they enter the body of their host.

1 .....

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2 .....

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(2 marks)

4 (b) Vaccines provide protection against disease. What is a vaccine?

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(2 marks)

4 (c) The only vaccine used against pulmonary tuberculosis is the BCG vaccine. Scientists have carried out trials on a 'booster' vaccine, MVA85A. This 'booster' vaccine is designed to increase the immune response to the BCG vaccine. One trial involved measuring the increase in the number of memory T cells in three groups of adult volunteers following different vaccination programmes.

- Group **A** – injected with BCG
- Group **B** – injected with MVA85A
- Group **C** – injected with BCG and, two weeks later, injected with MVA85A

4 (c) (i) Suggest **two** factors the scientists should have considered when selecting adult volunteers for this trial.

1 .....

2 .....

(2 marks)

4 (c) (ii) The adults in group **C** produced the greatest increase in the number of memory T cells.
Suggest what this shows about the BCG and MVA85A vaccines.

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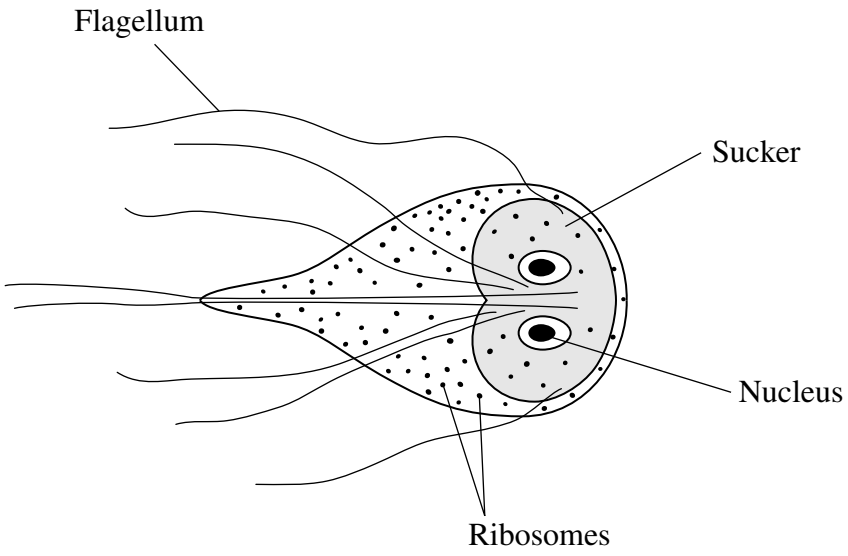
(1 mark)

7

Turn over for the next question

5 Giardiasis is an intestinal disease. It is caused by the microorganism *Giardia lamblia*. The drawing shows some of the structures present in *G. lamblia*.



5 (a) Name **one** structure shown in the drawing which confirms that *G. lamblia* is a eukaryotic organism.

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(1 mark)

5 (b) *G. lamblia* can attach itself with its sucker. Explain how this is an adaptation to living in the intestines.

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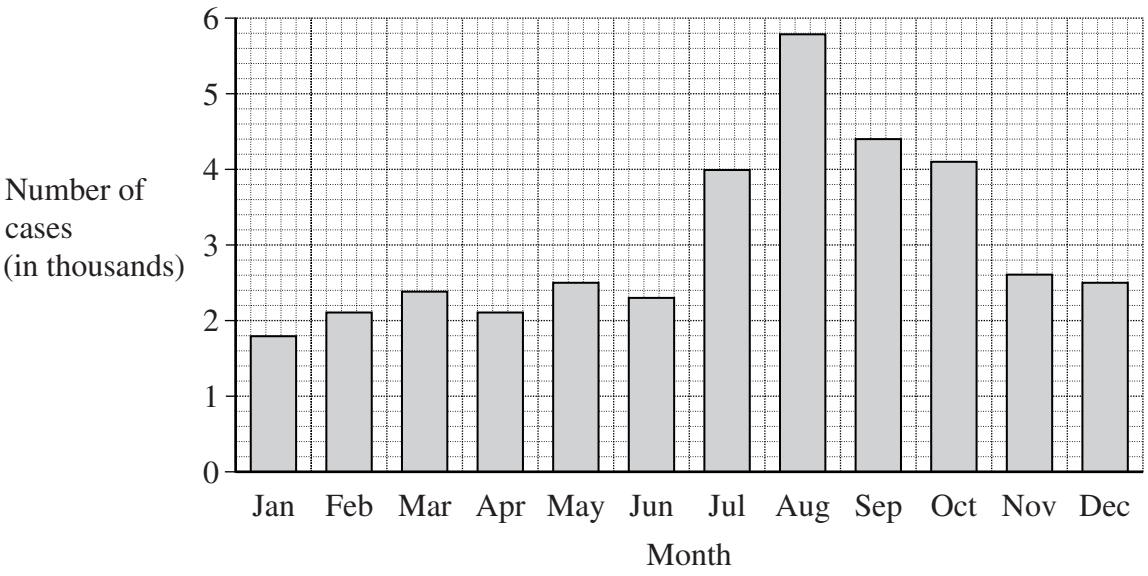
(1 mark)

5 (c) Giardiasis is one of the main causes of diarrhoea in the USA. It is usually transmitted by drinking contaminated water. The bar chart shows the number of cases of giardiasis in one state of the USA during one year.



5 (c) (i) Calculate the percentage increase in the number of cases of giardiasis from January to August. Show your working.

Answer ..... *(2 marks)*

5 (c) (ii) Suggest **one** reason for the number of cases being highest in the late summer months.

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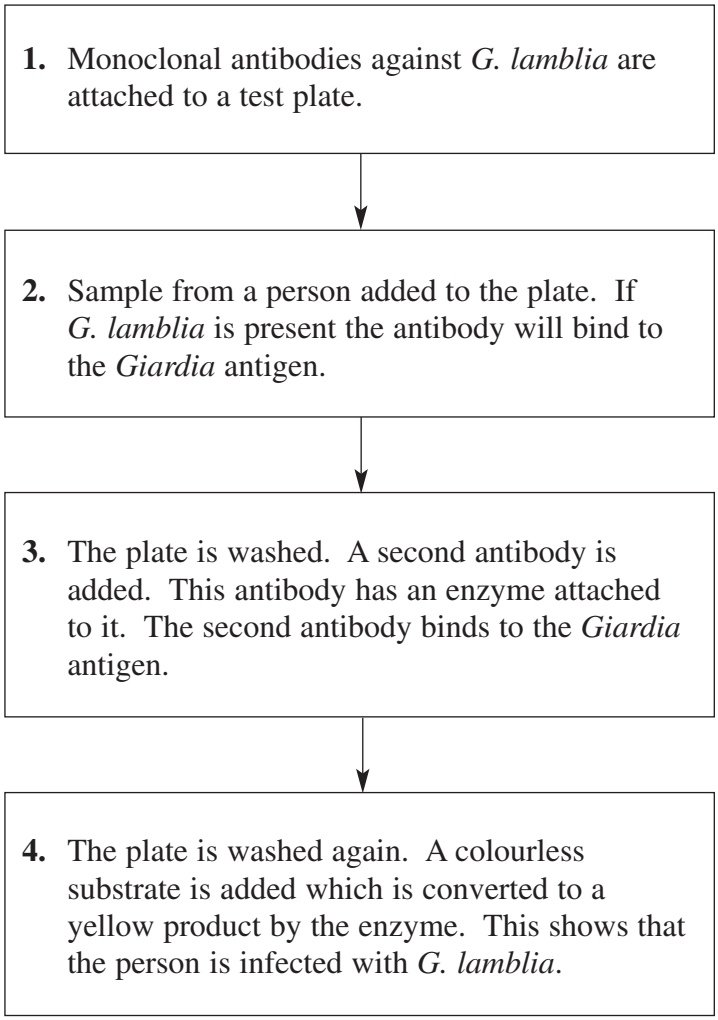
(1 mark)

Question 5 continues on the next page

5 (d) A test has been developed to find out whether a person is infected with *G. lamblia* The test is shown in the flow chart.



5 (d) (i) Explain why the antibodies used in this test must be monoclonal antibodies.

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(1 mark)

5 (d) (ii) Explain why the *Giardia* antigen binds to the antibody in step **2**.

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(1 mark)

5 (d) (iii) The plate must be washed at the start of step **4**, otherwise a positive result could be obtained when the *Giardia* antigen is not present. Explain why a positive result could be obtained if the plate is not washed at the start of step **4**.

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(2 marks)

Extra space .....

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9

Turn over for the next question

6 Read the following passage.

Several diseases are caused by inhaling asbestos fibres. Most of these diseases result from the build up of these tiny asbestos fibres in the lungs.

One of these diseases is asbestosis. The asbestos fibres are very small and enter the bronchioles and alveoli. They cause the destruction of phagocytes and the surrounding lung tissue becomes scarred and fibrous. The fibrous tissue reduces the elasticity of the lungs and causes the alveolar walls to thicken. One of the main symptoms of asbestosis is shortness of breath caused by reduced gas exchange.

People with asbestosis are at a greater risk of developing lung cancer. The time between exposure to asbestos and the occurrence of lung cancer is 20–30 years.

Use information in the passage and your own knowledge to answer the following questions.

6 (a) Destruction of phagocytes (lines 4–5) causes the lungs to be more susceptible to infections. Explain why.

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(2 marks)

Extra space .....

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6 (b) (i) The reduced elasticity of the lungs (lines 6–7) causes breathing difficulty. Explain how.

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(2 marks)

Extra space .....

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6 (b) (ii) Apart from reduced elasticity, explain how changes to the lung tissue reduce the efficiency of gas exchange.

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(4 marks)

(Extra space) .....

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6 (c) (i) Doctors did not make the link between exposure to asbestos and an increased risk of developing lung cancer for many years. Use information in the passage to explain why.

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(1 mark)

6 (c) (ii) Give **one** factor, other than asbestos, which increases the risk of developing lung cancer.

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(1 mark)

10

7 (a) Describe the role of the enzymes of the digestive system in the complete breakdown of starch.

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(5 marks)

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7 (b) Describe the processes involved in the absorption of the products of starch digestion.

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(5 marks)

(Extra space) .....

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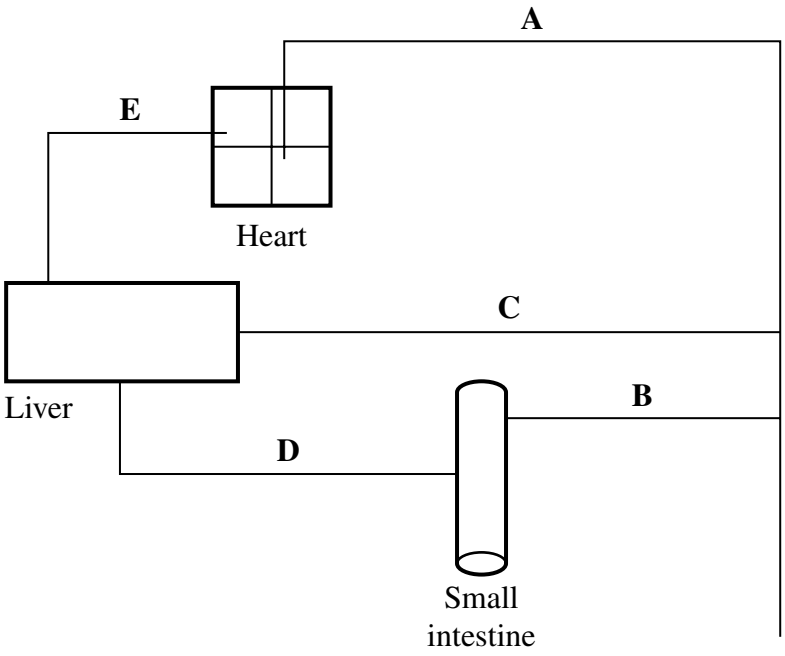
10

END OF QUESTIONS

Answer **all** questions in the spaces provided.

1 The diagram shows some of the large blood vessels in a mammal.



1 (a) Add arrows to the diagram to show the direction of blood flow in each of the blood vessels **A** to **E**. *(1 mark)*

1 (b) (i) Which of blood vessels **A** to **E** is the hepatic portal vein?

(1 mark)

1 (b) (ii) Which of blood vessels **A** to **E** contains blood at the lowest pressure?

(1 mark)

1 (c) Complete the table to show **two** differences between the structure of vessel **C** and the structure of vessel **E**.

Structural feature	Vessel C	Vessel E

(2 marks)

1 (d) Blood vessel **B** contains smooth muscle in its walls. Explain how this muscle may reduce the blood flow to the small intestine.

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(2 marks)

(*Extra space*).....

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1 (e) Elastic tissue in the walls of blood vessel **A** helps to even out the pressure of blood through this vessel. Explain how.

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(2 marks)

(*Extra space*).....

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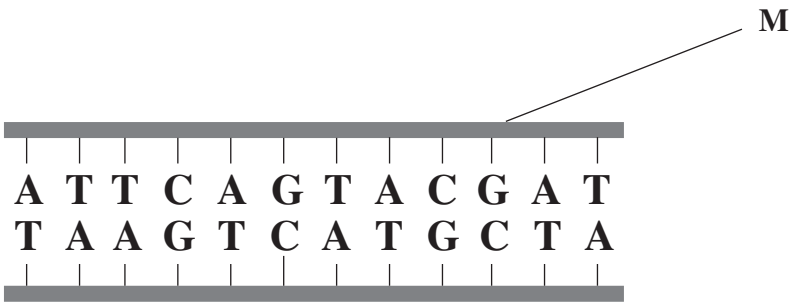
9

2 The diagram shows part of a DNA molecule.



2 (a) Name the **two** components of the part of the DNA molecule labelled **M**.

1 .....

2 .....

(2 marks)

2 (b) What is the maximum number of amino acids for which this piece of DNA could code?

(1 mark)

2 (c) Scientists calculated the percentage of different bases in the DNA from a species of bacterium. They found that 14% of the bases were guanine.

2 (c) (i) What percentage of the bases in this species of bacterium was cytosine?

Answer ..... *(1 mark)*

2 (c) (ii) What percentage of the bases in this species of bacterium was adenine?

Answer ..... *(1 mark)*

2 (d) The scientists found that, in a second species of bacterium, 29% of the bases were guanine.

Explain the difference in the percentage of guanine bases in the two species of bacterium.

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(2 marks)

(*Extra space*).....

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7

3 (a) Give **one** way in which a DNA molecule in a prokaryote, such as a bacterium, is different from a DNA molecule in a eukaryote.

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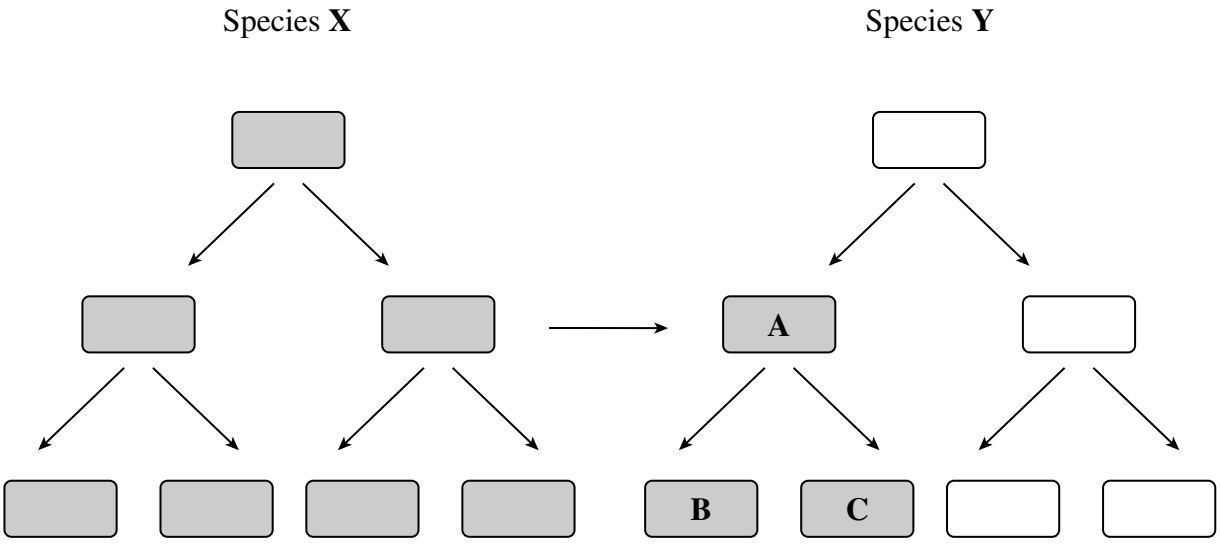
(1 mark)

Species **X** and **Y** are bacteria. The diagram shows gene transfer between bacteria in these two species. The bacteria that are shaded are resistant to the antibiotic penicillin.



3 (b) (i) Use the diagram to explain why bacterium **A** is resistant to penicillin.

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(3 marks)

(Extra space) .....

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3 (b) (ii) Use the diagram to explain why bacteria **B** and **C** are resistant to penicillin.

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(2 marks)

(Extra space) .....

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3 (c) A person is infected with bacteria of species **Y**. Some of these bacteria are resistant to penicillin. A doctor gives the person a course of penicillin.

What would happen to the proportion of species **Y** bacteria that are resistant to penicillin? Explain your answer.

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(2 marks)

(Extra space).....

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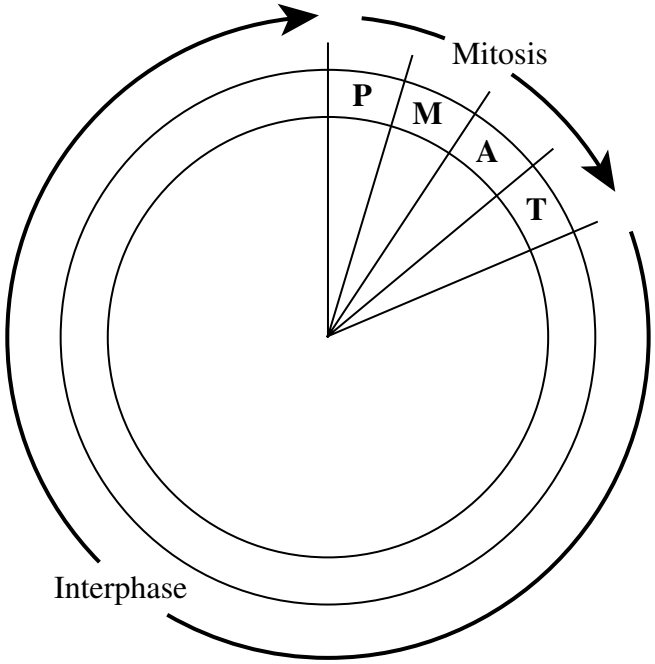
8

4 The diagram shows a cell cycle.



Key

P prophase

M metaphase

A anaphase

T telophase

4 (a) The table shows the number of chromosomes and the mass of DNA in different nuclei. All the nuclei come from the same animal. Complete this table.

Nucleus	Number of chromosomes	Mass of DNA / arbitrary units
At prophase of mitosis	26	60
At telophase of mitosis		
From a sperm cell		

(4 marks)

4 (b) If the DNA of the cell is damaged, a protein called p53 stops the cell cycle.

Mutation in the gene for p53 could cause cancer to develop. Explain how.

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(3 marks)

(Extra space).....

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4 (c) Drugs are used to treat cancer. At what phase in the cell cycle would each of the following drugs act?

4 (c) (i) A drug that prevents DNA replication

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(1 mark)

4 (c) (ii) A drug that prevents spindle fibres shortening

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(1 mark)

9

5 (a) What is a tissue?

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(1 mark)

5 (b) A student cut a thin section of tissue from a potato and examined it with an optical microscope.

5 (b) (i) Starch was present in the cells of this tissue. Describe how the student could find out where in the cells the starch was present.

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(2 marks)

5 (b) (ii) The student cut a thin section of the tissue. Explain why it was important that the section was thin.

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(2 marks)

5 (c) The cell walls of potato cells contain cellulose. Cellulose and starch are both carbohydrates. Describe **two** ways in which molecules of cellulose are similar to molecules of starch.

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(2 marks)

7

6 (a) An order is a taxonomic group. All seals belong to the same order. Name **one** other taxonomic group to which all seals belong.

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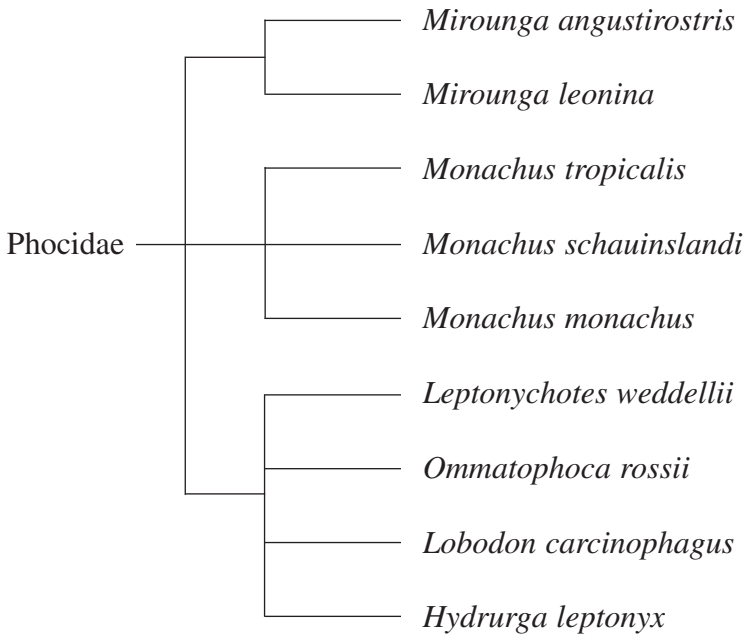
(1 mark)

6 (b) The diagram shows how some species of seal are classified.



6 (b) (i) How many different genera are shown in this diagram?

(1 mark)

6 (b) (ii) All the seals shown in the diagram are members of the Phocidae. Phocidae is an example of a taxonomic group. Of which taxonomic group is it an example?

.....

(1 mark)

6 (b) (iii) The diagram is based on the evolutionary history of the seals. What does the information in the diagram suggest about the common ancestors of *Mirounga angustirostris*, *Mirounga leonina* and *Monachus tropicalis*?

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(1 mark)

6 (c) A species of seal shows genetic diversity. Explain what is meant by genetic diversity.

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(1 mark)

6 (d) In the late 18th century, the population of northern elephant seals was estimated to be about 150 000. These seals lived in different colonies in different places. The seals were then hunted. By 1910, the total population had fallen to under 100. All these seals lived in a single colony on one island. Hunting then stopped. Numbers increased and there are now approximately 150 000 seals living in many different colonies.

Use this information to explain

6 (d) (i) what is meant by a genetic bottleneck

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(2 marks)

(Extra space) .....

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6 (d) (ii) how you would expect the founder effect to have influenced the genetic diversity of northern elephant seals after 1910.

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(2 marks)

(Extra space) .....

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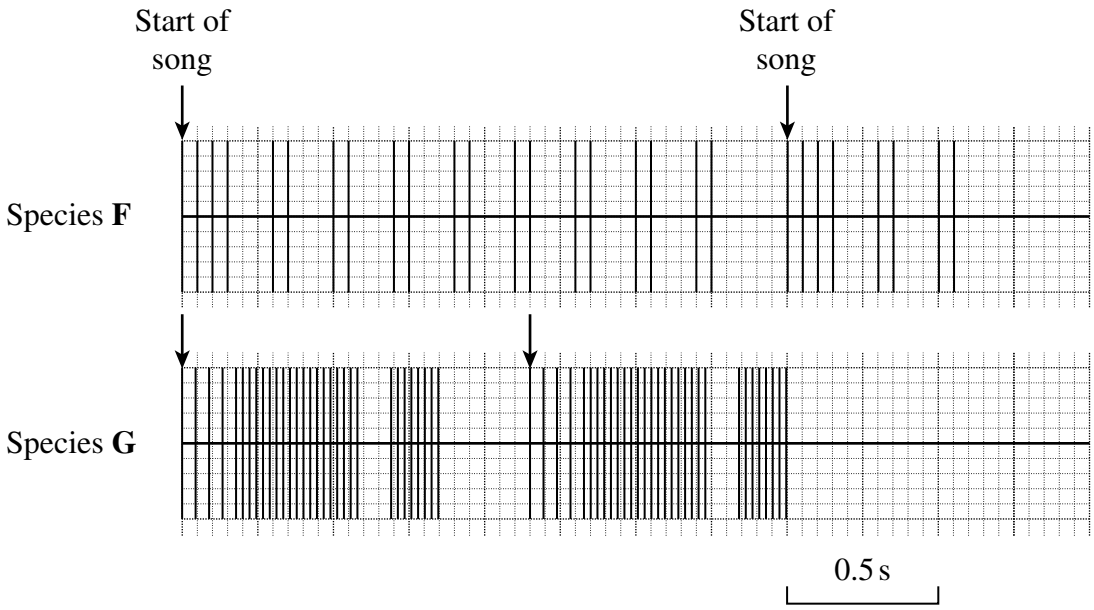
9

7 Mole crickets are insects that live underground. At night, a male cricket produces a courtship song. A female cricket is attracted by this song and mates with the male.

Scientists investigated courtship in two species of mole cricket. They found that female mole crickets were only attracted to the song produced by a male of the same species.

The charts show recordings of typical songs of two species of mole cricket.



7 (a) The song of species **F** is repeated at regular intervals. The arrows on the chart show the beginning of each song.

7 (a) (i) Calculate the time taken for one complete song.

Answer.....seconds *(1 mark)*

7 (a) (ii) Calculate the rate of singing in songs per minute.

Answer.....songs per minute *(1 mark)*

7 (b) Explain why courtship song is an important part of species recognition in mole crickets.

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(2 marks)

(Extra space).....

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7 (c) The scientists produced hybrids between the two crickets by fertilising eggs from one species with sperms from the other. The male hybrids had songs that had some features of one parent species and some features of the other. Suggest why the male hybrids were not able to reproduce.

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(2 marks)

(Extra space).....

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6

Turn over for the next question

8 (a) A fish uses its gills to absorb oxygen from water. Explain how the gills of a fish are adapted for efficient gas exchange.

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(6 marks)

(Extra space).....

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Mackerel live in the surface waters of the sea. Toadfish live on the seabed in deep water.

8 (b) The concentration of oxygen is higher in the surface waters than it is in water close to the seabed. Suggest why.

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(2 marks)

(Extra space).....

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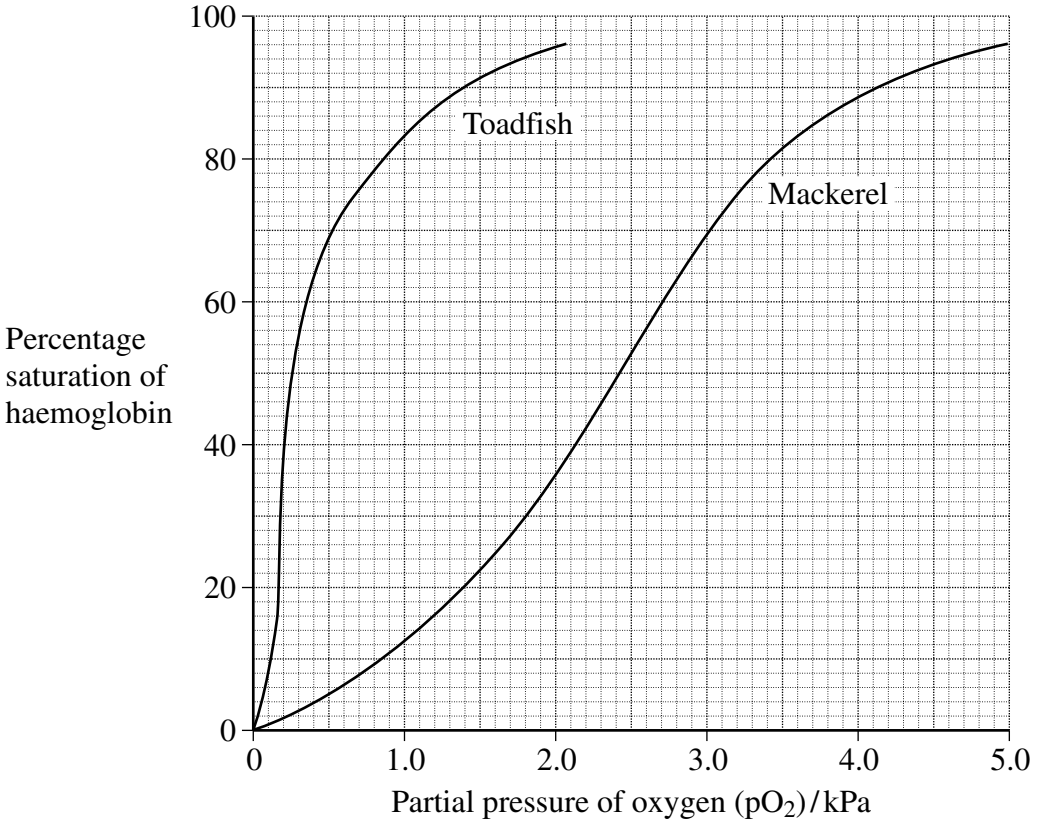
Question 8 continues on the next page

8 (c) The graph shows oxygen dissociation curves for toadfish haemoglobin and for mackerel haemoglobin.



Explain how the shape of the curve for toadfish haemoglobin is related to where the toadfish is normally found.

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(2 marks)

(Extra space).....

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8 (d) Scientists analysed the sequence of amino acids in one polypeptide chain in the haemoglobin of four different species of ape. The only difference they found affected the amino acids at three positions in the polypeptide chain. Their results are shown in the table. The letters are abbreviations for particular amino acids.

Species	Position 87	Position 104	Position 125
Chimpanzee	T	R	P
Bonobo	T	R	P
Gorilla	T	K	P
Orang utan	K	R	Q

8 (d) (i) What information do the data in the table suggest about the relationships between the chimpanzee, the bonobo and the gorilla? Explain your answer.

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(2 marks)

8 (d) (ii) Hybrid DNA was made from the gene for chimpanzee haemoglobin and the genes for the haemoglobin of the other three species of ape. Which of the three samples of hybrid DNA would separate into two strands at the lowest temperature?
Explain your answer.

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(3 marks)

(Extra space) .....

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15

9 (a) In the USA, members of the public found many frogs with deformed legs. Scientists investigated this. They collected samples of the frogs. They wanted to get reliable data. Give **one** feature of the sample, other than a large sample size, that would help to make sure that their data were reliable.

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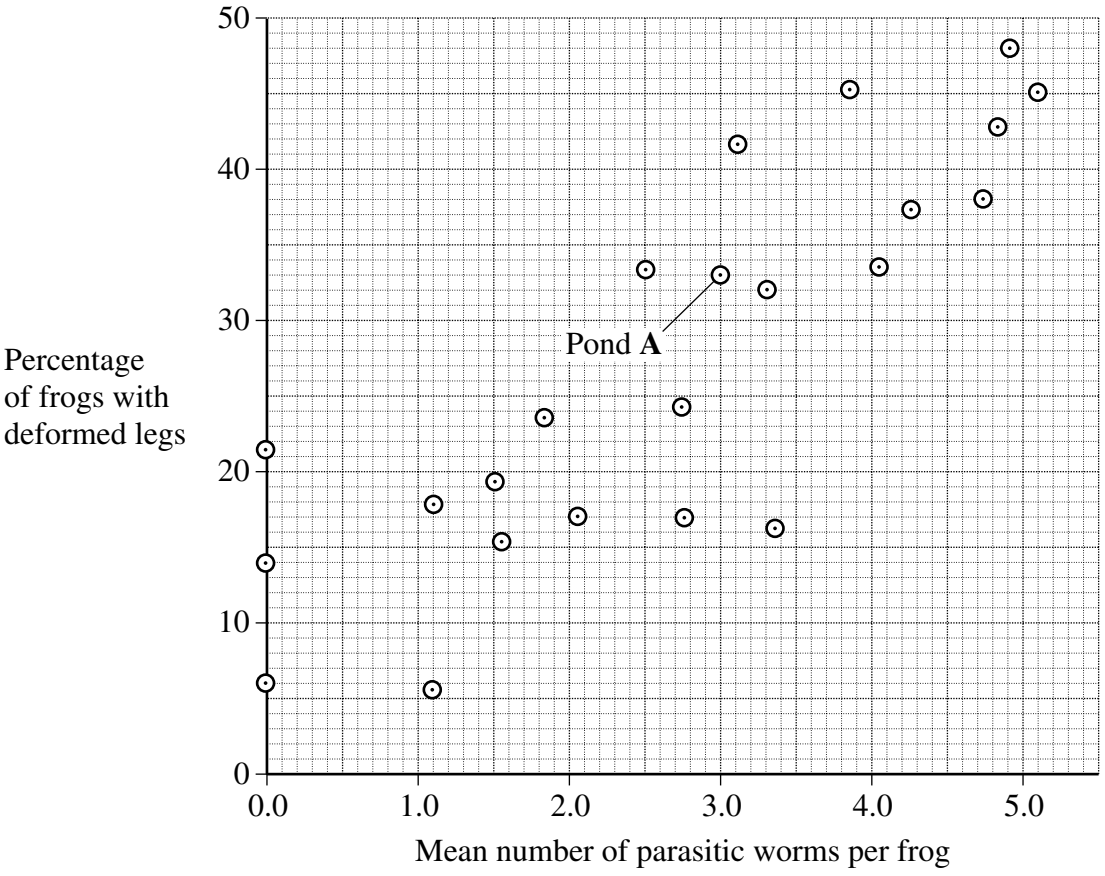
(1 mark)

The team of scientists then investigated frogs in ponds. The team measured many different factors and then analysed their results. The graph shows the relationship between the percentage of frogs with deformed legs and the mean number of parasitic worms found in the frogs.



9 (b) The scientists collected a sample of three frogs from pond **A**. What was the total number of parastic worms found in these three frogs?

(1 mark)

9 (c) One scientist suggested that the parasites caused the deformed legs found in frogs. Does the graph support this suggestion? Explain your answer.

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(4 marks)

(Extra space).....

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9 (d) The scientists wrote a paper. In their discussion they wrote that they found very few ponds that were free from human influence. The few that they did find were only in mountainous areas.

The scientists could not draw any reliable conclusions about whether human influence contributed to the frogs' deformed legs. Explain why each of the following meant that they could not draw reliable conclusions.

9 (d) (i) There were very few ponds free from human influence.

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(1 mark)

Question 9 continues on the next page

9 (d) (ii) The ponds free from human influence were found only in mountainous areas.

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(2 marks)

(Extra space) .....

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In a second investigation, another research team investigated deformed legs in frogs in a different way.

- They chose six ponds, all of which contained parasitic worms. Three of the ponds were close to fields and received agricultural run-off from these fields. The other three ponds did not receive agricultural run-off.
- They built two cages in each of the six ponds. One cage in each pond allowed parasitic worms to enter and one cage did not.
- They put frogs that were not infected with parasitic worms into all twelve cages.

The table shows the results of this second investigation.

	Percentage of frogs with deformed limbs					
	Ponds with agricultural run-off			Ponds with no agricultural run-off		
Pond number	1	2	3	4	5	6
Cage with mean mesh diameter of 500 µm	22	27	24	3	4	7
Cage with mean mesh diameter of 75 µm	0	0	0	0	0	0

9 (e) One of the boxes in the table has been shaded. Describe the information given in the shaded box.

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(2 marks)

(Extra space).....

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9 (f) What conclusions can you draw from the data in the table about the factors causing deformed leg in frogs? Explain your answer.

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(4 marks)

(Extra space).....

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15

END OF QUESTIONS