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

1 The equation shows the breakdown of lactose by the enzyme lactase.

$$\text{lactose} + \text{water} \xrightarrow{\text{lactase}} \text{galactose} + \text{monosaccharide } \mathbf{X}$$

1 (a) (i) Name the type of reaction catalysed by the enzyme lactase.

.....

(1 mark)

1 (a) (ii) Name monosaccharide **X**.

.....

(1 mark)

1 (b) (i) Describe how you would use a biochemical test to show that a reducing sugar is present.

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(2 marks)

1 (b) (ii) Lactose, galactose and monosaccharide **X** are all reducing sugars.
After the lactose has been broken down there is a higher concentration of reducing sugar. Explain why.

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(1 mark)

1 (c) A high concentration of galactose slows down the breakdown of lactose by lactase.
Use your knowledge of competitive inhibition to suggest why.

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(2 marks)

1 (d) People who are lactose intolerant are **not** able to produce the enzyme lactase.
Explain why these people get diarrhoea when they drink milk containing lactose.

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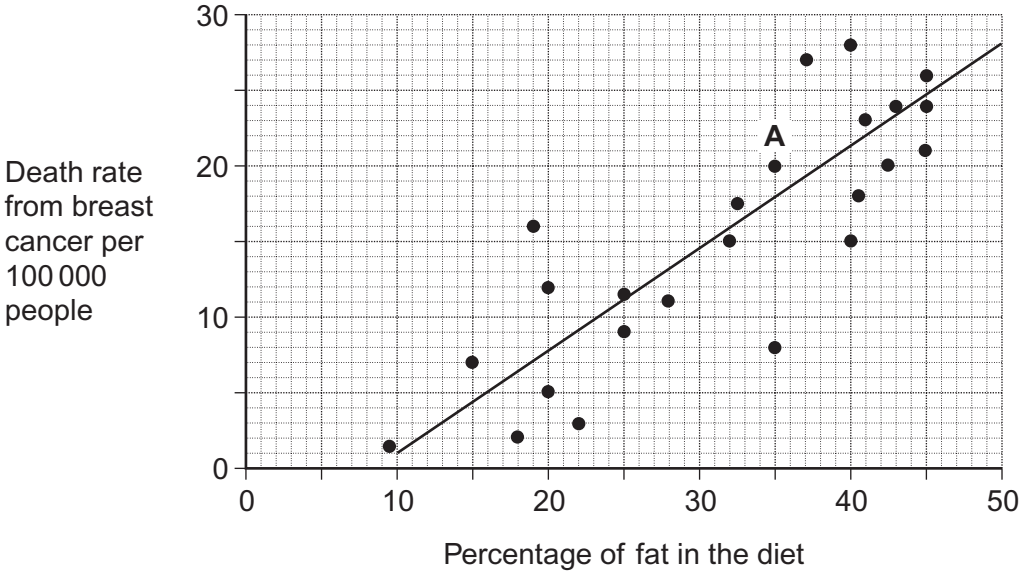
(2 marks)

9

2 Scientists investigated the relationship between the percentage of fat in the diet and the death rate from breast cancer in 24 different countries. They plotted the data from each country on the graph below.



2 (a) Describe the information given by point **A** on the graph.

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(1 mark)

2 (b) Describe how the scientists calculated the death rate from breast cancer for each country.

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(1 mark)

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2 (c) Some people have used the graph to conclude that a high percentage of fat in the diet causes breast cancer. Evaluate this conclusion.

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(3 marks)

(Extra space) .....

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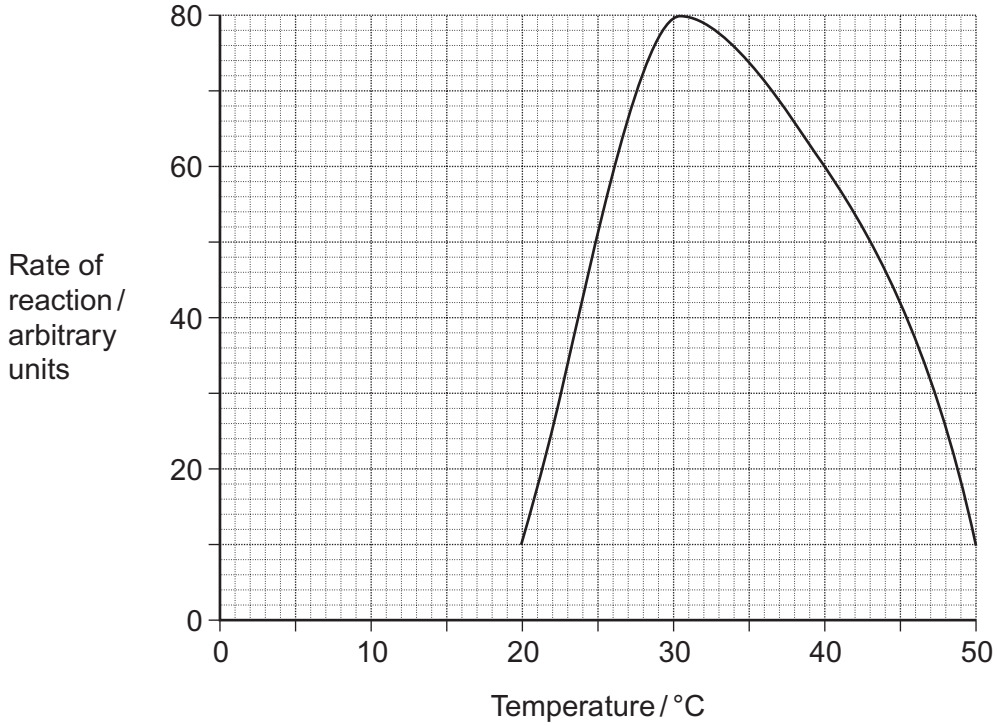
5

Turn over for the next question

3 A protease is an enzyme that digests protein. The graph shows how the activity of a protease varies with temperature.



3 (a) (i) Describe what the graph shows about the effect of temperature on the rate of reaction.

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(1 mark)

3 (a) (ii) Explain the shape of the curve between 30 °C and 50 °C.

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(3 marks)

(Extra space) .....

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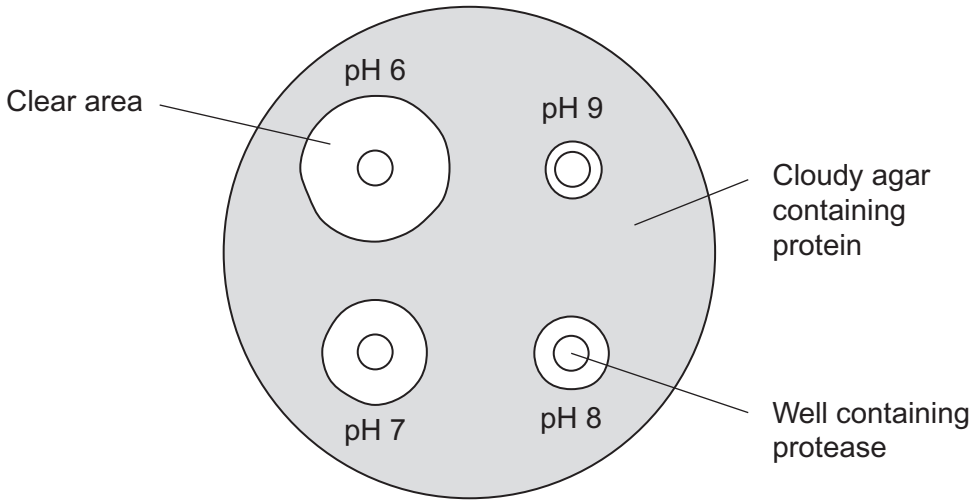
3 (b) Students investigated the effect of pH on the activity of the protease.

- The students used agar plates containing protein. The protein made the agar cloudy.
- They made four wells of equal size in the agar of each plate.
- They added a drop of protease solution to each of the wells. The protease solution in each well was at a different pH.
- The students incubated the agar plates for 4 hours at a constant temperature.

The diagram shows the agar plates after they were incubated and the pH of the protease solution in each well.



3 (b) (i) How should the students make sure that the pH of the protease solution did **not** change?

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(1 mark)

3 (b) (ii) Use the graph to suggest a suitable temperature for incubating the agar plates. Explain your answer.

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(1 mark)

3 (b) (iii) Use the diagram to describe the effect of pH on the activity of this protease.

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(1 mark)

7

4 A doctor measured the volume of air in the lungs of two people over a period of 7 seconds. Both people were resting. One person was healthy. The other had emphysema. The results are shown in the table.

Time / s	Volume of air in lungs / dm^3	
	Person **A**	Person **B**
0	6.5	7.0
1	3.8	6.0
2	3.0	5.6
3	2.3	5.1
4	2.0	4.8
5	1.7	4.5
6	1.6	4.2
7	1.6	3.9

4 (a) The two people were breathing out during the time shown. What evidence in the table supports this statement?

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(1 mark)

4 (b) Calculate the rate at which person **A** breathed air out of his lungs between 0 and 3 seconds. Show your working.

Answer ..... $dm^3\,s^{-1}$

(2 marks)

4 (c) Person **B** has emphysema. Give **one** piece of evidence from the table that shows this.

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(1 mark)

4 (d) Emphysema reduces the efficiency of gas exchange in the lungs. Explain why.

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(4 marks)

(Extra space) .....

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8

Turn over for the next question

5 (a) Give **two** ways in which active transport is different from facilitated diffusion.

1. .....

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2. .....

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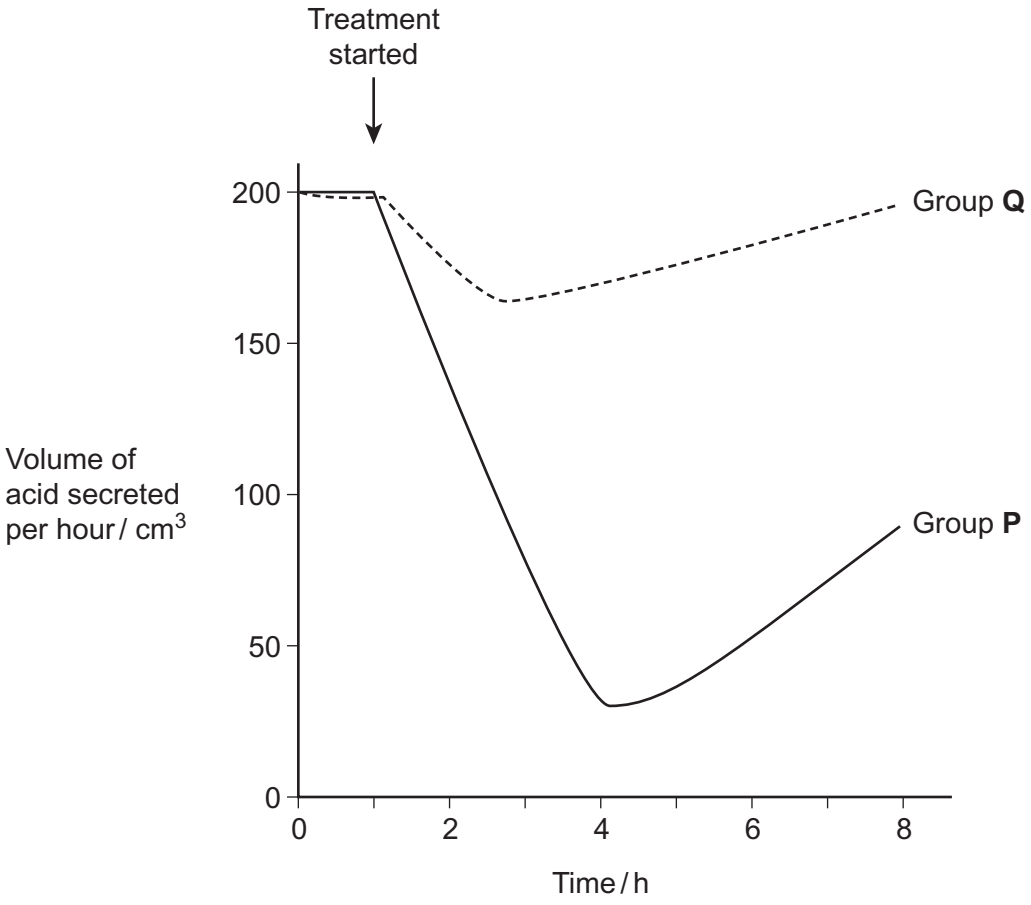
(2 marks)

Scientists investigated the effect of a drug called a proton pump inhibitor.
The drug is given as a tablet to people who produce too much acid in their stomach.
It binds to a carrier protein in the surface membrane of cells lining the stomach.
This carrier protein usually moves hydrogen ions into the stomach by active transport.

The scientists used two groups of people in their investigation. All the people produced too much acid in their stomach. People in group **P** were given the drug. Group **Q** was the control group.

The graph shows the results.



5 (b) (i) The scientists used a control group in this trial. Explain why.

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(1 mark)

5 (b) (ii) Suggest how the control group would have been treated.

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(2 marks)

5 (c) Describe the effect of taking the drug on acid secretion.

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(1 mark)

6

Turn over for the next question

6 The table shows pressure changes in the left side of the heart during one cardiac cycle.

	Blood pressure / kPa	
Time / s	**Left atrium**	**Left ventricle**
0.0	0.7	0.3
0.1	1.0	2.0
0.2	0.1	12.5
0.3	0.2	15.3
0.4	1.0	4.5
0.5	0.5	1.0
0.6	0.6	0.3
0.7	0.7	0.3

6 (a) Between which times is the valve between the atrium and the ventricle closed? Explain your answer.

Times …… s and …… s

Explanation .....

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(2 marks)

6 (b) The maximum pressure in the ventricle is much higher than that in the atrium. Explain what causes this.

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(2 marks)

6 (c) Use the information in the table to calculate the heart rate in beats per minute.

Answer ..... beats per minute
(1 mark)

5

Turn over for the next question

7 Read the following passage.

Chlamydia is a bacterium. Scientists have shown that infection with chlamydia can cause heart disease in humans. Infection with the bacterium can stimulate the formation of atheroma. This can lead to a heart attack.

Other scientists have been working with mice. These scientists have suggested that chlamydia may cause heart disease in a different way. They have found a protein on the surface of chlamydia cells which is similar to a protein in the heart muscle of mice. After an infection with chlamydia, cells of the immune system of the mice may attack their heart muscle cells and cause heart disease.

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

7 (a) Explain how atheroma can lead to a heart attack (line 3).

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(3 marks)

(Extra space) .....

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7 (b) (i) Using information from the passage, explain what is meant by an antigen.

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(2 marks)

7 (b) (ii) After an infection with chlamydia, cells of the immune system of the mice may attack the heart muscle cells (lines 7-8). Explain why.

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(2 marks)

7 (c) Some scientists have suggested that people should be vaccinated to prevent infection by chlamydia. Evaluate this suggestion.

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(3 marks)

(Extra space) .....

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10

Turn over for the next question

8 Different cells in the body have different functions.

8 (a) Some white blood cells are phagocytic. Describe how these phagocytic white blood cells destroy bacteria.

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(4 marks)

(Extra space) .....

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8 (b) The epithelial cells that line the small intestine are adapted for the absorption of glucose. Explain how.

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(6 marks)

(Extra space) .....

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10

END OF QUESTIONS

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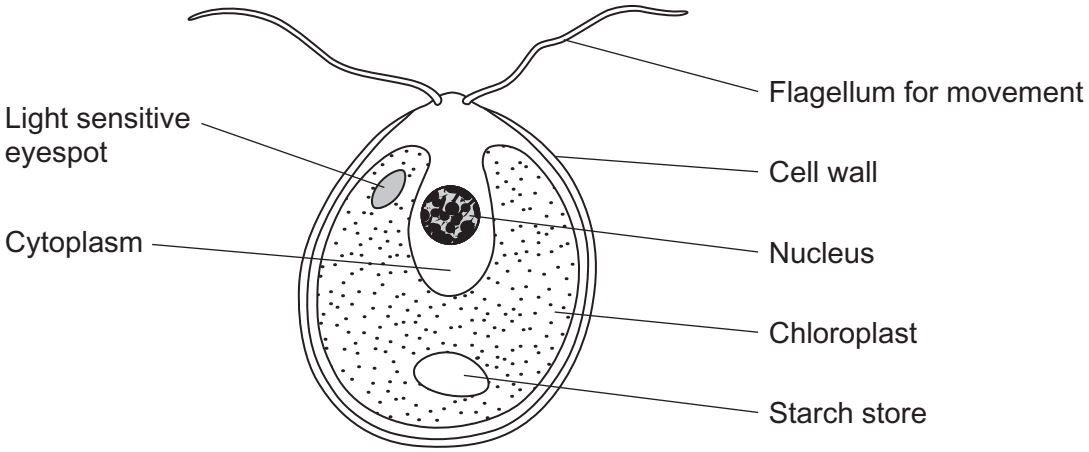
Answer **all** questions in the spaces provided.

1 The diagram shows an organism called *Chlamydomonas*.



1 (a) Name **two** structures shown in the diagram that are present in plant cells but are **not** present in animal cells.

1 .....

2 .....

(2 marks)

1 (b) *Chlamydomonas* lives in fresh water ponds. Use your knowledge of osmosis to suggest an advantage of using starch as a carbohydrate store.

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(2 marks)

Do not write outside the box

1 (c) *Chlamydomonas* has adaptations that help it to maintain a high rate of photosynthesis. Use information in the diagram to explain what these adaptations are.

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(3 marks)

(Extra space) .....

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7

2 (a) Explain what is meant by genetic diversity.

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(1 mark)

2 (b) Apart from genetic factors what other type of factor causes variation within a species?

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(1 mark)

2 (c) The spotted owl is a bird. Numbers of spotted owls have decreased over the past 50 years. Explain how this decrease may affect genetic diversity.

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(2 marks)

4

Do not write outside the box

3 The diagram shows a short sequence of DNA bases.

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

3 (a) (i) What is the maximum number of amino acids for which this sequence of DNA bases could code?

(1 mark)

3 (a) (ii) The number of amino acids coded for could be fewer than your answer to part **(a)(i)**. Give **one** reason why.

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(1 mark)

Do not write outside the box

3 (b) Explain how a change in the DNA base sequence for a protein may result in a change in the structure of the protein.

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(3 marks)

(Extra space) .....

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3 (c) A piece of DNA consisted of 74 base pairs. The two strands of the DNA, strands **A** and **B**, were analysed to find the **number** of bases of each type that were present. Some of the results are shown in the table.

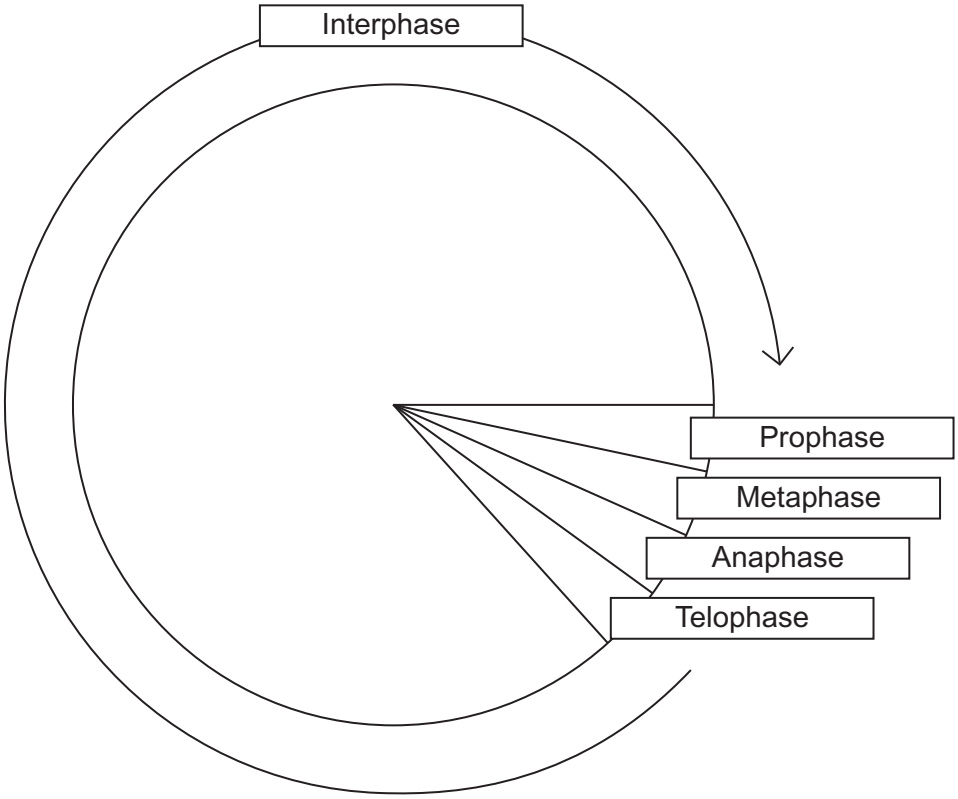
	Number of bases			
	C	G	A	T
Strand **A**	26			
Strand **B**	19		9	

Complete the table by writing in the missing values. *(2 marks)*

7

Do not write outside the box

4 The diagram shows a cell cycle.



4 (a) In prophase of mitosis, the chromosomes become visible. Describe what happens in

4 (a) (i) metaphase

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(2 marks)

4 (a) (ii) anaphase.

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(2 marks)

Do not write outside the box

4 (b) (i) Cells lining the human intestine complete the cell cycle in a short time. Explain the advantage of these cells completing the cell cycle in a short time.

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(1 mark)

4 (b) (ii) The time required for a cell to complete the cell cycle was 4 hours 18 minutes. Calculate the time required in minutes for this cell to multiply to produce eight cells. Show your working.

Answer .....

(2 marks)

4 (c) Mikanolide is a drug that inhibits the enzyme DNA polymerase. Explain why this drug may be effective against some types of cancer.

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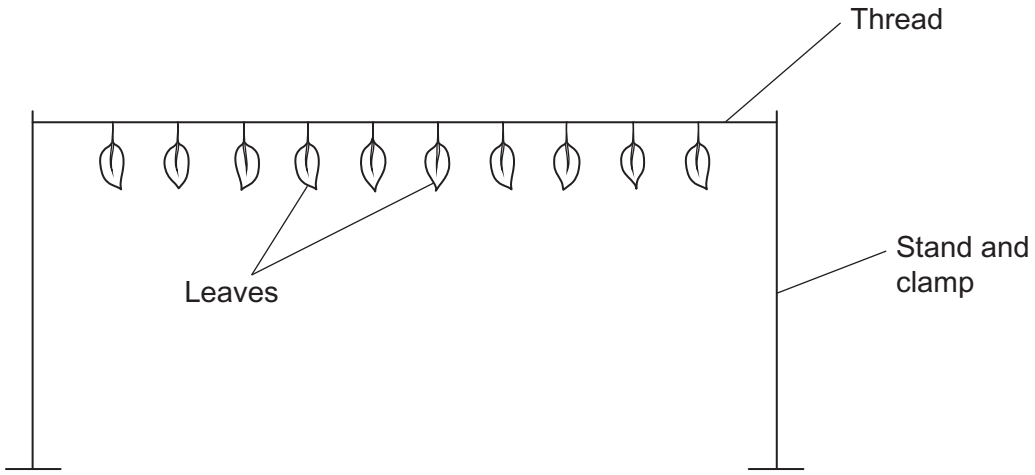
(2 marks)

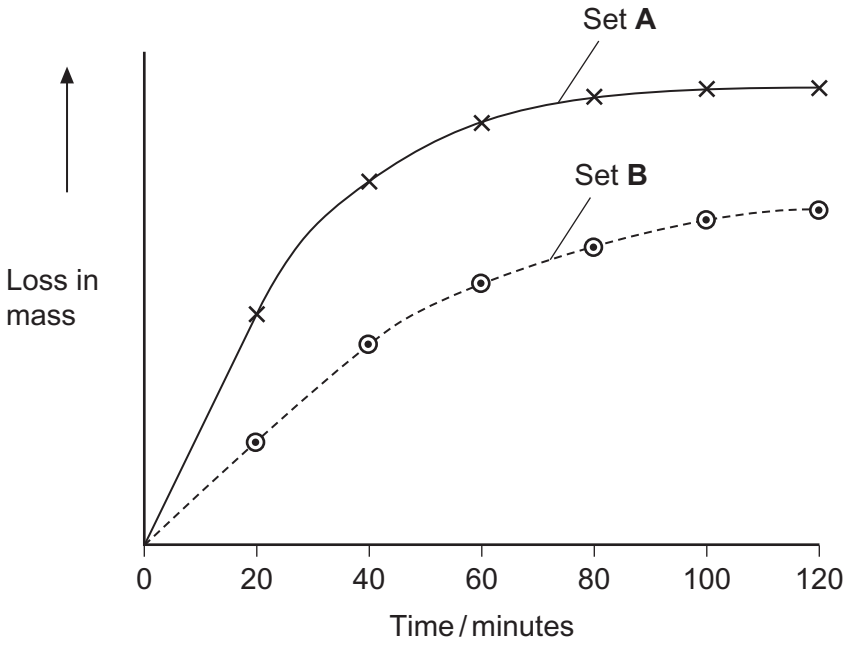
9

5 A student investigated the rate of transpiration from privet leaves.

- She obtained two sets of ten privet leaves.
- She left the ten leaves in set **A** untreated. She covered the upper surfaces of the ten leaves in set **B** with grease.
- She weighed each set of leaves and then tied all the leaves in each set to a separate length of thread. This is shown in the diagram.



- She then weighed each set of leaves every 20 minutes over a period of 2 hours and plotted a graph of her results.



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5 (a) Give **two** environmental conditions that the student should have kept constant during this investigation.

1 .....

2 .....

(2 marks)

5 (b) The student measured the water loss in milligrams. Explain the advantage of using ten leaves when taking measurements in milligrams.

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(1 mark)

5 (c) Explain the change in mass of untreated leaves in set **A** shown in the graph.

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(3 marks)

(Extra space) .....

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5 (d) The results that the student obtained for the leaves in set **B** were different from those for set **A**. Suggest an explanation for this difference.

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(2 marks)

8

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ANSWER IN THE SPACES PROVIDED

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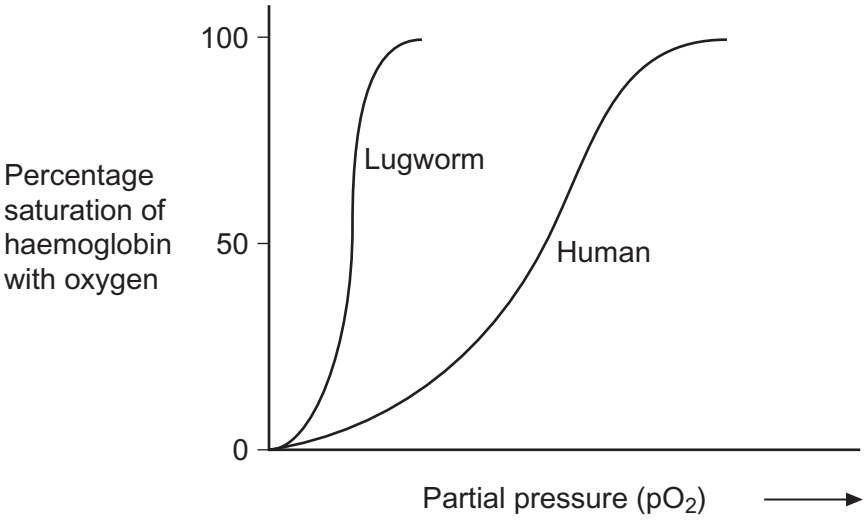
6 Lugworms live in mud where the partial pressure of oxygen is low. The graph shows oxygen dissociation curves for a lugworm and for a human.



6 (a) Explain the advantage to the lugworm of having haemoglobin with a dissociation curve in the position shown.

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(2 marks)

6 (b) In humans, substances move out of the capillaries to form tissue fluid. Describe how this tissue fluid is returned to the circulatory system.

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(3 marks)

(Extra space) .....

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5

7 Cranes are large birds. One of the earliest methods of classifying cranes was based on the calls they make during the breeding season.

7 (a) Explain why biologists could use calls to investigate relationships between different species of crane.

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(2 marks)

7 (b) More recently, biologists have used DNA hybridisation to confirm the relationships between different species of crane. They made samples of hybrid DNA from the same and from different species. They measured the percentage of hybridisation of each sample. The results are shown in the table.

Species of crane from which hybrid DNA was made			**Percentage DNA hybridisation**
Grus americana	and	*Grus monachus*	97.4
Grus monachus	and	*Grus rubicunda*	95.7
Grus americana	and	*Grus rubicunda*	95.5
Grus rubicunda	and	*Grus rubicunda*	99.9
Grus americana	and	*Grus americana*	99.9
Grus monachus	and	*Grus monachus*	99.8

7 (b) (i) Which **two** species seem to be the most closely related? Explain your answer.

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(2 marks)

7 (b) (ii) The biologists measured the temperatures at which the samples of hybrid DNA separated into single strands. Explain why these temperatures could be used to find the percentage of DNA hybridisation.

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(2 marks)

7 (c) Biologists can also use protein structure to investigate the relationship between different species of crane. Explain why.

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(2 marks)

8

Turn over for the next question

8 Costa Rica is a Central American country. It has a high level of species diversity.

8 (a) There are over 12 000 species of plants in Costa Rica. Explain how this has resulted in a high species diversity of animals.

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(2 marks)

8 (b) The number of species present is one way to measure biodiversity. Explain why an index of diversity may be a more useful measure of biodiversity.

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(2 marks)

8 (c) Crops grown in Costa Rica are sprayed with pesticides. Pesticides are substances that kill pests. Scientists think that pollution of water by pesticides has reduced the number of species of frog.

8 (c) (i) Frogs lay their eggs in pools of water. These eggs are small. Use this information to explain why frogs' eggs are very likely to be affected by pesticides in the water.

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(2 marks)

8 (c) (ii) An increase in temperature leads to evaporation of water. Suggest how evaporation may increase the effect of pesticides on frogs' eggs.

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(1 mark)

7

Turn over for the next question

9 Erythropoietin (EPO) is a substance produced in the body. It increases the production of red blood cells. Synthetic EPO is made artificially. It is used to treat patients who have a form of anaemia in which there is a reduced number of red blood cells. Scientists investigated the effect of synthetic EPO on volunteers with this form of anaemia.

- The scientists injected synthetic EPO in a salt solution into patients in the experimental groups. They also set up control groups.
- They gave the different experimental groups different doses of synthetic EPO and different lengths of treatment.
- At the beginning and end of the treatment, the scientists measured each patient's haemoglobin concentration. From these measurements, they calculated the mean increase in haemoglobin concentration.

Some of the results are shown in the table.

Number of volunteers	Length of treatment / weeks	Dose of synthetic EPO / units per kilogram per week	Mean increase in haemoglobin concentration / arbitrary units
58	8	85	19.0
18	8	170	26.0
40	12	150	12.5
82	12	450	34.2
46	24	120	23.0
53	24	240	31.0

9 (a) Explain why treatment with synthetic EPO affects the haemoglobin concentration in these volunteers.

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(2 marks)

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9 (b) Suggest how the control groups should have been treated in this investigation.

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(2 marks)

9 (c) The scientists measured the dose of synthetic EPO per kilogram per week. Explain why they measured the dose per unit mass and per unit time.

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(2 marks)

9 (d) Explain how the information that the scientists collected might be useful in treating patients with anaemia.

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(2 marks)

Question 9 continues on the next page

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9 (e) Some athletes have used synthetic EPO as a performance enhancer. Explain how synthetic EPO may improve performance in long-distance events.

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(4 marks)

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9 (f) Athletes may be tested to see if the concentration of EPO in their blood is above normal. Suggest how scientists determine the normal concentration of EPO in blood.

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(2 marks)

9 (g) Synthetic EPO can increase blood pressure. Suggest why.

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(1 mark)

15

10 (a) *Clostridium difficile* is a bacterium that is present in the gut of up to 3% of healthy adults and 66% of healthy infants.

10 (a) (i) *C. difficile* rarely causes problems, either in healthy adults or in infants. This is because its numbers are kept low by competition with harmless bacteria that normally live in the intestine.

Use this information to explain why some patients treated with antibiotics can be affected by *C. difficile*.

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(2 marks)

10 (a) (ii) Suggest why older people are more likely to be affected by *C. difficile*.

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(1 mark)

10 (b) The antibiotic methicillin inhibits the enzyme transpeptidase. This enzyme is used by some bacteria to join monomers together during cell wall formation. Methicillin has a similar structure to these monomers. Use this information to explain how methicillin inhibits the enzyme transpeptidase.

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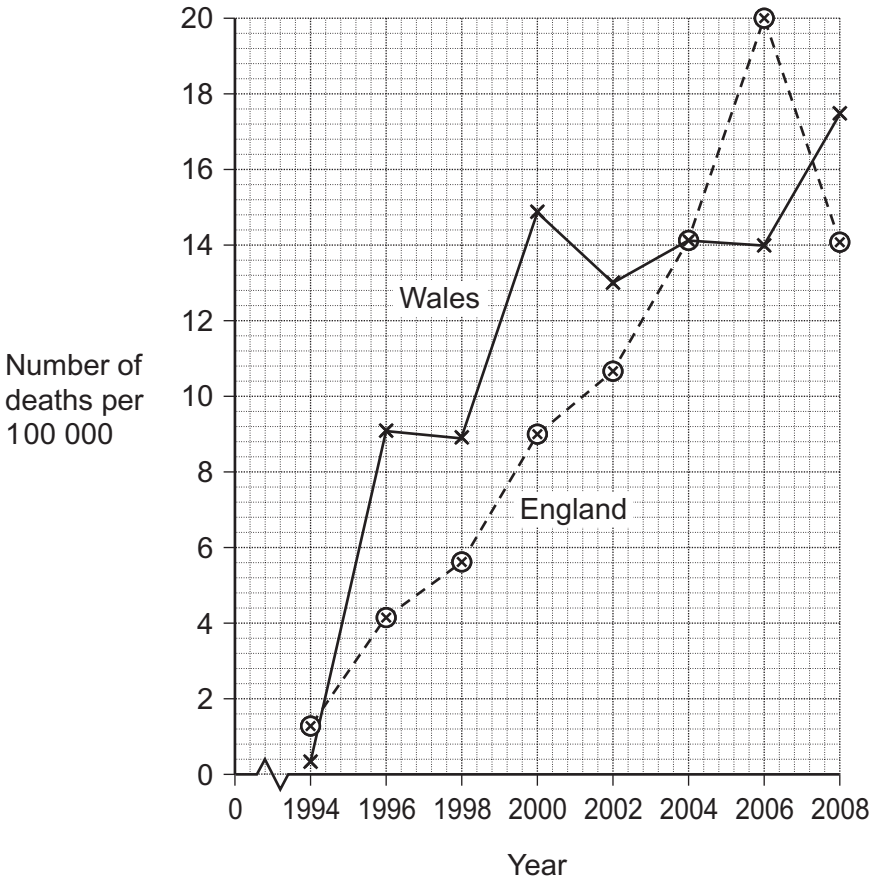
(2 marks)

10 (c) MRSA is a variety of *Staphylococcus aureus*. It is difficult to treat infections caused by this bacterium because it is resistant to methicillin and to some other antibiotics. As a result, some patients who are already very ill may die if they become infected with MRSA. The graph shows the number of deaths in England and Wales between 1994 and 2008 caused by MRSA.



10 (c) (i) It may be difficult to identify MRSA as the actual cause of death. Explain why.

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(1 mark)

10 (c) (ii) Describe the change in the number of deaths caused by MRSA in England in the period shown in the graph.

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(1 mark)

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10 (c) (iii) Calculate the percentage increase in the number of deaths caused by MRSA in Wales from 1996 to 2006. Show your working.

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

10 (d) Describe how gene transmission and selection have increased the difficulty of treating bacterial infections with antibiotics.

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(6 marks)

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END OF QUESTIONS

15

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

1 (a) The table contains statements about three biological processes.

Complete the table with a tick if the statement in the first column is true, for each process.

	Photosynthesis	**Anaerobic respiration**	**Aerobic respiration**
ATP produced			
Occurs in organelles			
Electron transport chain involved			

(3 marks)

1 (b) Write a simple equation to show how ATP is synthesised from ADP.

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(1 mark)

1 (c) Give **two** ways in which the properties of ATP make it a suitable source of energy in biological processes.

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(2 marks)

1 (d) Humans synthesise more than their body mass of ATP each day. Explain why it is necessary for them to synthesise such a large amount of ATP.

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(2 marks)

8

Turn over for the next question

2 Scientists measured the mean temperature in a field each month between March and October. The table shows their results.

Month	Mean temperature / °C
March	9
April	11
May	14
June	17
July	20
August	18
September	16
October	14

2 (a) The gross productivity of the plants in the field was highest in July. Use the data in the table to explain why.

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(2 marks)

2 (b) (i) Give the equation that links gross productivity and net productivity.

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(1 mark)

2 (b) (ii) The net productivity of the plants in the field was higher in August than in July. Use the equation in part **(b)(i)** and your knowledge of photosynthesis and respiration to suggest why.

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(2 marks)

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2 (c) A horse was kept in the field from March to October. During the summer months, the horse was able to eat more than it needed to meet its minimum daily requirements.

Suggest how the horse used the extra nutrients absorbed.

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(1 mark)

2 (d) The horse's mean energy expenditure was higher in March than it was in August. Use information in the table to suggest why.

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(2 marks)

8

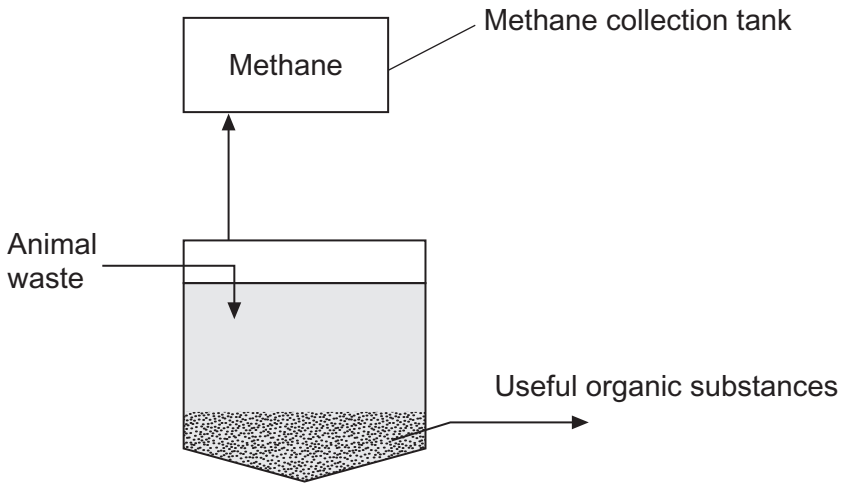
Turn over for the next question

Do not write outside the box

3 Intensive rearing of livestock produces large quantities of waste. Some farmers use an anaerobic digester to get rid of the waste.

In an anaerobic digester, microorganisms break down the large, organic molecules in the waste. This produces methane, which is a useful fuel. It also produces organic substances that can be used as a natural fertiliser.

The diagram shows an anaerobic digester.



3 (a) (i) Suggest **two** advantages of processing waste in anaerobic digesters rather than in open ponds.

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2 .....

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(2 marks)

3 (a) (ii) The anaerobic digester has a cooling system, which is not shown in the diagram. Without this cooling system the digester would soon stop working. Explain why.

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(2 marks)

3 (b) (i) The over-application of fertiliser increases the rate of leaching. Explain the consequences of leaching of fertiliser into ponds and lakes.

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(3 marks)

(*Extra Space)* .....

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3 (b) (ii) Give **one** advantage of using natural fertiliser produced in the digester rather than an artificial fertiliser.

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(1 mark)

8

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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4 (a) Explain what is meant by birth rate.

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(1 mark)

4 (b) The table shows life expectancies for babies born in the United Kingdom and in the Sudan in 2009.

	United Kingdom	**Sudan**
Life expectancy males / years	76.5	50.5
Life expectancy females / years	81.6	52.4

4 (b) (i) Describe the patterns shown by these data.

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(2 marks)

4 (b) (ii) Suggest reasons for the differences in the life expectancy shown by these data.

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(2 marks)

5

5 A breeder crossed a black male cat with a black female cat on a number of occasions. The female cat produced 8 black kittens and 4 white kittens.

5 (a) (i) Explain the evidence that the allele for white fur is recessive.

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(1 mark)

5 (a) (ii) Predict the likely ratio of colours of kittens born to a cross between **this** black male and a white female.

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(1 mark)

5 (b) The gene controlling coat colour has three alleles. The allele **B** gives black fur, the allele **b** gives chocolate fur and the allele $\mathbf{b^i}$ gives cinnamon fur.

- Allele **B** is dominant to both allele **b** and $\mathbf{b^i}$.
- Allele **b** is dominant to allele $\mathbf{b^i}$.

5 (b) (i) Complete the table to show the phenotypes of cats with each of the genotypes shown.

Genotype	Phenotype
$\mathbf{Bb^i}$	
$\mathbf{bb^i}$	
Bb	

(1 mark)

A chocolate male was crossed several times with a black female.
They produced

- 11 black kittens
- 2 chocolate kittens
- 5 cinnamon kittens.

5 (b) (ii) Using the symbols given on the previous page, complete the genetic diagram to show the results of this cross.

Parental phenotypes	Chocolate male		Black female
Parental genotypes	……		……
Gametes	……		……
Offspring genotypes	……	……	……
Offspring phenotypes	Black	Chocolate	Cinnamon

(3 marks)

5 (b) (iii) The breeder had expected equal numbers of chocolate and cinnamon kittens from the cross between the chocolate male and black female. Explain why the actual numbers were different from those expected.

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(1 mark)

5 (b) (iv) The breeder wanted to produce a population of cats that would all have chocolate fur. Is this possible? Explain your answer.

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(2 marks)

9

6 Sea otters were close to extinction at the start of the 20th century. Following a ban on hunting sea otters, the sizes of their populations began to increase. Scientists studied the frequencies of two alleles of a gene in one population of sea otters. The dominant allele, **T**, codes for an enzyme. The other allele, **t**, is recessive and does not produce a functional enzyme.

In a population of sea otters, the allele frequency for the recessive allele, **t**, was found to be 0.2.

6 (a) (i) Use the Hardy-Weinberg equation to calculate the percentage of homozygous recessive sea otters in this population. Show your working.

Answer ..... %

(2 marks)

6 (a) (ii) What does the Hardy-Weinberg principle predict about the frequency of the **t** allele after another 10 generations?

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(1 mark)

6 (b) Several years later, scientists repeated their study on this population. They found that the frequency of the recessive allele had decreased.

6 (b) (i) A statistical test showed that the difference between the two frequencies of the **t** allele was significant at the P = 0.05 level.

Use the terms **probability** and **chance** to help explain what this means.

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(2 marks)

6 (b) (ii) What type of natural selection appears to have occurred in this population of sea otters? Explain how this type of selection led to a decrease in the frequency of the recessive allele.

Type of selection .....

Explanation .....

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(2 marks)

7

7 Parasites are organisms that live on or in host organisms. The populations of many organisms may be reduced by the effects of parasites.

Feather mites are small parasites found on the wing feathers of many birds. The mites feed on the oil that the birds produce. This oil keeps the feathers in good condition. Birds unable to oil their feathers properly use more energy in maintaining their body temperature. This results in less energy being available for other processes.

Scientists investigated the relationship between the numbers of feather mites and the breeding success of one species of bird, the great tit.

7 (a) Use the information above to suggest how feather mites could affect breeding in great tits.

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(2 marks)

7 (b) The scientists located a large number of great tit nests. They sampled these at random.

For each nest they recorded

- the total number of eggs laid
- the number of chicks that hatched from the eggs
- the number of chicks that survived to leave the nest
- the total number of feather mites on the two parent birds.

7 (b) (i) Explain why the scientists sampled the nests at random.

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(2 marks)

The scientists calculated the percentage of each pair's eggs from which chicks survived to leave the nest. They called this 'breeding success per pair'.

The table shows some of the data that the scientists obtained.

Total number of feather mites on both parent birds	Breeding success per pair
0	86
2	100
5	64
10	82
14	70
15	85
170	42

7 (b) (ii) Do these data support the hypothesis that the presence of feather mites reduces the ability of great tits to reproduce successfully? Give reasons for your answer.

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(3 marks)

(*Extra Space)* .....

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Question 7 continues on the next page

7 (c) The scientists calculated a correlation coefficient for these data.

7 (c) (i) State a null hypothesis that would be appropriate for this investigation.

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(1 mark)

7 (c) (ii) The correlation coefficient that they obtained had a negative value. What does a negative value indicate about these data?

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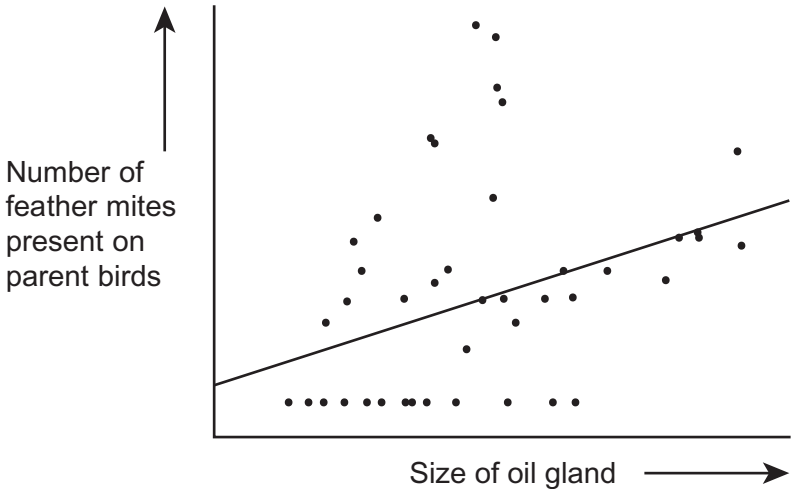
(1 mark)

7 (d) The oil that a great tit puts on its feathers is made in an oil gland at the base of the tail. The bird uses its beak to spread the oil over its feathers. This is called preening. Preening takes place in early morning and evening and empties the oil gland each time. After preening, the oil gland is considerably smaller.

At the same time that the scientists recorded the number of feather mites on each great tit, they also measured the size of the oil gland. The graph shows their results and includes the scientist's line of best fit.



7 (d) (i) Describe the relationship between the number of feather mites present on each great tit and the size of the oil gland.

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(2 marks)

7 (d) (ii) Explain how measuring the oil gland at the same time as counting the feather mites may have affected the reliability of the data.

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(2 marks)

7 (e) Feather mites eat pathogenic bacteria and fungi as well as oil. Explain how this may affect the breeding success of the birds.

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(2 marks)

15

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8 Much of Indonesia is covered with forest. Large areas of forest have been cleared and planted with oil-palm trees to be used in the production of fuel.

8 (a) In these forests, nitrogen in dead leaves is made available to growing plants by the action of bacteria. Describe the role of bacteria in making the nitrogen in dead leaves available to growing plants.

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(5 marks)

(Extra space) .....

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8 (b) Clearing the forests and burning the vegetation affects the carbon dioxide concentration in the atmosphere.
Describe how and explain why.

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(4 marks)

(Extra space) .....

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Question 8 continues on the next page

8 (c) During photosynthesis, oil-palm trees convert carbon dioxide into organic substances. Describe how.

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(6 marks)

(Extra space) .....

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15

END OF QUESTIONS

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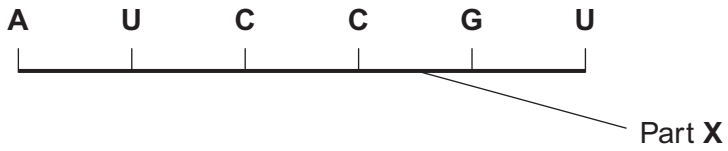
Answer **all** questions in the spaces provided.

1 The diagram shows part of a pre-mRNA molecule.



1 (a) (i) Name the **two** substances that make up part **X**.

..... and .....

(1 mark)

1 (a) (ii) Give the sequence of bases on the DNA strand from which this pre-mRNA has been transcribed.

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(1 mark)

1 (b) (i) Give **one** way in which the structure of an mRNA molecule is different from the structure of a tRNA molecule.

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(1 mark)

1 (b) (ii) Explain the difference between pre-mRNA and mRNA.

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(1 mark)

1 (c) The table shows the percentage of different bases in two pre-mRNA molecules. The molecules were transcribed from the DNA in different parts of a chromosome.

Part of chromosome	Percentage of base			
	A	**G**	**C**	**U**
Middle	38	20	24	
End	31	22	26	

1 (c) (i) Complete the table by writing the percentage of uracil (U) in the appropriate boxes.

(1 mark)

1 (c) (ii) Explain why the percentages of bases from the middle part of the chromosome and the end part are different.

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(2 marks)

7

Turn over for the next question

Do not write outside the box

2 Different substances are involved in coordinating responses in animals.

2 (a) Hormones are different from local chemical mediators such as histamine in the cells they affect.

2 (a) (i) Describe how hormones are different in the cells they affect.

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(1 mark)

2 (a) (ii) Describe how hormones and local chemical mediators reach the cells they affect.

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(2 marks)

2 (b) Synapses are unidirectional. Explain how acetylcholine contributes to a synapse being unidirectional.

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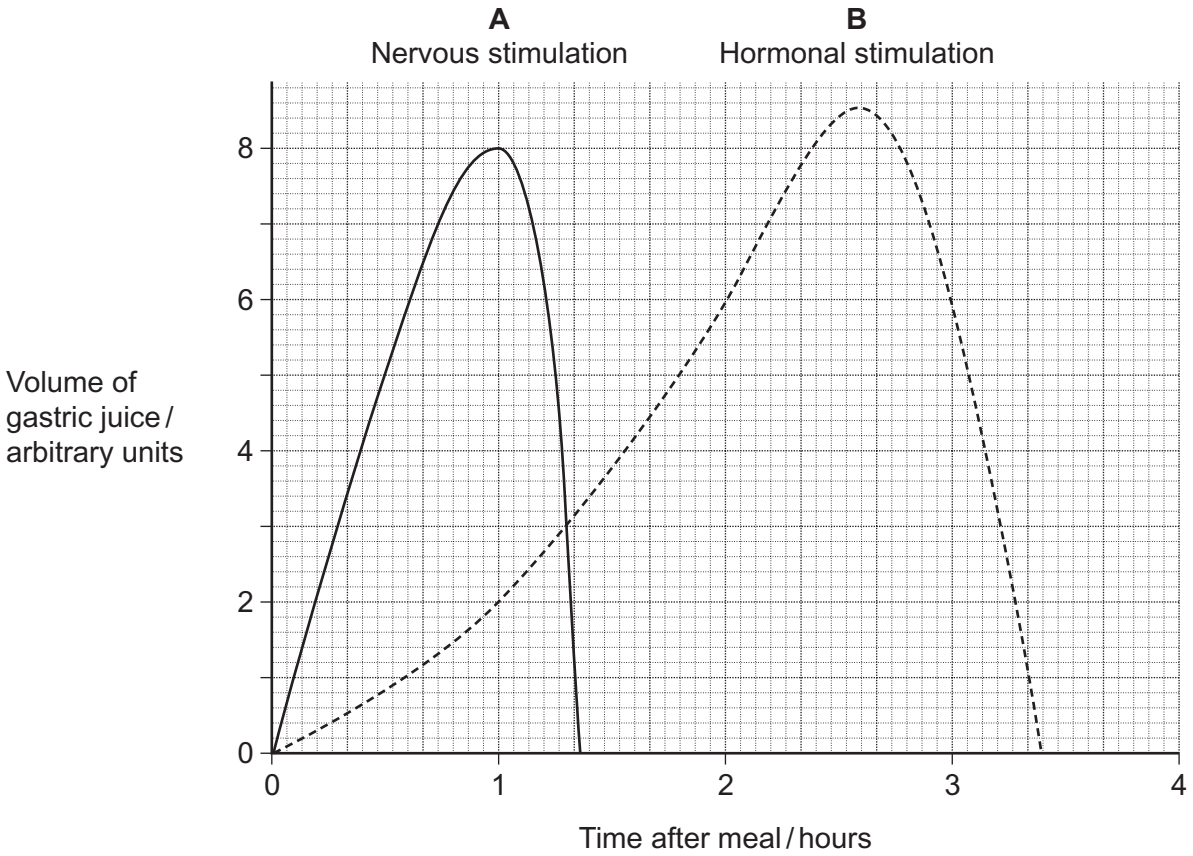
(2 marks)

2 (c) Cells in the stomach wall release gastric juice after a meal. The graph shows how the volumes of gastric juice produced by nervous stimulation and by hormonal stimulation change after a meal.



2 (c) (i) Describe the evidence from the graph that curve **A** represents the volume of gastric juice produced by nervous stimulation.

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(2 marks)

2 (c) (ii) Complete the table to show the percentage of gastric juice produced by nervous stimulation at the times shown.

	Time after meal / hours		
	1	**2**	**3**
Percentage of gastric juice produced by nervous stimulation			

(1 mark)

8

3 IAA is a specific growth factor.

3 (a) Name the process by which IAA moves from the growing regions of a plant shoot to other tissues.

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(1 mark)

3 (b) When a young shoot is illuminated from one side, IAA stimulates growth on the shaded side. Explain why growth on the shaded side helps to maintain the leaves in a favourable environment.

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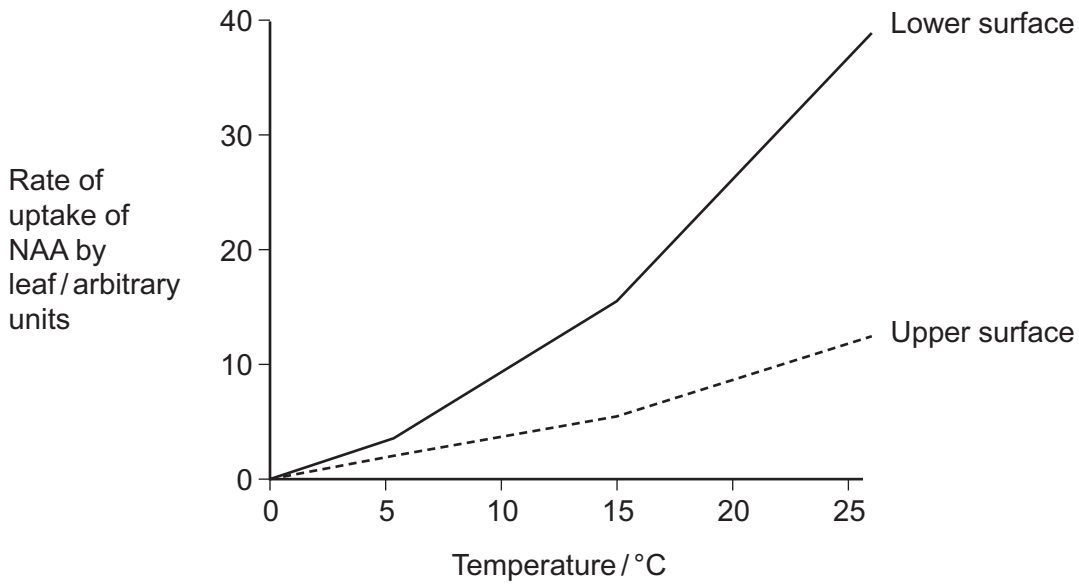
(2 marks)

NAA is a similar substance to IAA. It is used to control the growth of cultivated plants. Plant physiologists investigated the effect of temperature on the uptake of NAA by leaves. They sprayed a solution containing NAA on the upper and lower surfaces of a leaf. The graph shows their results.



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3 (c) Explain the effect of temperature on the rate at which NAA is taken up by the lower surface of the leaf.

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(2 marks)

3 (d) There are differences in the properties of the cuticle on the upper and lower surfaces of leaves.

3 (d) (i) Suggest how these differences in the cuticle might explain the differences in rates of uptake of NAA by the two surfaces.

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(2 marks)

3 (d) (ii) In this investigation, the physiologists investigated the leaves of pear trees. Explain why the results might be different for other species.

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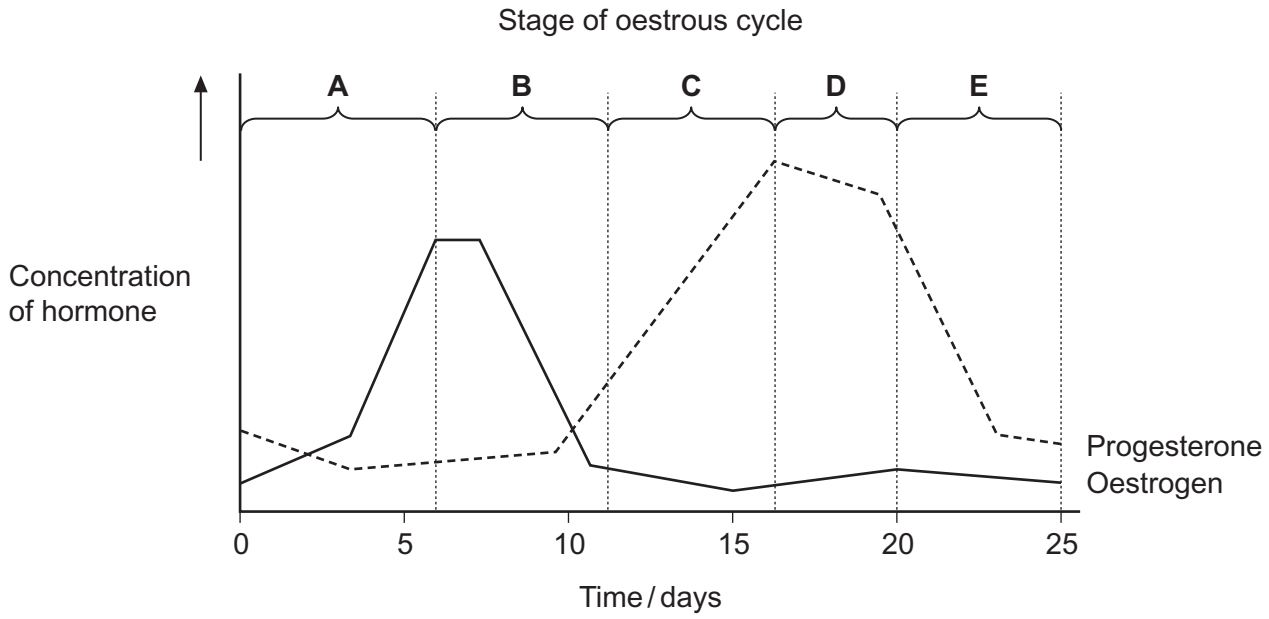
(1 mark)

8

4 The graph shows the concentrations of two hormones in the blood of an adult female pig over 25 days.



4 (a) (i) Use the graph to give the letter of the stage where ovulation occurred.

(1 mark)

4 (a) (ii) Give **one** piece of evidence from the graph that this pig was **not** pregnant at 25 days.

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(1 mark)

4 (b) The relationship between oestrogen and LH is an example of positive feedback. Explain how.

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(2 marks)

4 (c) Farmers sometimes give progesterone to sheep to prevent ovulation. Explain how progesterone prevents ovulation.

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(2 marks)

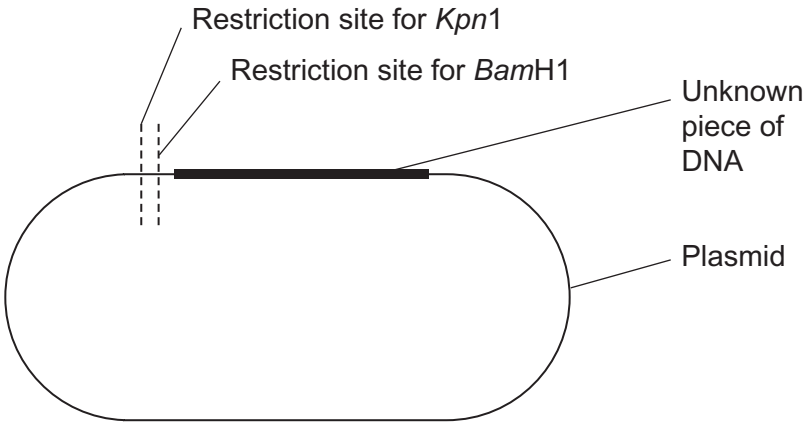
6

Turn over for the next question

5 Scientists used restriction mapping to investigate some aspects of the base sequence of an unknown piece of DNA. This piece of DNA was 3 000 base pairs (bp) long.

The scientists took plasmids that had one restriction site for the enzyme *Kpn*1 and one restriction site for the enzyme *Bam*H1. They inserted copies of the unknown piece of DNA into the plasmids. This produced recombinant plasmids.

The diagram shows a recombinant plasmid.



5 (a) When the scientists digested one of the recombinant plasmids with *Kpn*1, they obtained two fragments. One fragment was measured as 1 000 bp.
The other fragment was described as "very large".

5 (a) (i) What does this show about the base sequence of the unknown piece of DNA?

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(2 marks)

5 (a) (ii) One of the fragments that the scientists obtained was described as "very large".
What is represented by this very large fragment?

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(1 mark)

5 (b) When the scientists digested another of the recombinant plasmids with *Bam*H1, they obtained three fragments.

How many *Bam*H1 restriction sites are there in the unknown piece of DNA?

(1 mark)

5 (c) (i) Scientists can separate fragments of DNA using electrophoresis. Suggest how they can use electrophoresis to estimate the number of base pairs in the separated fragments.

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(2 marks)

5 (c) (ii) Scientists need to take precautions when they carry out restriction mapping. They need to make sure that the enzyme they have used has completely digested the DNA. One check they may carry out is to add the sizes of the fragments together. How could scientists use this information to show that the DNA has **not** been completely digested? Explain your answer.

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(2 marks)

8

6 Plant physiologists attempted to produce papaya plants using tissue culture.
They investigated the effects of different concentrations of two plant growth factors on small pieces of the stem tip from a papaya plant. Their results are shown in the table.

Concentration of auxin / μmol dm^{-3}	Concentration of cytokinin / μmol dm^{-3}		
	5	25	50
0	No effect	No effect	Leaves produced
1	No effect	Leaves produced	Leaves produced
5	No effect	Leaves produced	Leaves and some plantlets produced
10	Callus produced	Leaves and some plantlets produced	Plantlets produced
15	Callus produced	Callus and some leaves produced	Callus and some leaves produced

Callus is a mass of undifferentiated plant cells.
Plantlets are small plants.

6 (a) Explain the evidence from the table that cells from the stem tip are totipotent.

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(2 marks)

6 (b) Calculate the ratio of cytokinin : auxin that you would recommend to grow papaya plants by this method.

Answer .....

(2 marks)

6 (c) (i) Papaya plants reproduce sexually by means of seeds. Papaya plants grown from seeds are very variable in their yield. Explain why.

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(2 marks)

6 (c) (ii) Explain the advantage of growing papaya plants from tissue culture rather than from seeds.

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(1 mark)

7

Turn over for the next question

7 (a) Desert iguanas are lizards that live in hot, dry conditions. Scientists measured the rate of oxygen consumption of desert iguanas at different body temperatures. Some of their results are shown in the table.

Body temperature / °C	Mean rate of oxygen consumption at rest / $cm^3\ g^{-1}\ h^{-1}$
25	0.4
30	0.7
35	1.2
40	1.5

7 (a) (i) Explain how an increase in the iguana's body temperature affects its oxygen consumption when it is at rest.

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(3 marks)

(Extra space) .....

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7 (a) (ii) The units in the table allowed the scientists to compare the oxygen consumptions of different iguanas. Explain how.

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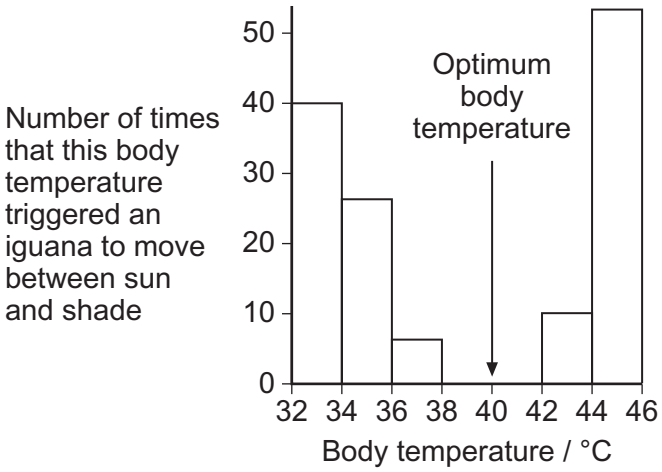
(1 mark)

7 (b) The scientists then investigated how body temperature affected the behaviour of desert iguanas. They kept the iguanas in cages. Half of each cage was in the sun and half was covered to provide shade. The scientists continuously measured the body temperature of each iguana. They also recorded the body temperature when the iguana moved between sun and shade. Their results are shown in the graph.



7 (b) (i) Describe how the movements of the iguanas between sun and shade are related to body temperature.

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(1 mark)

7 (b) (ii) The behaviour of the desert iguanas keeps their body temperatures within a narrow range. Explain how.

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(2 marks)

7 (c) At high temperatures, a desert iguana keeps its mouth wide open and breathes in and out rapidly. This is called panting. Explain how panting helps to reduce the body temperature of an iguana.

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(2 marks)

9

8 (a) Transcriptional factors are important in the synthesis of particular proteins. Describe how.

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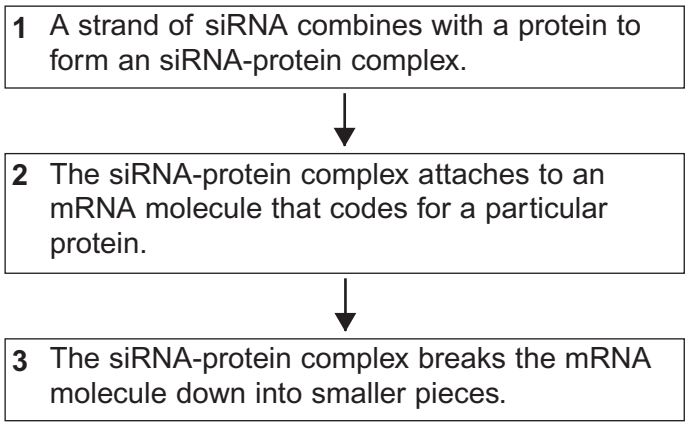
(2 marks)

8 (b) The flowchart shows how small interfering RNA (siRNA) affects the expression of a particular target gene.



8 (b) (i) The siRNA-protein complex attaches to an mRNA molecule coding for a particular protein (step **2**). Explain what causes the siRNA to attach only to one sort of mRNA molecule.

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(1 mark)

8 (b) (ii) Describe and explain how expression of the target gene is affected by siRNA.

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(2 marks)

8 (b) (iii) Scientists have suggested that siRNA may be useful in treating some diseases. Suggest why siRNA may be useful in treating disease.

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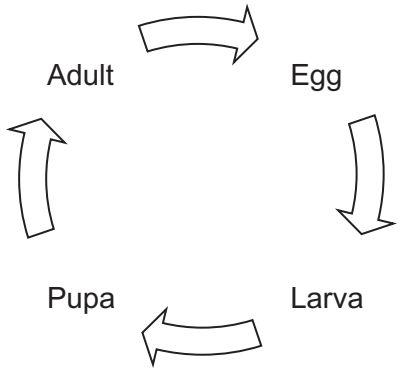
(2 marks)

7

Turn over for the next question

9 The diagram shows the life cycle of a fly.



When the larva is fully grown, it changes into a pupa. The pupa does not feed. In the pupa, the tissues that made up the body of the larva are broken down. New adult tissues are formed from substances obtained from these broken-down tissues and from substances that were stored in the body of the larva.

9 (a) Hydrolysis and condensation are important in the formation of new adult proteins. Explain how.

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(2 marks)

9 (b) Most of the protein stored in the body of a fly larva is a protein called calliphorin. Explain why different adult proteins can be made using calliphorin.

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(1 mark)

The table shows the mean concentration of RNA in fly pupae at different ages.

Age of pupa as percentage of total time spent as a pupa	Mean concentration of RNA / µg per pupa
0	20
20	15
40	12
60	17
80	33
100	20

9 (c) Describe how the concentration of RNA changes during the time spent as a pupa.

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(2 marks)

9 (d) (i) Describe how you would expect the number of lysosomes in a pupa to change with the age of the pupa. Give a reason for your answer.

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(2 marks)

9 (d) (ii) Suggest an explanation for the change in RNA concentration in the first 40 % of the time spent as a pupa.

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(2 marks)

9 (e) Suggest an explanation for the change in RNA concentration between 60 and 80 % of the time spent as a pupa.

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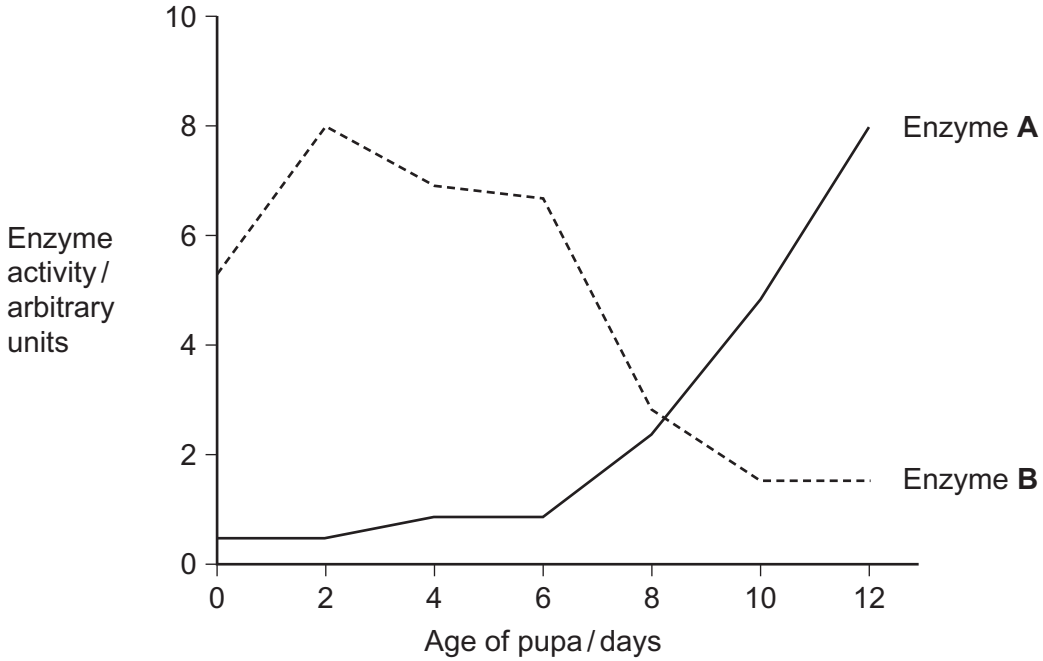
(2 marks)

Question 9 continues on the next page

9 (f) The graph shows changes in the activity of two respiratory enzymes in a fly pupa.

- Enzyme **A** catalyses a reaction in the Krebs cycle
- Enzyme **B** catalyses the formation of lactate from pyruvate



During the first 6 days as a pupa, the tracheae break down. New tracheae are formed after 6 days. Use this information to explain the change in activity of the two enzymes.

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(4 marks)

(Extra space) .....

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15

Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) Using DNA in science and technology

(25 marks)

OR

10 (b) A cycle is a biological pathway or process in which the end product of one cycle becomes the starting point for the next cycle. Write an essay about cycles in biology.

(25 marks)

If you want to make a plan write it here.

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END OF QUESTIONS

Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Molecules are transported into and out of cells by several mechanisms.

(a) Read through the following passage that describes some of these mechanisms, then write on the dotted lines the most appropriate word or words to complete the passage.

(4)

Some molecules move across a cell surface membrane by passing down a concentration gradient, through the phospholipid bilayer. The movement of some polar molecules across the membrane involves carrier and channel ..... molecules. When this movement occurs down a concentration gradient, the process is called ..... and when it occurs against a concentration gradient the process is called ..... .

Energy in the form of ..... is used in the movement of molecules against a concentration gradient.

(b) A student wanted to sweeten some strawberries, so she sprinkled some sugar on top of them, one hour before eating them. The student noticed that the sugar that she had sprinkled on them was no longer visible and that there was some juice at the bottom of the bowl.

Appearance on adding sugar

Appearance one hour after adding sugar

The student thought that the juice was the sugar dissolved in water and that the water had come from the fruit.

In order to test this hypothesis, she weighed some fresh strawberries and sprinkled them with sugar. One hour later she rinsed off the juice and reweighed the strawberries. The mass of the strawberries before adding the sugar was 77 g. The mass after rinsing off the juice was 70 g.

(i) Calculate the percentage decrease in the mass of the strawberries.

Show your working.

(2)

Answer ..... %

(ii) Suggest **one** possible source of error in the student's procedure that could make this value for the percentage decrease in the mass of the strawberries inaccurate.

Explain how this source of error would affect the value for the percentage decrease in the mass of the strawberries.

(3)

Source of error .....

.....

.....

Effect on value and explanation .....

.....

.....

.....

.....

(iii) Using your knowledge of cell transport mechanisms and the properties of water, explain how the juice is formed from the water that came from the fruit.

(3)

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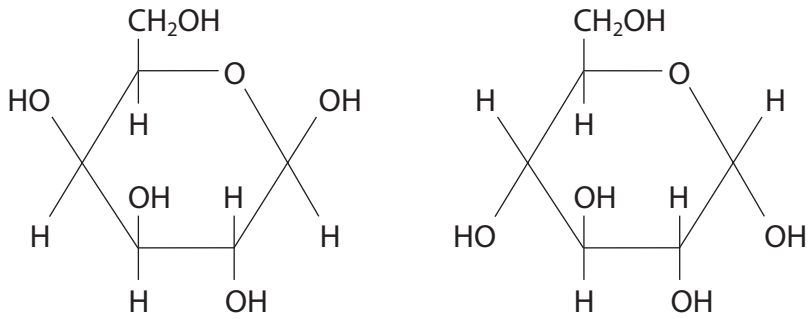
(Total for Question 1 = 12 marks)

2 Galactosaemia is a genetic disorder that affects an individual's ability to metabolise the monosaccharide galactose.

Dairy products contain the disaccharide lactose, which is broken down into galactose and glucose during digestion. If the galactose is not broken down further this may result in damage to the brain, kidneys or liver.

(a) The diagram below shows the structure of a galactose molecule and a glucose molecule.



(i) In the space below, draw a diagram to show the products formed when these two molecules join together to form lactose.

(3)

(ii) Name the chemical reaction that joins the galactose and glucose molecules together.

(1)

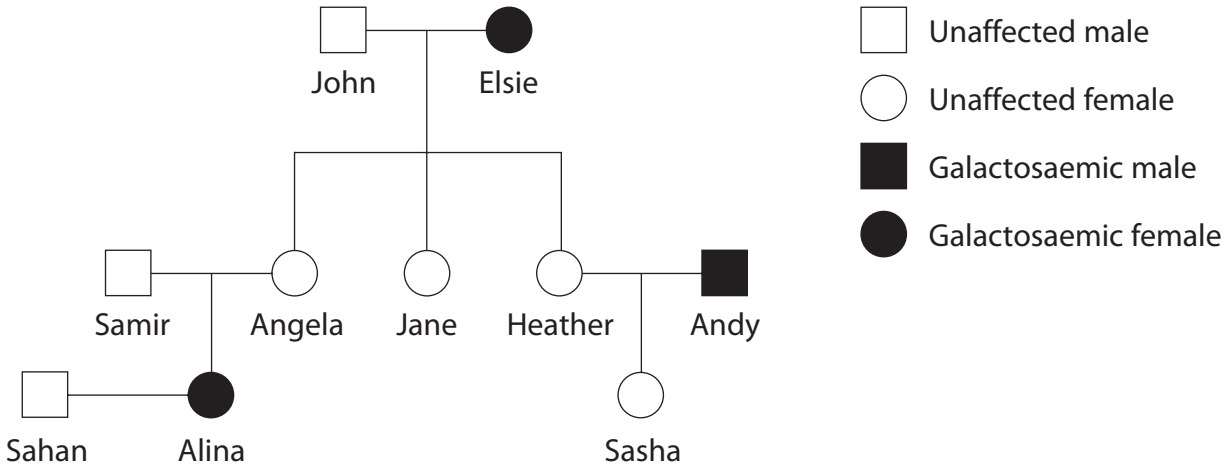
.....

(iii) Name the bond that joins the galactose and glucose molecules together.

(1)

.....

(b) The pedigree diagram below shows the inheritance of galactosaemia in a family.



The normal allele is represented by G and the defective recessive allele by g.

Place a cross ☒ in the box next to the correct letter that completes each of the following statements.

(i) An allele is a

(1)

☒ **A** form of a gene

☒ **B** length of DNA

☒ **C** part of a gene

☒ **D** protein

(ii) If John is heterozygous for galactosaemia, Jane's genotype must be

(1)

☒ **A** GG

☒ **B** Gg

☒ **C** gg

☒ **D** impossible to tell

(iii) Samir's genotype must be

(1)

☒ **A** GG

☒ **B** Gg

☒ **C** gg

☒ **D** impossible to tell

(c) (i) Use a genetic diagram to calculate the probability that Sahan and Alina's first child will be heterozygous (a carrier) if Sahan is heterozygous.

(4)

Answer .....

(ii) What is the probability that their second child would also be a carrier?

(1)

.....

.....

(Total for Question 2 = 13 marks)

3 Cystic fibrosis is a genetic disease that can affect many body systems, including the digestive system. In a carrier of this disorder, preimplantation genetic diagnosis can be used to detect the presence of an allele for cystic fibrosis.

*(a) Explain how cystic fibrosis affects the digestive system.

(4)

(b) Explain how **preimplantation** genetic diagnosis is performed to detect cystic fibrosis.

(3)

(c) Discuss either **one** ethical issue or **one** social issue relating to the use of preimplantation genetic diagnosis.

(2)

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(Total for Question 3 = 9 marks)

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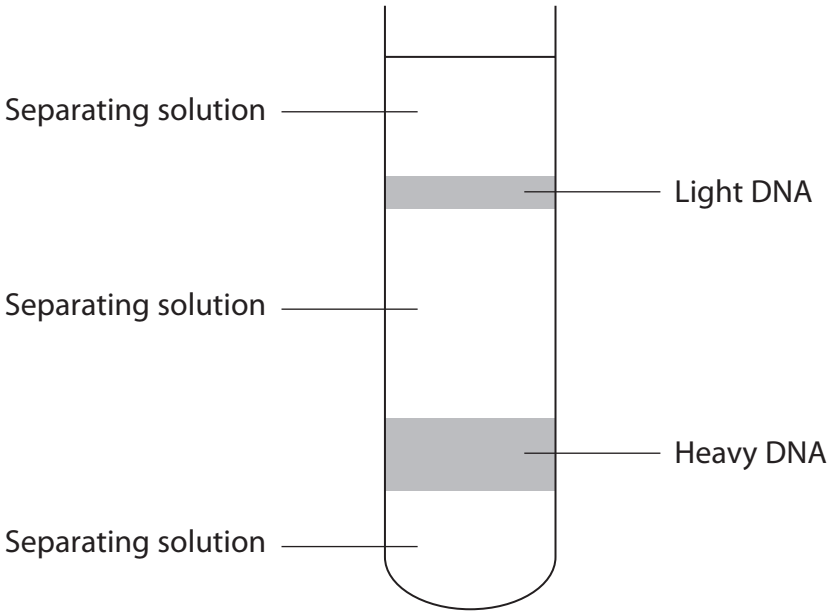
4 In the late 1950s, Meselson and Stahl performed some important experiments. These experiments provided evidence to support the idea that new DNA was synthesised by semi-conservative replication.

(a) Name an enzyme involved in DNA replication.

(1)

.....

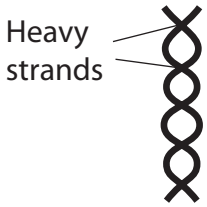
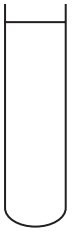
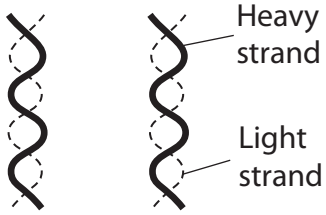
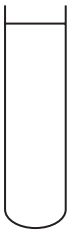
(b) Meselson and Stahl's experiments involved growing bacteria in culture media containing either heavy nitrogen (^{15}N) or light nitrogen (^{14}N). The DNA was then extracted from the bacteria. The DNA was analysed as shown in the diagram below.



The table below summarises the three stages of Meselson and Stahl's experiment and their results.

Complete the table by drawing, in the appropriate boxes, diagrams of the DNA molecules and mark the position and size of the DNA bands in the tubes.

(6)

Experimental stage	Diagram to show the strands in the DNA molecules of the bacteria	Position and size of DNA bands in the tube of separating solution
Stage 1 Bacteria grown for several generations in culture medium containing heavy nitrogen		
Stage 2 The bacteria from the end of stage 1 were grown for another generation in culture medium containing light nitrogen		
Stage 3 The bacteria from the end of stage 2 were grown for one more generation in culture medium containing light nitrogen		

(Total for Question 4 = 7 marks)

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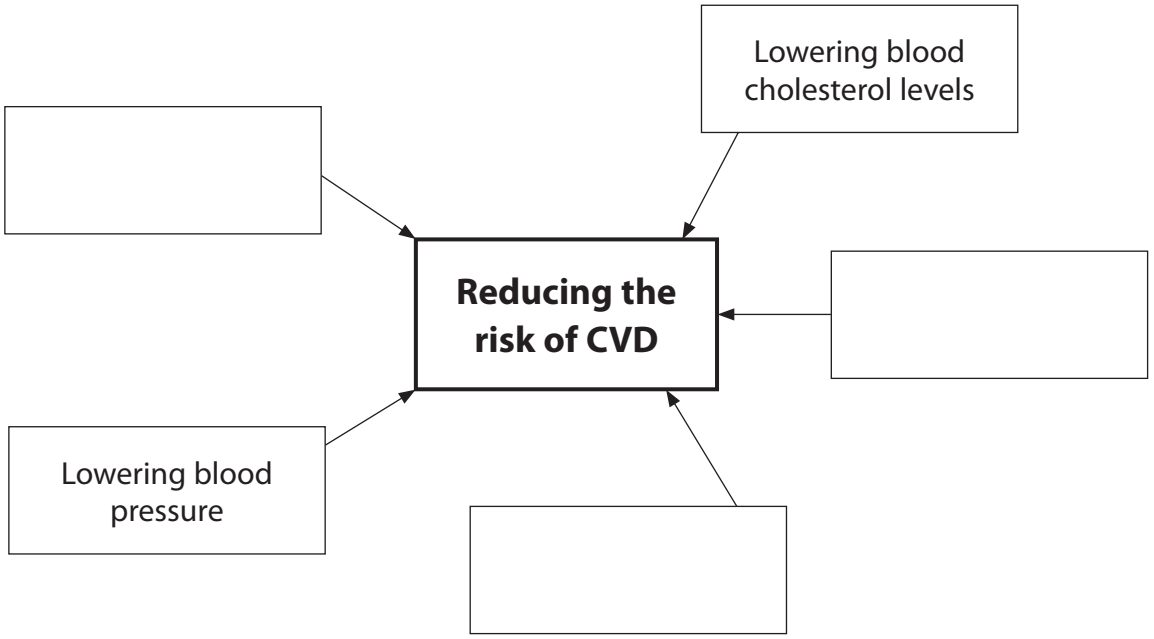
5 The risk of developing cardiovascular disease (CVD) can be reduced in several ways. Lowering blood cholesterol levels and lowering blood pressure are two ways of reducing CVD.

(a) (i) Complete the diagram below by giving three other ways in which the risk of CVD may be reduced. Write your answers in the empty boxes.

(3)



(ii) Explain how lowering blood cholesterol levels can reduce the risk of CVD.

(2)

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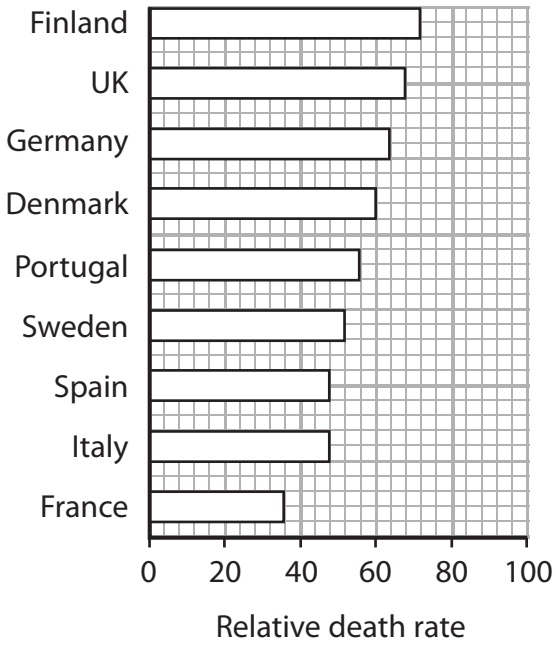
(b) Risk calculators can be used to estimate the probability that a person will develop CVD. Many of these calculators start by asking for the age and gender of the person using them. Explain why information about age and gender is important in estimating the risk of developing CVD.

(2)

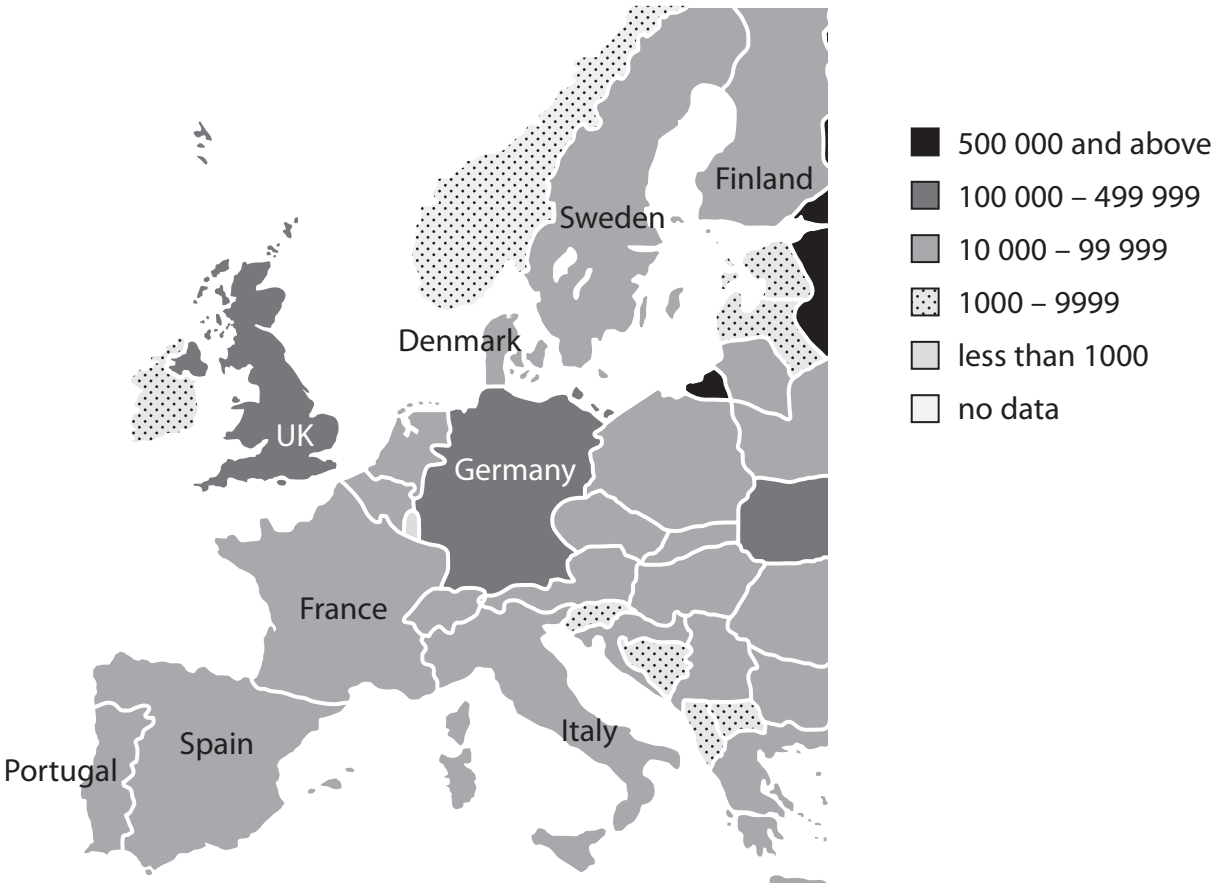
(c) The graph below shows the relative death rate from CVD in some countries in Western Europe.



(i) Compare the relative death rates from CVD in Finland, Denmark and Sweden.

(3)

(ii) The map below shows the number of deaths from CVD in one year in Western Europe.



Describe **two** differences between the data presented in the map and the data shown in the graph.

(2)

1 .....

.....

2 .....

.....

(iii) Suggest **one** reason for the differences between the data presented in the map and the data shown in the graph.

(1)

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(Total for Question 5 = 13 marks)

6 The sequence of amino acids in a polypeptide chain is determined by the sequence of bases in DNA. This sequence of bases is used as a template to synthesise messenger RNA (mRNA).

(a) Describe the structure of an amino acid.

(2)

(b) Describe how mRNA is synthesised.

(4)

(c) The table below shows the amino acids coded for by the codons on **mRNA**.

Three-letter codons of mRNA and the amino acids specified by the codons			
AAU, AAC — Asparagine	CAU, CAC — Histidine	GAU, GAC — Asparatic acid	UAU, UAC — Tyrosine
AAA, AAG — Lysine	CAA, CAG — Glutamine	GAA, GAG — Glutamate	UAA, UAG — Stop
ACU, ACC, ACA, ACG — Threonine	CCU, CCC, CCA, CCG — Proline	GCU, GCC, GCA, GCG — Alanine	UCU, UCC, UCA, UCG — Serine
AGU, AGC — Serine AGA, AGG — Arginine	CGU, CGC, CGA, CGG — Arginine	GGU, GGC, GGA, GGG — Glycine	UGU, UGC — Cysteine UGA — Stop UGG — Tryptophan
AUU, AUC, AUA — Isoleucine AUG — Methionine	CUU, CUC, CUA, CUG — Leucine	GUU, GUC, GUA, GUG — Valine	UUU, UUC — Phenylalanine UUA, UUG — Leucine

The diagram below shows part of a messenger RNA molecule.

(i) Place a cross ☒ in the box next to the complementary sequence of bases found on the strand of the **DNA** molecule, from which part of this mRNA molecule was synthesised.

(1)

☒ **A** G G T A A G C G C C T T

☒ **B** G G U A A C G C G G A A

☒ **C** A A C G G A U A U U G G

☒ **D** A A C G G A T A T T G G

(ii) Place a cross ☒ in the box next to the sequence of amino acids found in the polypeptide chain that is coded for by this part of the **mRNA** molecule.

(1)

☒ **A** proline lysine alanine valine

☒ **B** proline phenylalanine alanine valine

☒ **C** glycine lysine arginine glutamine

☒ **D** proline lysine alanine glutamine

(iii) Place a cross ☒ in the box next to the final codon on this **mRNA** molecule if GUU is the last codon for an amino acid.

(1)

☒ **A** AGU

☒ **B** ACU

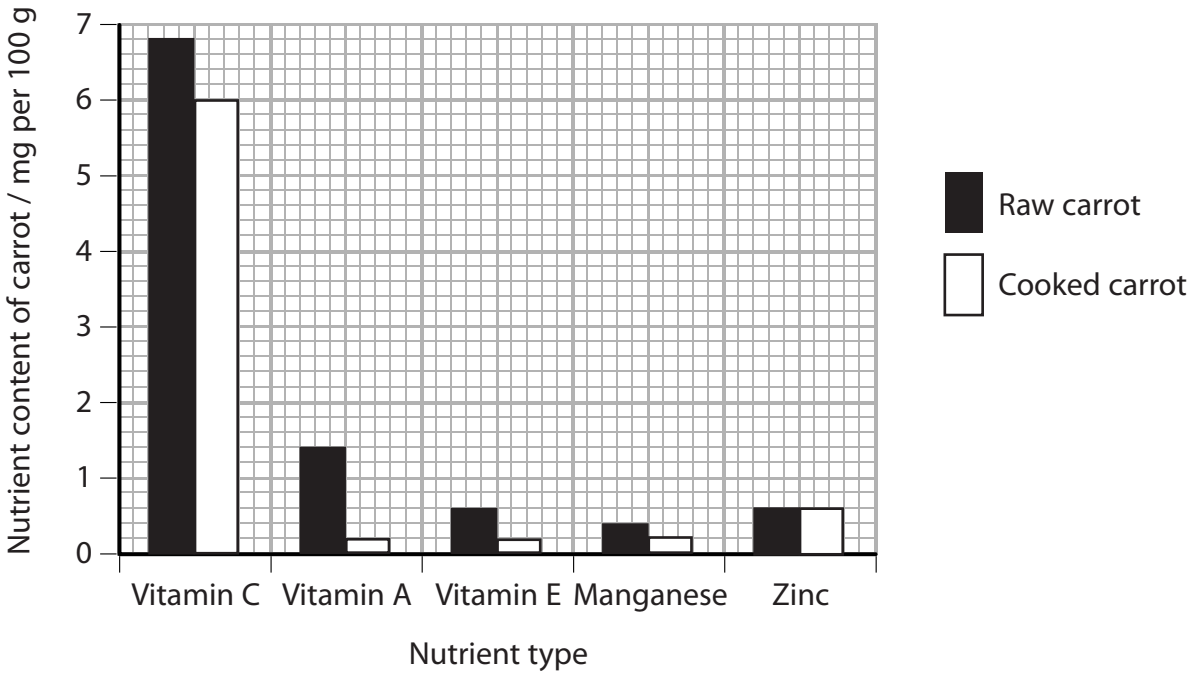
☒ **C** UCA

☒ **D** UGA

(Total for Question 6 = 9 marks)

7 When vegetables are cooked in boiling water, they may lose some of their nutrients.

The graph below shows the effect of cooking on the content of three vitamins and two minerals found in carrots.



(a) Using the information in the graph, compare the effects of cooking on the content of vitamins and minerals found in carrots.

(3)

*(b) It has been suggested that cooking food in a microwave oven does not reduce the nutrient content of foods by as much as cooking in boiling water.

A student wanted to test this idea on the vitamin C content of carrots.

Describe an investigation that the student could carry out to compare these two methods of cooking on the vitamin C content of carrots.

(5)

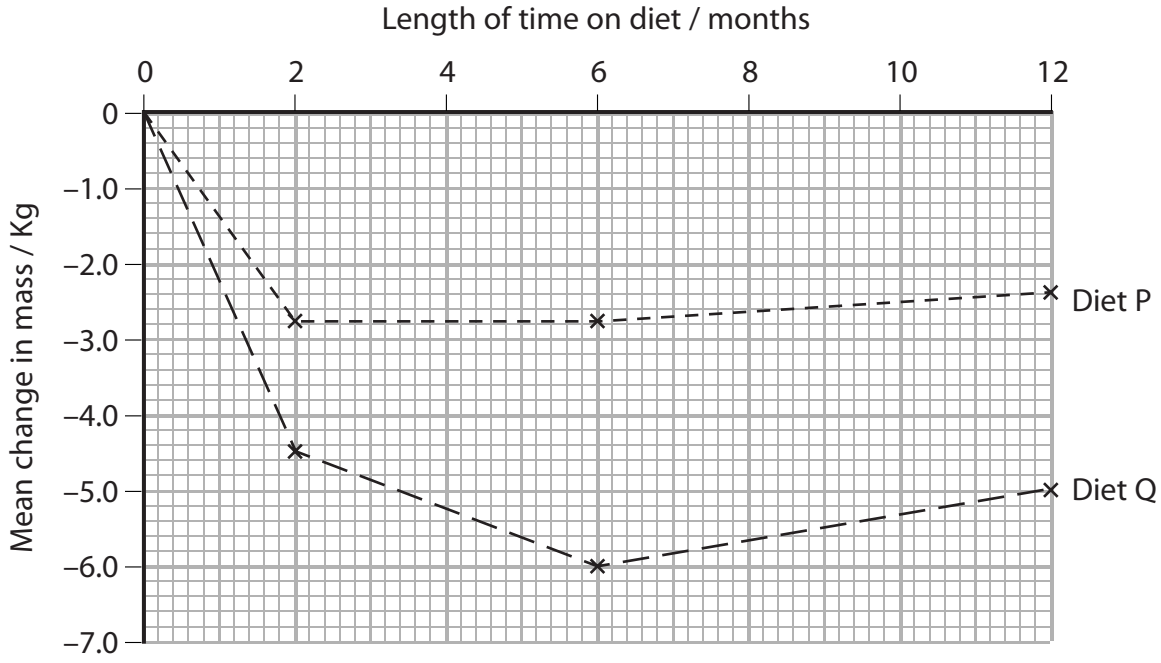
(Total for Question 7 = 8 marks)

8 Many different diets are available for people who want to lose weight. There is a lot of confusion over the merits of each one.

A scientist carried out an investigation to compare the effects of diet P and diet Q, on volunteers.

The changes in mass of two groups of volunteers on each of these diets were monitored over a 12-month period.

The graph below shows the mean changes in mass for each group of volunteers.



(a) (i) Compare the mean change in mass, over the first 6 months, for these two groups of volunteers.

(3)

(ii) Suggest why there was an increase in the mean mass of the volunteers on both diets between 6 months and 12 months.

(1)

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(iii) State **two** variables that the scientist needed to control in this investigation.

(2)

1 .....

2 .....

(b) Suggest why exercise is usually included as part of a weight loss programme.

(3)

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(Total for Question 8 = 9 marks)

TOTAL FOR PAPER = 80 MARKS

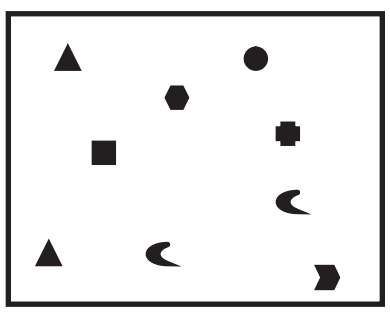
Practice 6

Answer ALL questions.

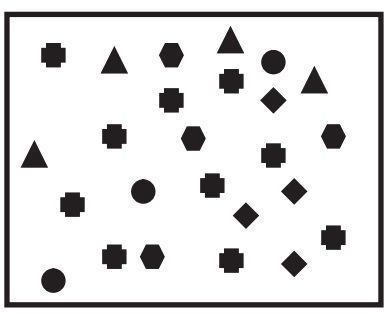
Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Biodiversity is an important concept in conservation.

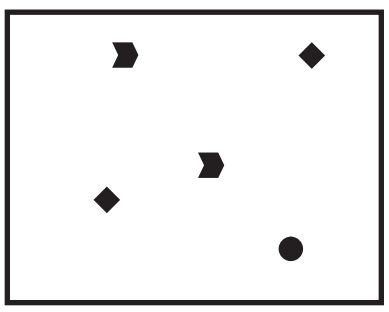
(a) The diagrams below show four identically sized areas A, B, C and D.
Different shapes represent different species.



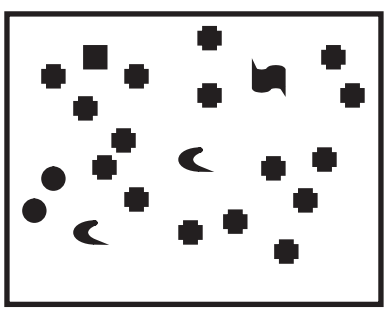
Area A



Area B



Area C



Area D

Place a cross ☒ in the box next to the correct letter to complete each of the following statements.

(i) The area with the highest species richness is

(1)

☒ **A** ☒ **B** ☒ **C** ☒ **D**

(ii) The area with the lowest species richness is

(1)

☒ **A** ☒ **B** ☒ **C** ☒ **D**

(iii) State which area contains an endemic species, giving reasons for your answer.

(3)

Area.....

Reasons.....

.....

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.....

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Turn over ▶

(b) Zoos help to conserve rare endemic species through captive breeding programmes and reintroduction programmes.

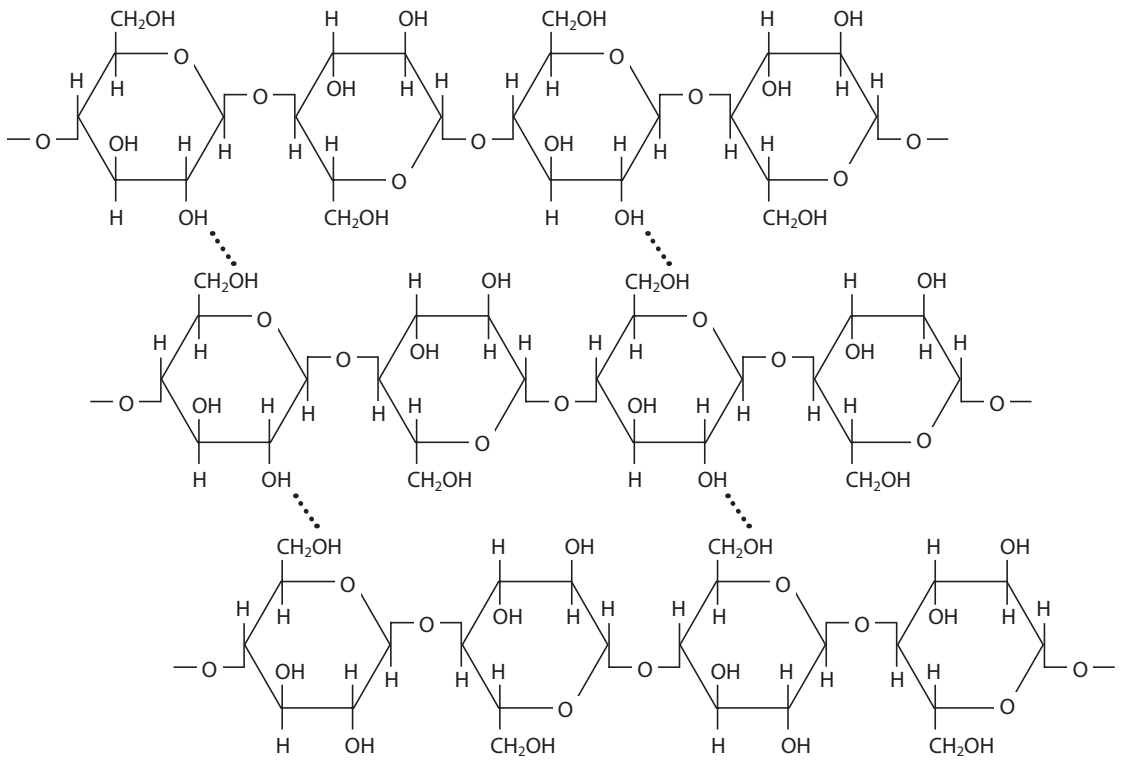
* Describe how zoos use these programmes to help conserve rare species.

(5)

(Total for Question 1 = 10 marks)

2 Cellulose and mineral ions are important components of a plant.

(a) The diagram below shows part of a cellulose microfibril.



(i) On the diagram above, draw a circle labelled **G** round **one** of the glycosidic bonds.

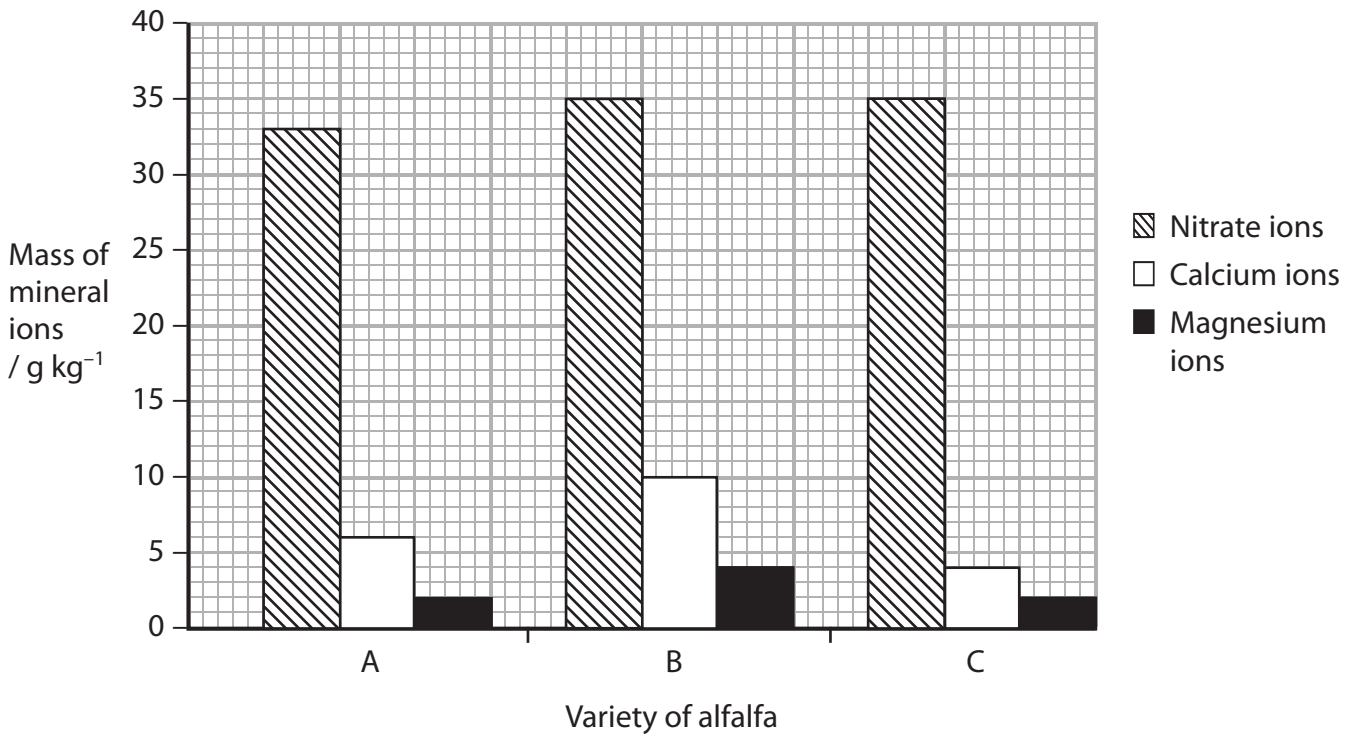
(1)

(ii) On the diagram above, draw a circle labelled **H** round **one** of the hydrogen bonds.

(1)

(b) An investigation was carried out to find the mass of mineral ions in three varieties (A, B and C) of the alfalfa plant.

The results of this investigation are shown in the graph below.



(i) Using the information in the graph, suggest which variety of alfalfa could have the highest concentration of chlorophyll. Give a reason for your answer.

(2)

Variety .....

Reason .....

.....

.....

(ii) Using the information in the graph, suggest which variety of alfalfa could have the strongest cell walls. Give an explanation for your answer.

(3)

Variety .....

Explanation .....

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.....

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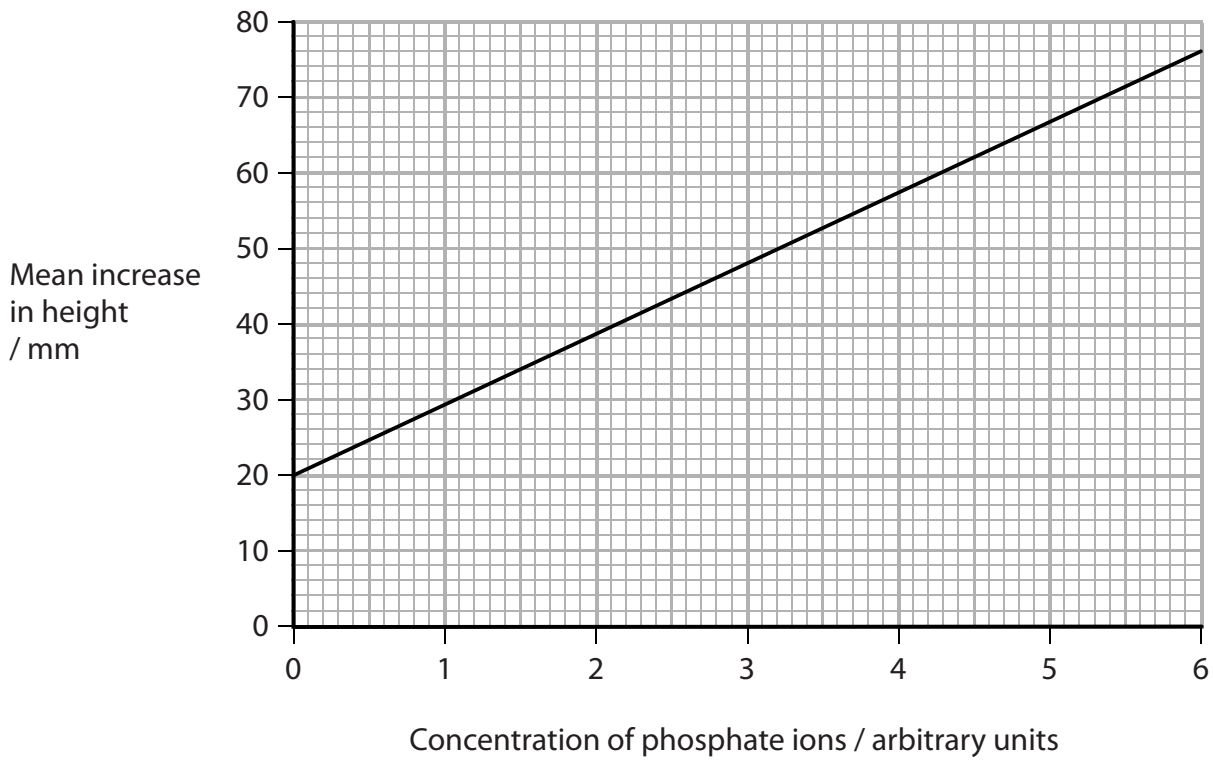
(c) An investigation was carried out to find the concentration of phosphate ions in a soil sample.

Five wheat seedlings were grown in a solution containing all necessary mineral ions, except for phosphate ions. After three weeks, the increase in height of each seedling was measured and the mean increase in height was calculated.

This procedure was repeated for solutions containing different concentrations of phosphate ions.

The results are shown in the graph below.



(i) Another five wheat seedlings were grown in a sample of soil for three weeks and their mean increase in height was found to be 45 mm.

Use the graph to estimate the concentration of phosphate ions in this sample of soil.

(1)

Answer ..... arbitrary units

Turn over ▶

(ii) In this investigation, all the seedlings were grown from seeds from the same wheat plant. Suggest why this would improve the validity of the results.

(1)

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(iii) Suggest **two** factors, other than the time for growth and the source of the seeds, that should have been kept constant in this investigation.

(2)

1 .....

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2 .....

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(Total for Question 2 = 11 marks)

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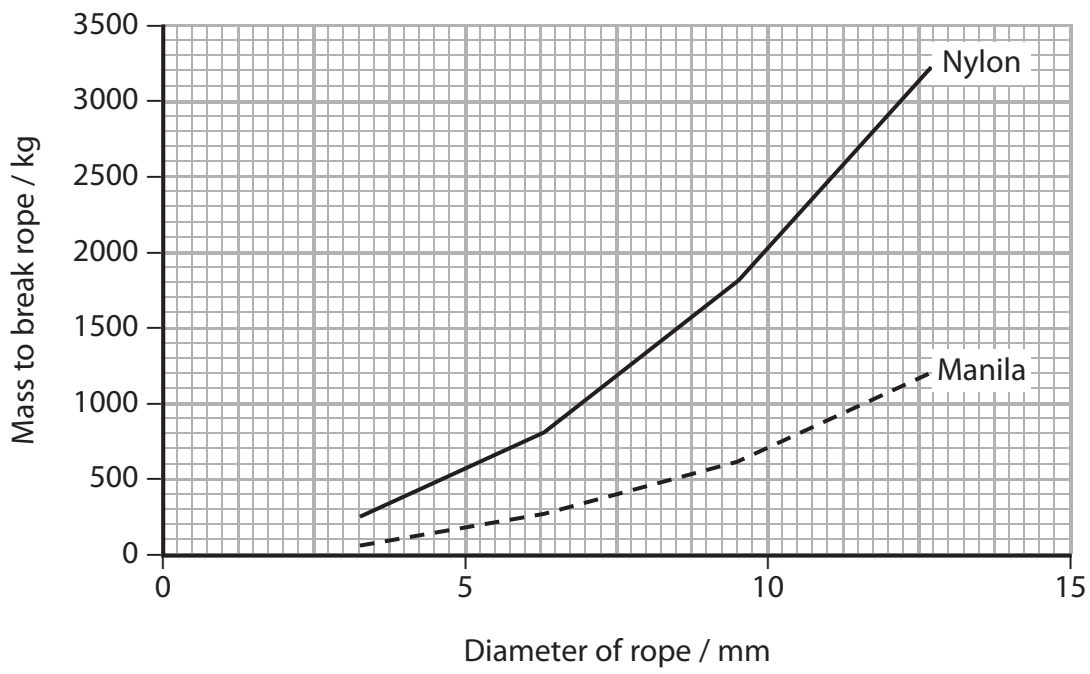
Turn over ▶

3 Ropes can be made from many substances including nylon and manila.
Nylon is a synthetic fibre. Manila is made of fibres from the *Musa textilis* plant, shown in the photograph below.

Malkolm Warrington / Science Photo Library

(a) The mass required to break ropes, of different diameters, made from nylon and manila was investigated.
The results of this investigation are shown in the graph below.



Compare the effect of increasing the diameter on the mass needed to break nylon rope rather than manila rope.

(3)

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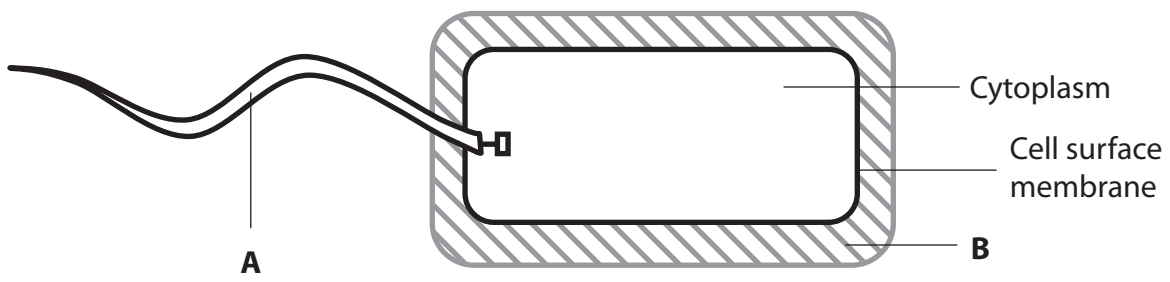
(b) In the process of making rope, waste material is produced. Some of these waste materials can be broken down by prokaryotic cells such as bacteria.

The diagram below shows the structure of a prokaryotic cell.



(i) Name the parts labelled **A** and **B** on the diagram.

(2)

A .....

B .....

(ii) On the diagram, draw and label **two** structures present in the cytoplasm.

(2)

(Total for Question 3 = 7 marks)

Turn over ▶

4 Mitosis and meiosis are both forms of nuclear division. Mitosis can be observed in root tip squashes from a plant such as garlic.

(a) Place a cross ☒ in the box next to the correct word or words to complete each of the following statements.

(i) The stain used in a root tip squash can be intensified by

(1)

☒ **A** adding acid

☒ **B** adding alkali

☒ **C** gently heating

☒ **D** squashing the tip

(ii) Mitosis occurs in

(1)

☒ **A** plant fibres

☒ **B** sclerenchyma fibres

☒ **C** stem cells

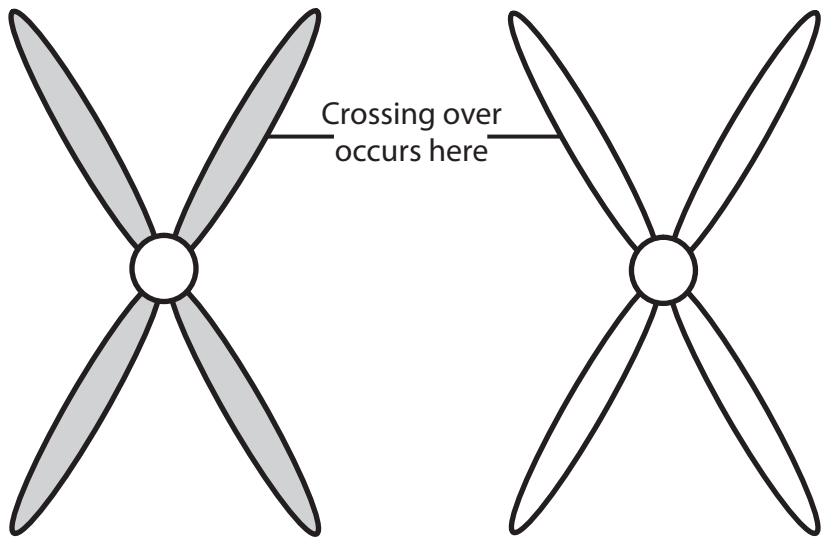
☒ **D** xylem vessels

(b) Describe the appearance of a cell in telophase of mitosis as seen in a root tip squash.

(3)

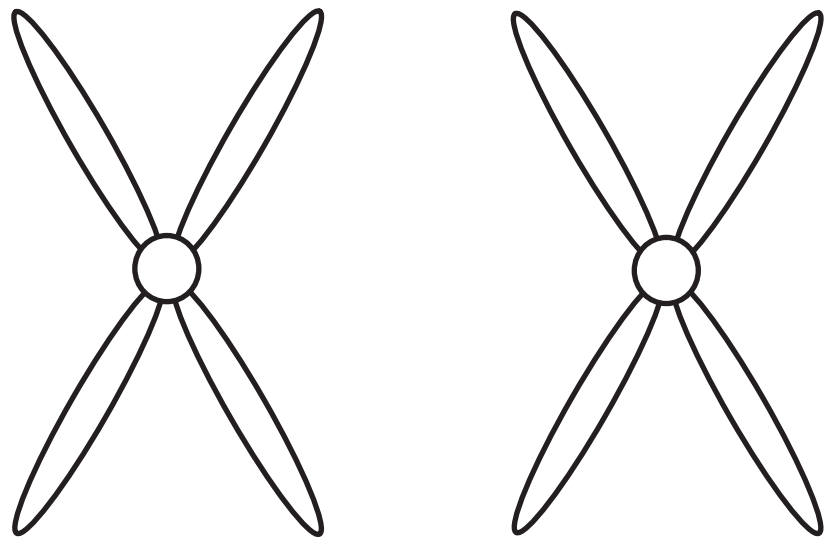
(c) One way in which meiosis increases genetic variation is through crossing over.

(i) The diagram below shows a pair of homologous chromosomes during meiosis. They are positioned next to each other but crossing over has not yet occurred.



Complete the diagram below to show these chromosomes after crossing over has occurred.

(1)

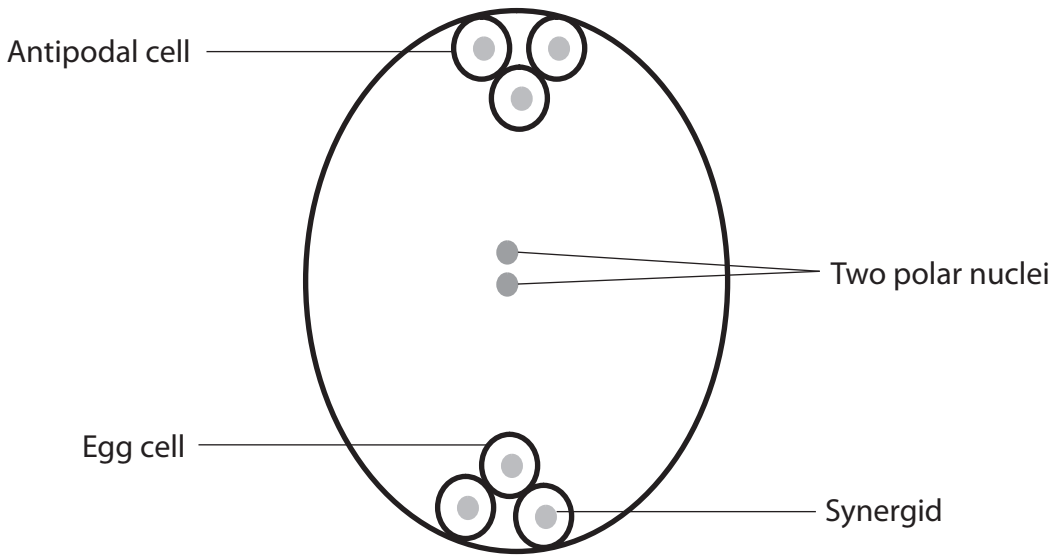


Turn over ▶

(ii) Meiosis produces haploid structures in the plant.

The diagram below shows an embryosac.
Draw a circle round each of the labels of **two** haploid structures that are fertilised in the embryosac.

(2)



(iii) Explain what is meant by the term **haploid number** of chromosomes.

(1)

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(Total for Question 4 = 9 marks)

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Turn over ▶

5 Genetic diversity is important for the long term survival, adaptation and evolution of organisms. Genetic diversity can be considered as the number of different alleles found at each gene locus in a population of organisms.

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

(2)

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(b) The genetic diversity of two breeds of dog, P and Q, was investigated.
The total number of different alleles found at 31 gene loci was recorded for each breed.

The results are shown in the table below.

Breed of dog	Total number of different alleles at 31 gene loci
P	239
Q	144

(i) The mean number of different alleles per gene locus for both breeds was calculated.
Place a cross ☒ in the box next to the mean for breed P.

(1)

☒ **A** 5.7

☒ **B** 7.2

☒ **C** 7.7

☒ **D** 31.0

(ii) Breed Q has a mean of 4.6 different alleles per gene locus.
If their environment changed, breed P would be more likely to survive and evolve than breed Q.

Using information on mean number of different alleles per gene locus and your own knowledge, explain why breed P is more likely to survive and evolve than breed Q.

(5)

Turn over ▶

(c) Two groups of dogs, of breed P, were taken from the same population.
The total number of different alleles at the same 31 gene loci was recorded for each of these two groups.

The results are shown in the table below.

Group	Number of dogs of breed P	Total number of different alleles at 31 gene loci
1	40	239
2	20	215

Suggest why the total number of different alleles in group 1 was greater than in group 2.

(2)

(d) Adaptation can be behavioural, physiological or anatomical.
Place a cross ☒ in the box that correctly identifies a **behavioural adaptation** in humans.

(1)

☒ **A** Long necks are more common in people living in hot dry conditions

☒ **B** More red blood cells in people living high up a mountain

☒ **C** More white blood cells in people with an infection

☒ **D** Taking a rest in the heat of the day

(Total for Question 5 = 11 marks)

6 Woese was the scientist who proposed a classification of organisms into three domains called the Archaea, Bacteria and Eukaryota (Eucarya).

(a) The table below shows some of the characteristics of the three domains.

Characteristic	Domain		
	A	**B**	**C**
Mitochondria	Absent	Absent	Present
Cell wall containing peptidoglycan	Yes	No	No
Amino acid carried on tRNA that starts protein synthesis	Formylmethionine	Methionine	Methionine
Sensitive to antibiotics	Yes	No	No
May contain chlorophyll	Yes	No	Yes

(i) Using the information in the table, suggest which of A, B and C represents the Eukaryota domain. Give a reason for your answer.

(2)

Domain .....

Reason .....

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(ii) Many scientists believe that the Eukaryota domain is more closely related to the Archaea domain than to the Bacteria domain.

Using the information in the table, suggest which of A, B and C represents the Archaea domain. Give a reason for your answer.

(2)

Domain .....

Reason .....

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(b) Cells of the Eukaryota domain contain rough endoplasmic reticulum and Golgi apparatus.
Both the rough endoplasmic reticulum and the Golgi apparatus are made up of membrane-bound sacs.

(i) Describe how you would recognise the Golgi apparatus as seen using an electron microscope.

(3)

*(ii) Explain the roles of rough endoplasmic reticulum and the Golgi apparatus in a cell.

(6)

(Total for Question 6 = 13 marks)

Turn over ▶

7 Stem cells can differentiate into specialised cells and tissues.

(a) There are about 23 000 genes in a human body cell. The table below shows the number of genes that have not been switched off, in three different cells, A, B and C.

Cell	Number of genes that have not been switched off
A	11 000
B	18 000
C	23 000

Suggest which of these cells is a totipotent stem cell.
Give reasons for your answer.

(3)

Cell .....

Reasons .....

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(b) A fertilised egg can be used as a source of human pluripotent stem cells.

(i) Explain what is meant by the term **pluripotent stem cell**.

(2)

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(ii) Describe how a fertilised egg can be used as a source of human pluripotent stem cells.

(3)

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(Total for Question 7 = 8 marks)

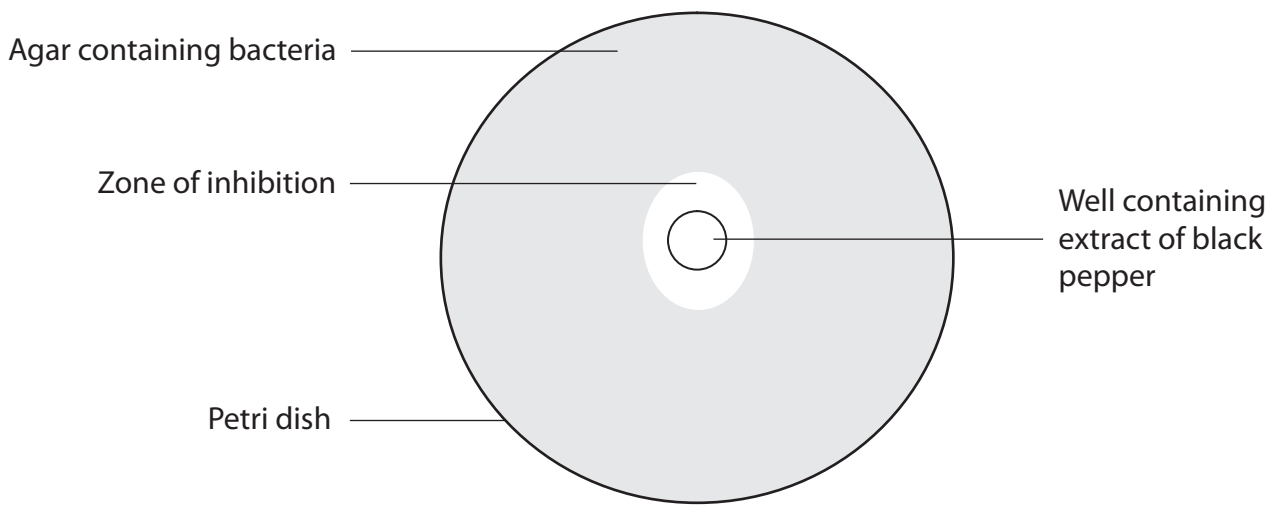
Turn over ▶

8 An investigation was carried out to extract antimicrobial substances from black pepper.

One extraction method used ethanol. The black pepper was crushed and soaked in the ethanol for 24 hours. The crushed pepper was then removed, leaving an ethanol extract.

A Petri dish containing agar and one species of bacterium (B1) had a cylinder of agar removed to produce a well.
The ethanol extract was then placed in the well.

The Petri dish was incubated at 37 °C for 24 hours. After incubation, the diameter of the zone of inhibition around the well was measured. This was repeated using Petri dishes with different species of bacteria (B2, B3, B4 and B5).



The investigation was repeated using an extract prepared with hot water in place of ethanol.

(a) (i) Describe how the bacteria should be added to the Petri dish.

(2)

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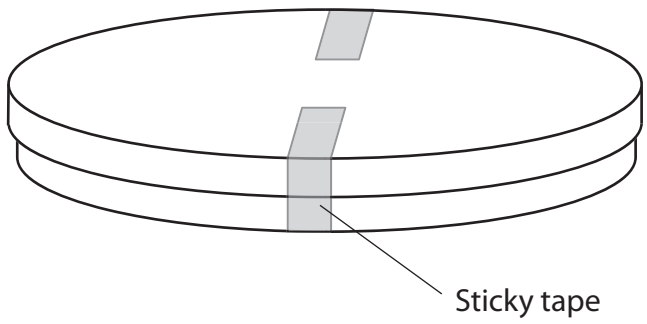
(ii) Before incubation, the lid was secured to the base of the Petri dish as shown in the diagram below.



Explain why the lid was secured in this way.

(2)

(iii) Suggest why an incubation temperature of 37 °C should not be used in a school or college laboratory.

(1)

Turn over ▶

(b) The results of this investigation are shown in the table below.

Species of bacterium	Mean diameter of zone of inhibition / mm	
	Ethanol extract	Hot water extract
B1	27.4	18.2
B2	26.2	16.8
B3	15.0	29.6
B4	25.0	16.4
B5	15.0	29.8
Mean	21.7	22.2

(i) One student used the data in the table to form the hypothesis that using ethanol was more effective than hot water at extracting antimicrobial substances from crushed black pepper.

Give evidence from the table that supports this hypothesis.

(1)

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(ii) A second student formed the hypothesis that using hot water to extract the antimicrobial substances was more effective than using ethanol.

Give evidence from the table that supports this hypothesis.

(1)

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(c) Another investigation was carried out using cold water to extract the antimicrobial substances. The same method was used but only bacterium species B1 was tested.
The table below shows the mean diameter of the zones of inhibition and the ranges of the data.

Mean diameter of zone of inhibition / mm	
Hot water extract	**Cold water extract**
18.2 ± 1.4	16.4 ± 0.6

(i) A third student stated that some of the results for the hot water extract overlapped with some of the results for the cold water extract.

Suggest what evidence from the table above the student could have used to support this statement.

(2)

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(ii) Using the table above, suggest whether the data for the hot or cold water extract were more reliable. Give a reason for your answer.

(2)

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(Total for Question 8 = 11 marks)

TOTAL FOR PAPER = 80 MARKS