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Areas outside the box will not be scanned for marking

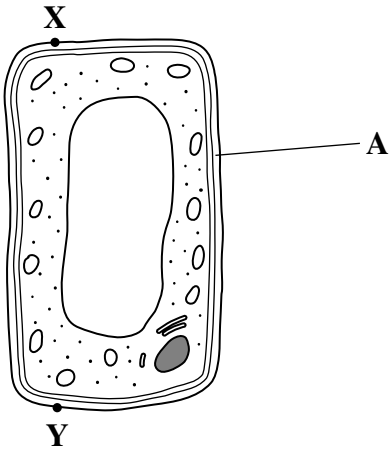
Answer **all** questions in the spaces provided.

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

.....

(1 mark)

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



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

.....

(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.

.....

.....

(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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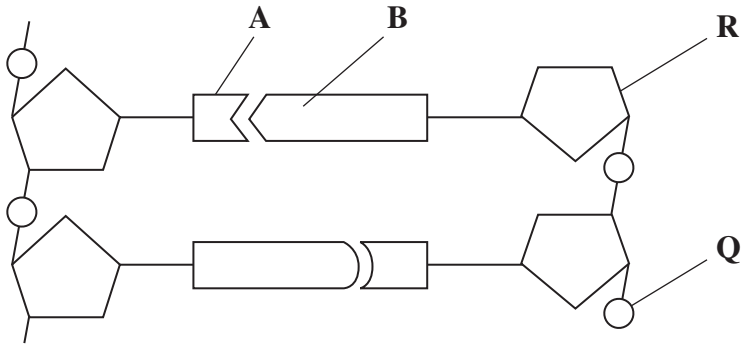
(1 mark)

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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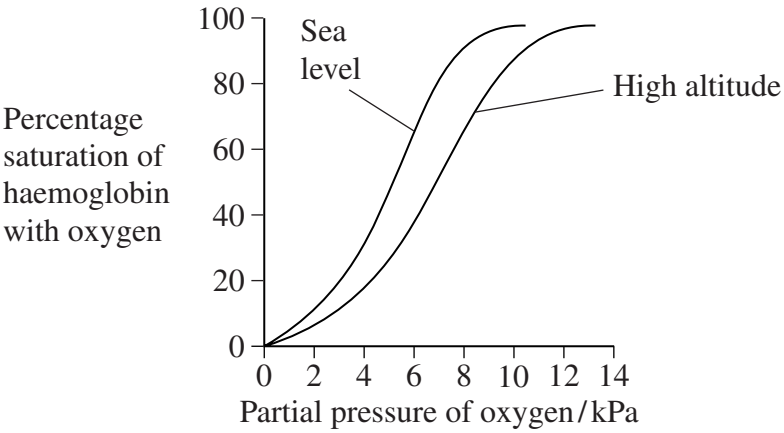
(2 marks)

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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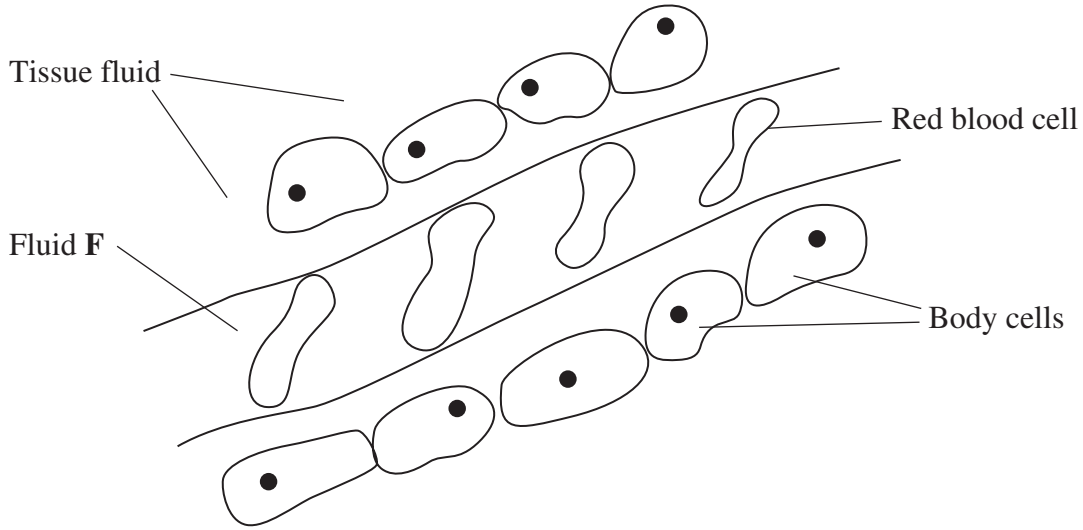
(2 marks)

7

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



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

.....

(1 mark)

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

.....

(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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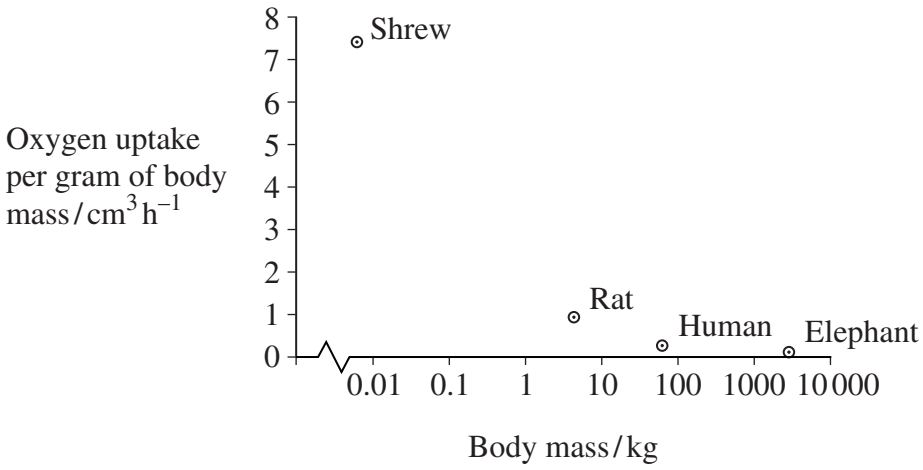
(2 marks)

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

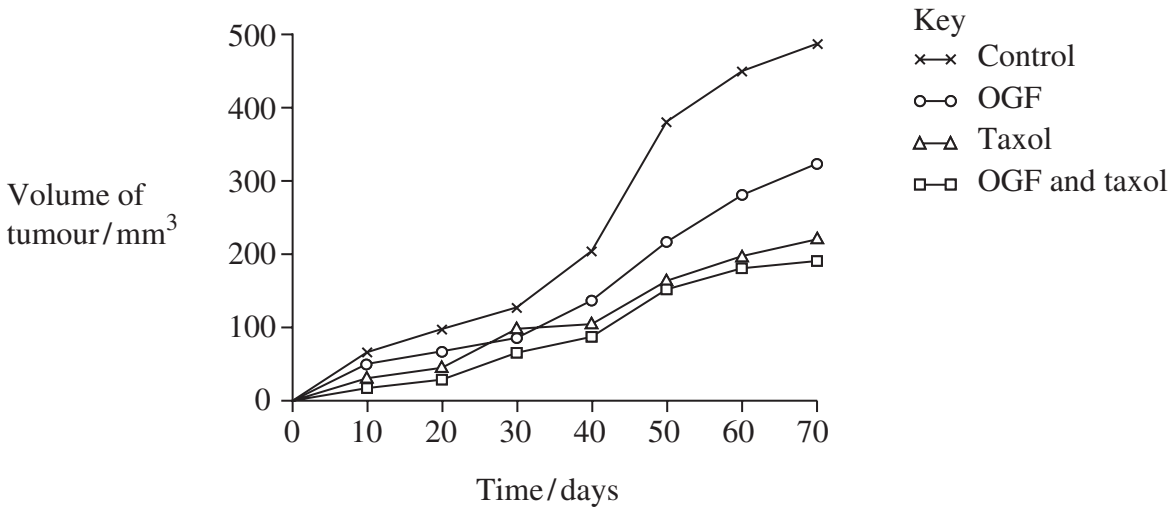

Figure 5

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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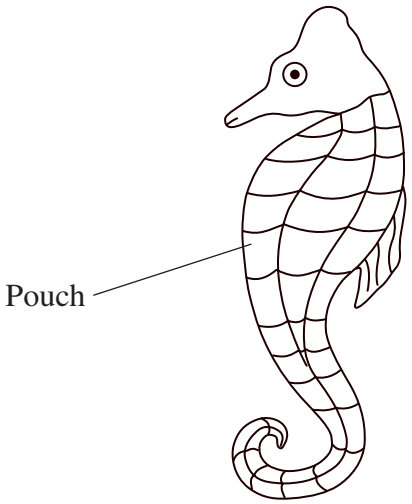
15

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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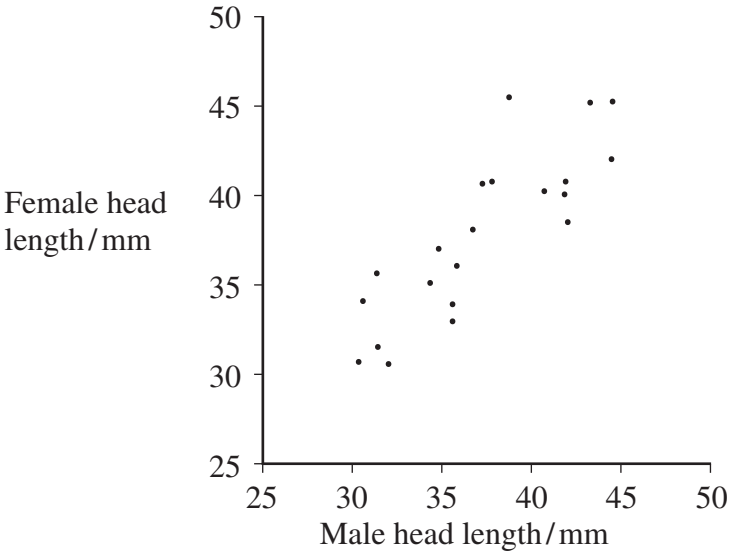
(1 mark)

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

Practice 2

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 The photograph below shows some human epithelial tissue, as seen using an electron microscope. The tissue includes a goblet cell which contains a large number of Golgi apparatus.

magnification ×5000

(a) Explain the meaning of the term **tissue**.

(2)

1

2

3

(b) The Golgi apparatus of a goblet cell is involved in receiving protein, modifying it and then packaging the modified protein into vesicles.

(i) In the space below, draw a diagram of a Golgi apparatus. Add an arrow to your drawing to show the direction of movement of the protein material as it moves through the Golgi apparatus.

(3)

(ii) Proteins in a cell can be made radioactive by supplying the cell with radioactive amino acids. The movement of the radioactive protein within the cell can be traced over time.

In an investigation, it was found that the quantity of radioactivity in the protein that entered the Golgi apparatus was less than that supplied to the cell.

Suggest **three** reasons for this difference.

(3)

1 .....

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2 .....

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3 .....

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(Total for Question 1 = 8 marks)

2 In a study of plant structure, a leaf cell and a cell from a root tip were observed.

(a) Name **one** structure that may be found in a leaf cell that identifies it as **both** a eukaryotic cell **and** a plant cell.

(1)

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(b) The cell from the root tip was observed to be undergoing anaphase of mitosis.

(i) Describe **anaphase** of mitosis.

(3)

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(ii) During anaphase, the cell from the root tip did not have a nucleus but was still considered to be eukaryotic. Suggest **two** reasons why this cell was still considered to be eukaryotic.

(2)

1 .....

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2 .....

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(c) The table below shows the number of cells at each stage of the cell cycle in one sample of tissue taken from the growing region of a plant root.

Stage of the cell cycle	Number of cells in each stage	Percentage of cells in each stage (%)
Interphase	47	78.3
Prophase	3	5.0
Metaphase		3.3
Anaphase	1	1.7
Telophase	3	5.0
Cytokinesis		6.7
TOTAL	**60**	**100**

(i) Complete the table by calculating the number of cells undergoing metaphase and cytokinesis. Give your answer to the nearest whole number.

(2)

(ii) Using the table above, suggest which stage of the cell cycle takes the longest. Give a reason for your answer.

(2)

(iii) Suggest **one** reason why your answer to (c)(ii) may be unreliable.

(1)

(Total for Question 2 = 11 marks)

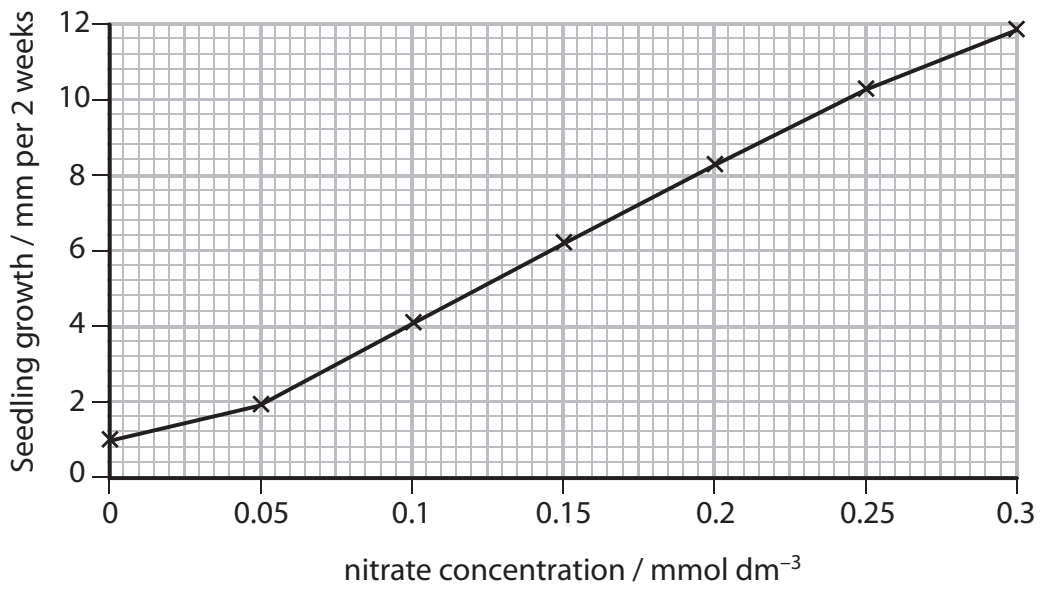
Turn over ▶

3 A student investigated the effect of nitrate ion concentration on the growth of wheat seedlings.

She took seven wheat seedlings and measured the length from the shoot tip to the root tip of each seedling. She placed each seedling in a different test tube so that its roots were in a mineral ion solution. Each tube contained a mineral ion solution with a different concentration of nitrate ions.

She left the seedlings on a window sill for two weeks and then measured the new length between the shoot tip and the root tip of each seedling. She then calculated the difference between the final length and initial length of each wheat seedling.

The results are shown in the graph below.



(a) After her investigation, she said "I conclude that nitrates are needed for seedling growth and the higher the nitrate concentration the greater the growth."

(i) Give **one** piece of evidence from the graph that supports her conclusion.

(1)

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(ii) Give **one** piece of evidence from the graph that does not support her conclusion

(1)

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1

2

3

An

(iii) State the nitrate ion concentration of the solution that acted as the control.

(1)

..... mmol dm^{-3}

(iv) Explain why it is better to use the difference in length as the measure of seedling growth rather than just the final length.

(1)

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(v) Suggest why calculating the difference between final mass and initial mass of each seedling may be an even better indicator of growth than measuring length.

(1)

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(vi) Suggest **three** variables that the student would need to keep constant to ensure the reliability of her data.

(3)

1 .....

2 .....

3 .....

(b) The student repeated the investigation using another wheat seedling. However, she replaced the mineral ion solution with soil from her garden. After two weeks the wheat seedlings had grown. She found the total increase in length to be 5.2 mm.

Use the graph to estimate the nitrate ion concentration of her soil.

(2)

Answer .....

(c) Inorganic ions are used by plants to make molecules. The table below refers to two inorganic ions, the molecules made and the main role of these molecules in a plant. Complete the table by writing the most appropriate word or words in each of the empty boxes.

(2)

Inorganic ion	Molecule made	Main role of the molecule in a plant
Nitrate		Plant growth
Calcium	Calcium pectate (pectin)	

(Total for Question 3 = 12 marks)

4

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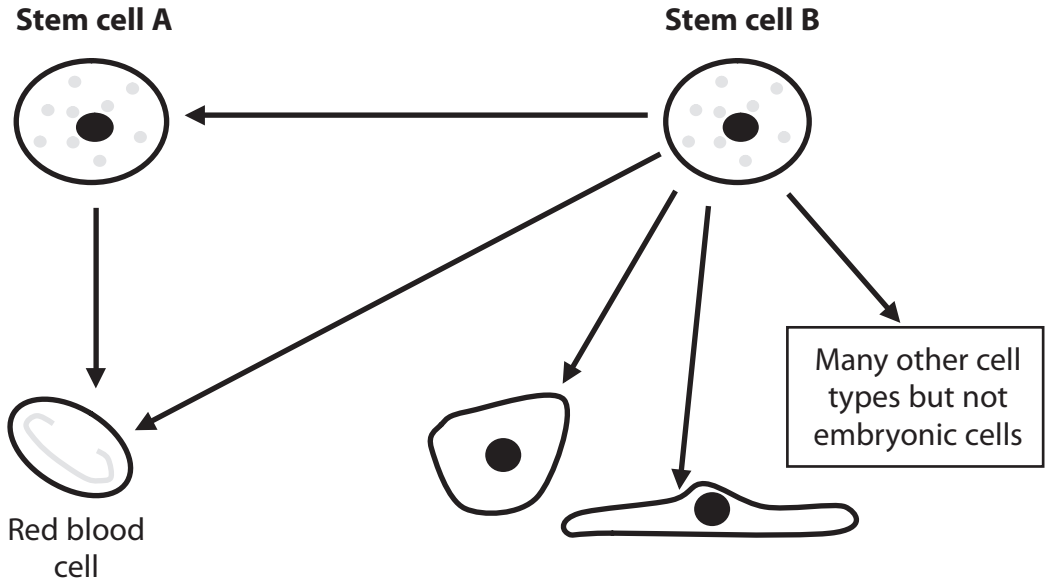
4 (a) The diagram below shows two different stem cells and the differentiated cells that they can form.



(i) Use the diagram to explain why stem cell B is described as **pluripotent**.

(2)

(ii) Suggest **one** site where stem cell A may be found in an **adult** human.

(1)

(iii) All the differentiated cells derived from stem cell B have the same genotype but have very different structures and functions. This is due to differential gene expression.

Explain how **differential gene expression** can enable cells which have the same genetic material to have very different structures and functions.

(3)

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(b) Three examples of how temperature affects organisms are given below. If the example is due to differential gene expression, place a cross (☒) in the box to the right of that example.

(1)

Examples	
The rate of protein synthesis within a plant is temperature dependent.	☒
The gender of turtles is determined by the temperature of the ground in which the eggs are laid.	☒
Asexual reproduction is more rapid in bacteria if the temperature is higher.	☒

(Total for Question 4 = 7 marks)

5

A

B

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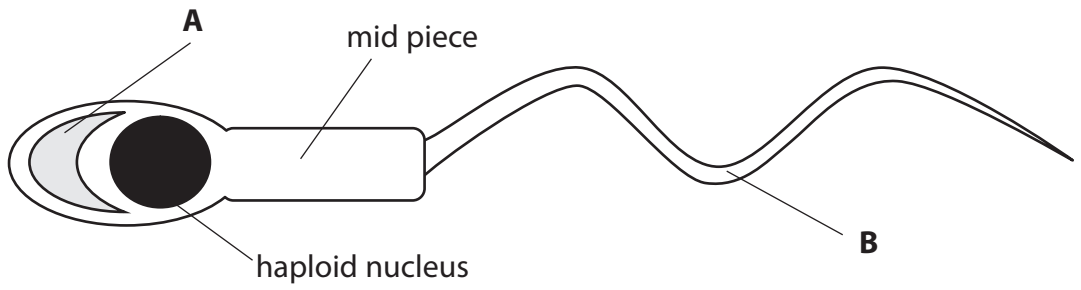
5 Fertilisation involves the fusion of haploid nuclei.

(a) The diagram below shows a human sperm cell.



(i) Name the structures labelled **A** and **B**.

(2)

A .....

B .....

(ii) Explain why it is important that the sperm has a nucleus that is haploid.

(2)

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Turn over ▶

(iii) Describe the changes in the female gamete from the point when a sperm releases its digestive enzymes to the point when the two nuclei fuse.

(3)

(b) An investigation into the effect of temperature on pollen tube growth was carried out. Two different varieties of cotton pollen grain were used, variety A and variety B.

Twenty newly-germinated cotton pollen grains of variety A were placed on growth medium in a Petri dish and incubated in the dark for 24 hours at 15 °C. After this time, the length of each pollen tube was measured and the mean calculated. This was repeated at 5 different temperatures.

The investigation was then repeated using variety B. The results are shown in the table below.

Incubation temperature / °C	**Mean length of pollen tube after 24 hours incubation / mm**	
	variety A	**variety B**
15	0.18	0.19
20	0.35	0.48
25	0.53	0.83
30	0.60	0.90
35	0.57	0.60
40	0.10	0.10

(i) Describe the effect of temperature on the mean length of pollen tubes for variety A.

(2)

(ii) Compare the effect of temperature on the mean length of pollen tubes in variety A with variety B, between 15 °C and 30 °C.

(2)

(iii) Suggest an explanation for the change in the mean length of pollen tubes when the temperature increased from 35 °C to 40 °C.

(1)

(Total for Question 5 = 12 marks)

6 Humans have found that plants are a valuable source of cellulose, starch and fibres.

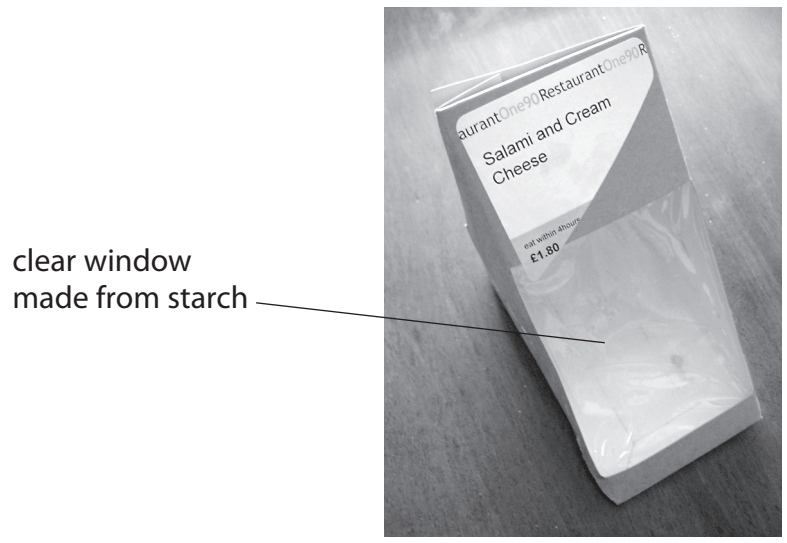
(a) The table below lists some statements about polysaccharides.

Indicate whether each statement is true or false by placing a cross (☒) in the appropriate box.

(5)

Statements	True	False
Polymer of glucose	☒	☒
Molecule contains α and β glucose	☒	☒
Glycosidic bonds present	☒	☒
Molecule may have side branches	☒	☒
Molecule can form hydrogen bonds with adjacent molecules	☒	☒

(b) The clear window in this sandwich packaging is made from starch rather than plastic.



Suggest how this use of starch, rather than plastic, may contribute to **sustainability**.

(2)

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(c) Plant stems contain xylem vessels and sclerenchyma fibres.

Give **one** similarity and **one** difference between xylem vessels and sclerenchyma fibres.

(2)

Similarity .....

.....

Difference .....

.....

(Total for Question 6 = 9 marks)

Turn over ▶

7 The process of natural selection can lead to the adaptation of organisms to their environment as well as to evolution.

(a) The diagram below shows two species of invertebrates found in freshwater.

Mayfly nymph

Rat-tailed maggot

(i) Suggest **two** features of the mayfly nymph, shown in the diagram above, that makes it well-adapted to survival in fast-flowing streams. Explain how each feature helps it to survive.

(4)

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2 .....

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(ii) The rat-tailed maggot lives in water which has a low concentration of dissolved oxygen. Suggest how the structure labelled T helps it to survive in this environment.

(2)

(b) Adaptation can occur within the same species. Leopards and panthers are members of the same species found in Africa. Leopards have spotted fur and hunt in open grasslands, whilst panthers have black fur and hunt in forests.

Suggest how natural selection has led to the evolution of these two different forms of the same species.

(4)

(Total for Question 7 = 10 marks)

Turn over ▶

8 Classification of organisms is important when trying to assess biodiversity.

(a) All organisms can be classified into one of three domains.

Name the **three** domains of organisms.

(3)

1 .....

2 .....

3 .....

(b) (i) Explain what is meant by the term **species**.

(2)

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(ii) Explain the meaning of the term **genetic diversity** within a species.

(2)

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(iii) Describe how zoos maintain the genetic diversity of endangered species.

(4)

(Total for Question 8 = 11 marks)

TOTAL FOR THE PAPER = 80 MARKS

Do not write outside the box

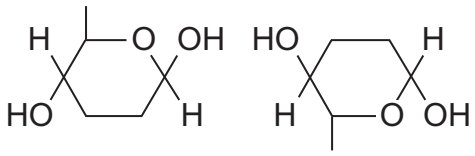
Answer **all** questions in the spaces provided.

1 (a) The table shows some substances found in cells. Complete the table to show the properties of these substances. Put a tick in the box if the statement is correct.

Statement	Substance			
	Starch	Glycogen	Deoxyribose	DNA helicase
Substance contains only the elements carbon, hydrogen and oxygen				
Substance is made from amino acid monomers				
Substance is found in both animal cells and plant cells				

(4 marks)

1 (b) The diagram shows two molecules of β-glucose.



On the diagram, draw a box around the atoms that are removed when the two β-glucose molecules are joined by condensation.

(2 marks)

1 (c) (i) Hydrogen bonds are important in cellulose molecules. Explain why.

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(2 marks)

1 (c) (ii) A starch molecule has a spiral shape. Explain why this shape is important to its function in cells.

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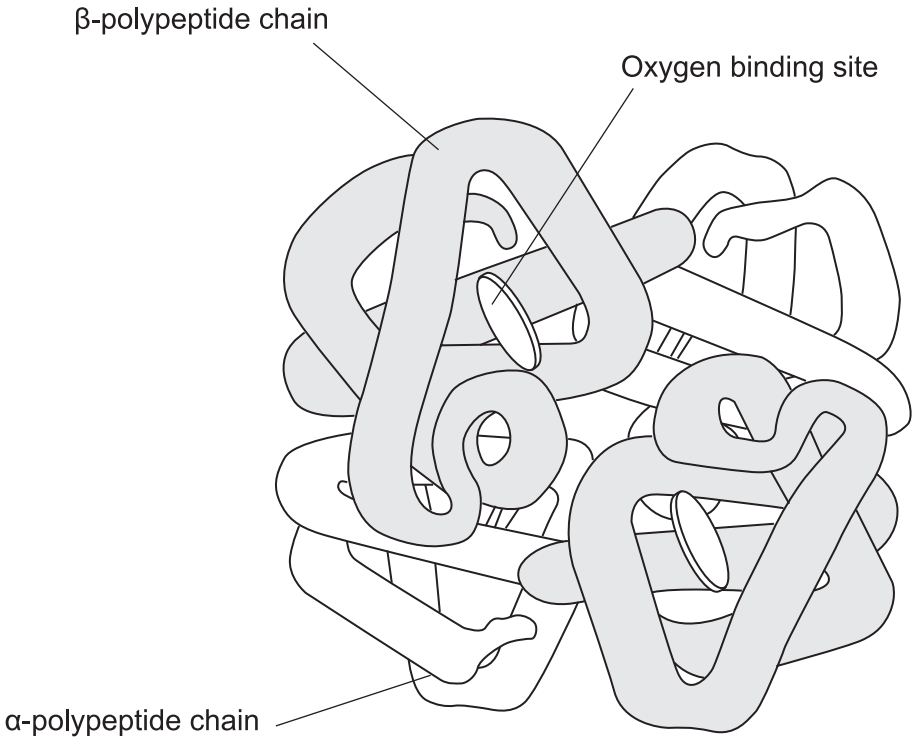
(1 mark)

9

Turn over for the next question

Do not write outside the box

2 The diagram shows a molecule of haemoglobin.



2 (a) What is the evidence from the diagram that haemoglobin has a quaternary structure?

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(1 mark)

2 (b) (i) A gene codes for the α-polypeptide chain. There are 423 bases in this gene that code for amino acids. How many amino acids are there in the α-polypeptide chain?

(1 mark)

2 (b) (ii) The total number of bases in the DNA of the α-polypeptide gene is more than 423. Give **two** reasons why there are more than 423 bases.

1 .....

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2 .....

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(2 marks)

2 (c) The haemoglobin in one organism may have a different chemical structure from the haemoglobin in another organism. Describe how.

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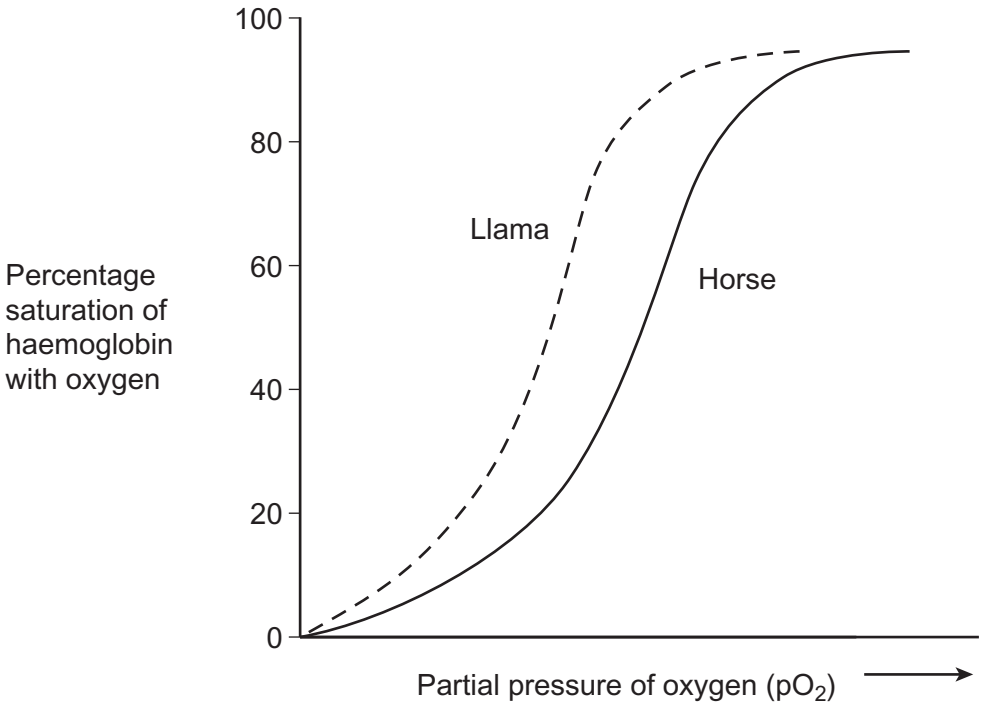
(1 mark)

2 (d) The graph shows oxygen dissociation curves for horse haemoglobin and for llama haemoglobin. Horses are adapted to live at sea level and llamas are adapted to live in high mountains.



Use the graph to explain why llamas are better adapted to live in high mountains than horses.

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(3 marks)

(Extra space) .....

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8

Do not write outside the box

3 (a) An order is a taxonomic group. Fruit flies and mosquitoes belong to the same order of insects. Name the other **three** taxonomic groups to which fruit flies and mosquitoes both belong.

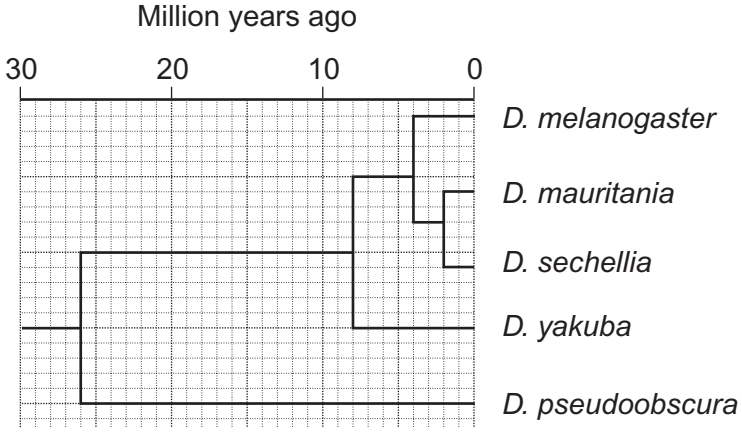
1 .....

2 .....

3 .....

(2 marks)

The diagram shows the phylogenetic relationship between five species of fruit fly that belong to the genus *Drosophila.*



3 (b) (i) Explain what is meant by a phylogenetic relationship.

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(1 mark)

3 (b) (ii) How many million years ago did *D. melanogaster* and *D. pseudoobscura* last share a common ancestor?

(1 mark)

3 (c) Scientists used DNA hybridisation to confirm the relationship between *D. mauritania, D. sechellia* and *D. yakuba.*

3 (c) (i) They made samples of hybrid DNA using a gene that was found in all three species. Explain why it was important that they made samples of hybrid DNA from the same gene.

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(2 marks)

3 (c) (ii) The hybrid DNA formed between *D. mauritania* and *D. sechellia* separated at a higher temperature than the hybrid DNA formed between *D. mauritania* and *D. yakuba.* Explain what caused the DNA to separate at a higher temperature.

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(2 marks)

8

Turn over for the next question

Do not write outside the box

4 The table shows some differences between three varieties of banana plant.

	Variety **A**	Variety **B**	Variety **C**
Number of chromosomes in a leaf cell	22	33	44
Growth rate of fruit / cm^3 $week^{-1}$	2.9	6.9	7.2
Breaking strength of leaf / arbitrary units	10.8	9.4	7.8

4 (a) (i) How many chromosomes are there in a male gamete from variety **C**?

(1 mark)

4 (a) (ii) Variety **B** cannot produce fertile gametes. Use information in the table to explain why.

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(2 marks)

In some countries very strong winds may occur. Banana growers in these countries choose to grow variety **B**.

4 (b) (i) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **A**.

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(1 mark)

4 (b) (ii) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **C**.

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(1 mark)

4 (c) Banana growers can only grow new variety **B** plants from suckers. Suckers grow from cells at the base of the stem of the parent plant.

Use your knowledge of cell division to explain how growing variety **B** on a large scale will affect the genetic diversity of bananas.

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(2 marks)

7

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DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

5 (a) What information is required to calculate an index of diversity for a particular community?

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(1 mark)

5 (b) Farmers clear tropical forest and grow crops instead. Explain how this causes the diversity of insects in the area to decrease.

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(3 marks)

(Extra space) .....

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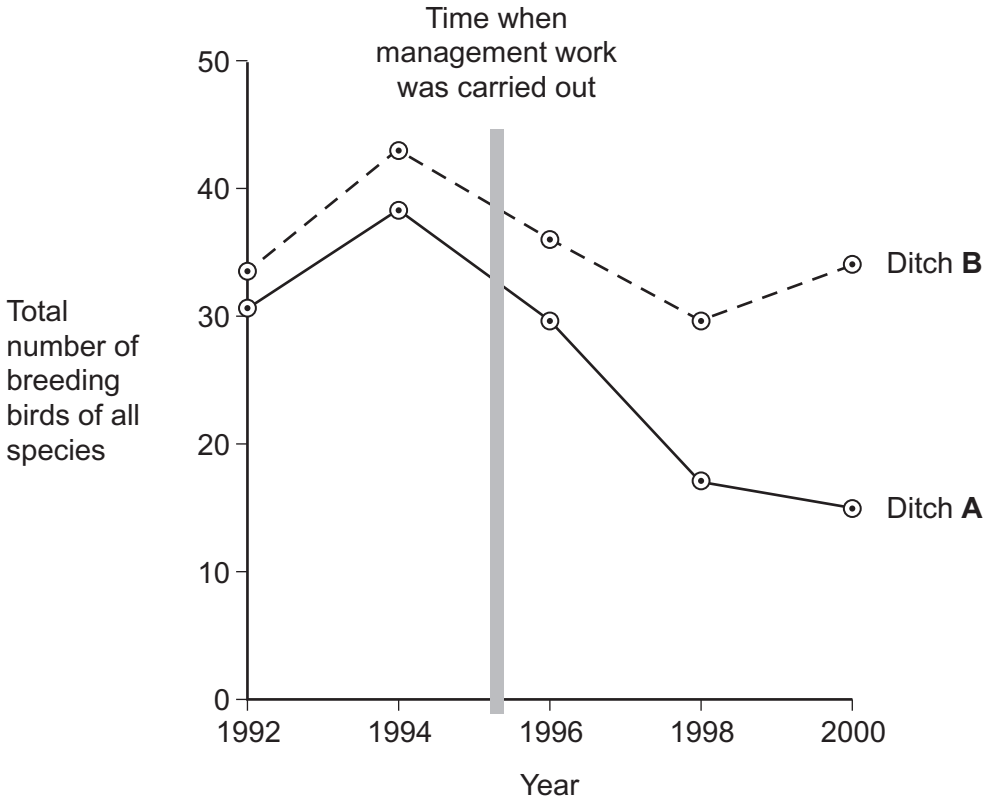
Question 5 continues on the next page

Farmers manage the ditches that drain water from their fields. If they do not, the ditches will become blocked by plants. Biologists investigated the effects of two different ways of managing ditches on farmland birds.

- Ditch **A** was cleared of plants on both banks
- Ditch **B** was cleared of plants on one bank.

The graph shows the number of breeding birds of all species along the two ditches, before and after management.



5 (c) (i) The points on the graph have been joined with straight lines rather than with a smooth curve. Explain why they have been joined with straight lines.

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(1 mark)

5 (c) (ii) It would have been useful to have had a control ditch in this investigation. Explain why.

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(1 mark)

5 (d) A farmer who wanted to increase the diversity of birds on his land read about this investigation.
He concluded that clearing the plants from one bank would not decrease diversity as much as clearing the plants from both banks. Evaluate this conclusion.

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(3 marks)

(Extra space) .....

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9

Turn over for the next question

6 Penicillins are antibiotics. Some bacteria produce an enzyme that breaks down one sort of penicillin.

6 (a) The gene that codes for this enzyme may be passed from one species of bacteria to another species. Describe how.

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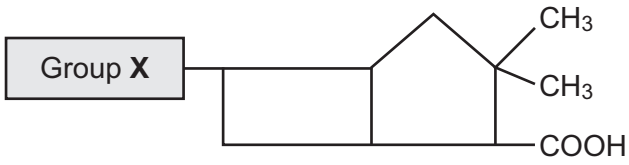
(2 marks)

6 (b) There are different sorts of penicillin. All of these have the same basic chemical structure shown in the diagram but group **X** is different.



A bacterial infection that cannot be treated with one sort of penicillin can be treated with a different sort. Use your knowledge of enzyme action to explain why the different sort of penicillin is effective in treating the infection.

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(3 marks)

(Extra space) .....

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6 (c) Farmers often keep large numbers of cattle together. Farmers used to give cattle food which had antibiotics added to it.

6 (c) (i) Suggest how adding antibiotics to the food of the cattle increased profit for the farmers.

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(2 marks)

6 (c) (ii) Adding antibiotics to the food of cattle is now banned in many countries. Use your knowledge of selection to explain why adding antibiotics was banned.

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(2 marks)

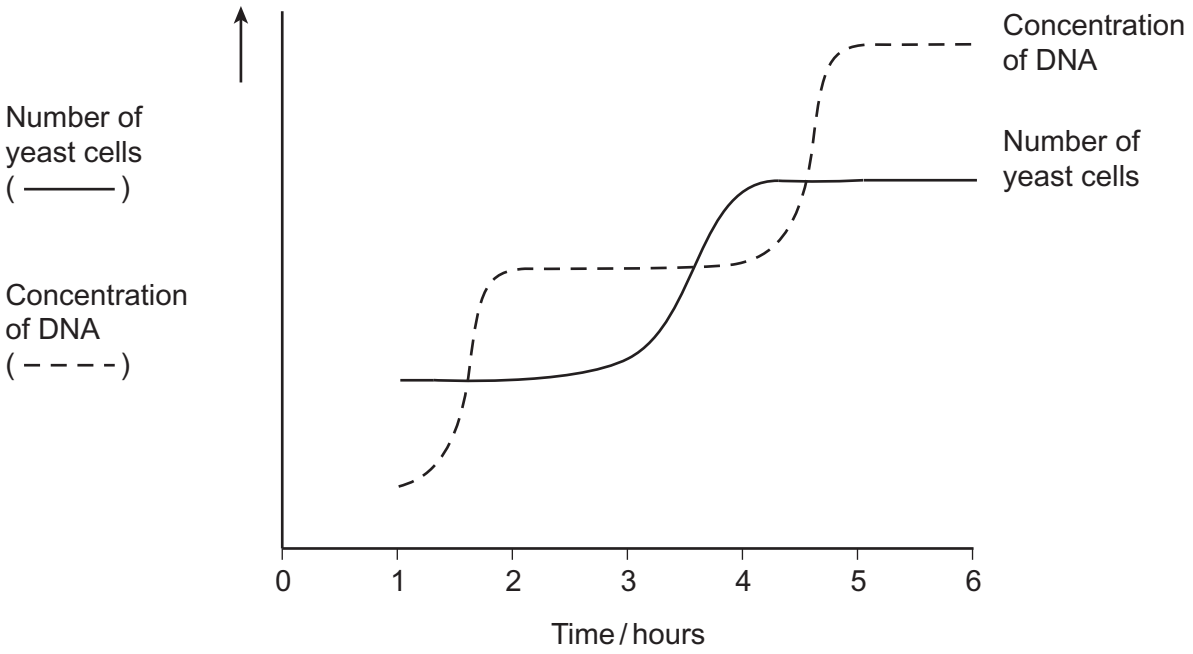
9

Turn over for the next question

Do not write outside the box

7 Yeast is a single-celled eukaryotic organism. When yeast cells are grown, each cell forms a bud. This bud grows into a new cell. This allows yeast to multiply because the parent cell is still alive and the new cell has been formed.

Scientists grew yeast cells in a culture. They counted the number of cells present and measured the total concentration of DNA in the culture over a period of 6 hours. Their results are shown in the graph.



Do not write outside the box

7 (a) Use your knowledge of the cell cycle to explain the shape of the curve for the number of yeast cells

7 (a) (i) between 1 and 2 hours

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(1 mark)

7 (a) (ii) between 3 and 4 hours.

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(1 mark)

7 (b) Use the curve for the concentration of DNA to find the length of a cell cycle in these yeast cells. Explain how you arrived at your answer.

Length of cell cycle .....

Explanation .....

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(3 marks)

5

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DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

8 (a) Students measured the rate of transpiration of a plant growing in a pot under different environmental conditions. Their results are shown in the table.

Conditions			Transpiration rate / g h^{-1}
A	Still air	15 °C	1.2
B	Moving air	15 °C	1.7
C	Still air	25 °C	2.3

During transpiration, water diffuses from cells to the air surrounding a leaf.

8 (a) (i) Suggest an explanation for the difference in transpiration rate between conditions **A** and **B.**

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(2 marks)

8 (a) (ii) Suggest an explanation for the difference in transpiration rate between conditions **A** and **C.**

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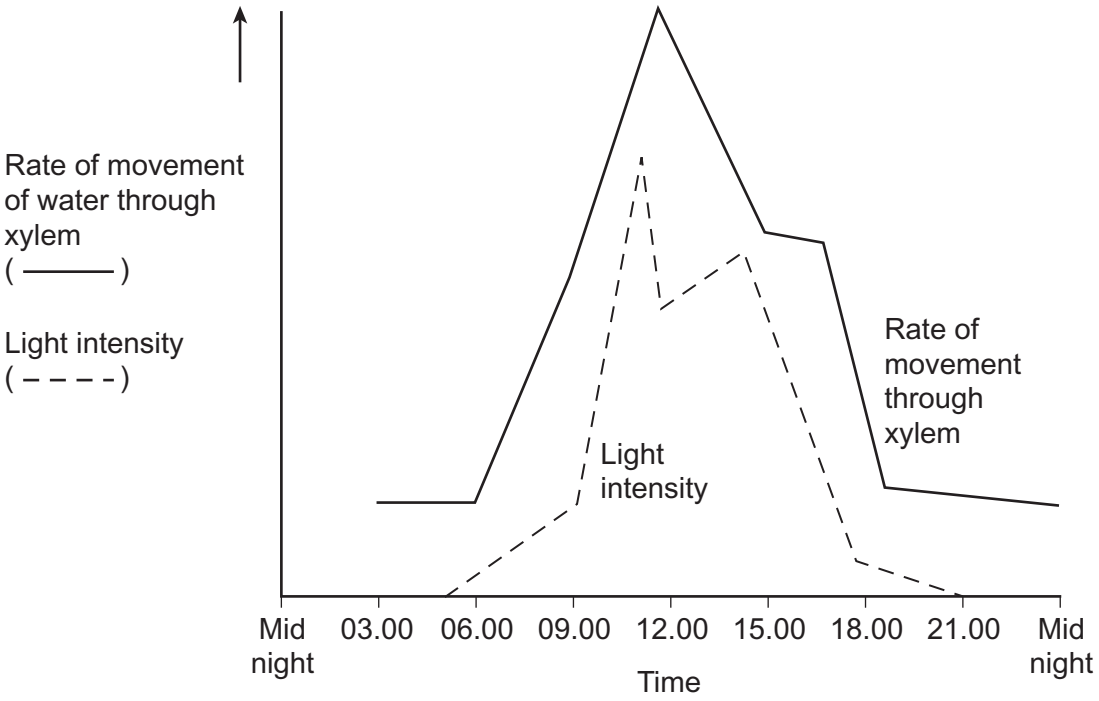
(2 marks)

Question 8 continues on the next page

Do not write outside the box

8 (b) Scientists investigated the rate of water movement through the xylem of a twig from a tree over 24 hours. The graph shows their results. It also shows the light intensity for the same period of time.



8 (b) (i) Describe the relationship between the rate of water movement through the xylem and the light intensity.

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(1 mark)

8 (b) (ii) Explain the change in the rate of water movement through the xylem between 06.00 and 12.00 hours.

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(2 marks)

Do not write outside the box

8 (b) (iii) The scientists also measured the diameter of the trunk of the tree on which the twig had been growing. The diameter was less at 12.00 than it was at 03.00 hours. Explain why the diameter was less at 12.00 hours.

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(2 marks)

Question 8 continues on the next page

Do not write outside the box

8 (c) Arteries and arterioles take blood away from the heart.
Explain how the structures of the walls of arteries and arterioles are related to their functions.

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(6 marks)

(Extra space) .....

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15

Question 9 starts on page 24

Do not write outside the box

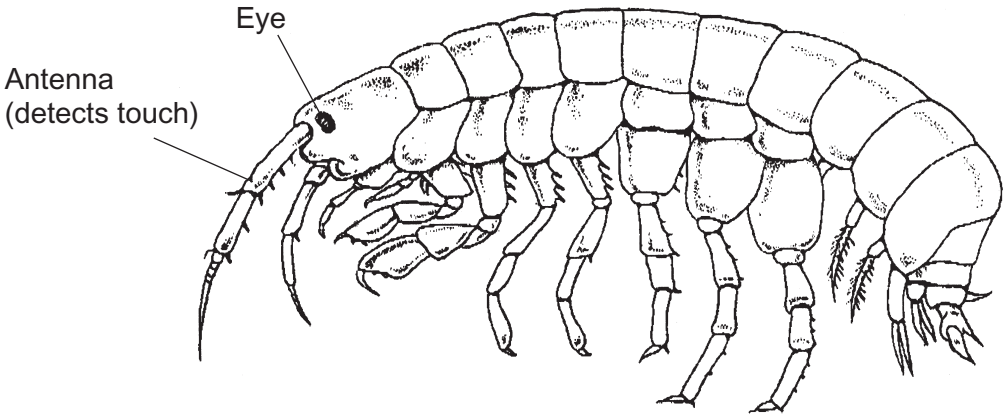
Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

9 **Figure 1** shows a fresh-water shrimp.

Figure 1



Biologists collected shrimps from a stream inside a cave and from the same stream when it was in the open.
They measured the maximum diameter of each shrimp's eye. They also measured the length of its antenna. From these measurements they calculated the mean values for each site. **Figure 2** shows their results.

Figure 2

	Shrimps from the stream	
	inside the cave	**in the open**
Mean diameter of eye / mm	0.09	0.24
Mean length of antenna / mm	8.46	5.81

9 (a) The biologists measured the maximum diameter of each shrimp's eye.
Explain why they measured the **maximum** diameter.

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(1 mark)

Do not write outside the box

9 (b) A scientist working many years earlier suggested that animals which live in caves had similar adaptations. These adaptations included

- smaller eyes
- greater use of sense organs such as those involved in detecting touch.

9 (b) (i) Do the data in **Figure 2** support this scientist's suggestion? Explain your answer.

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(2 marks)

9 (b) (ii) The data in **Figure 2** are mean values. Explain how standard deviations of these mean values would help you to interpret the data in **Figure 2.**

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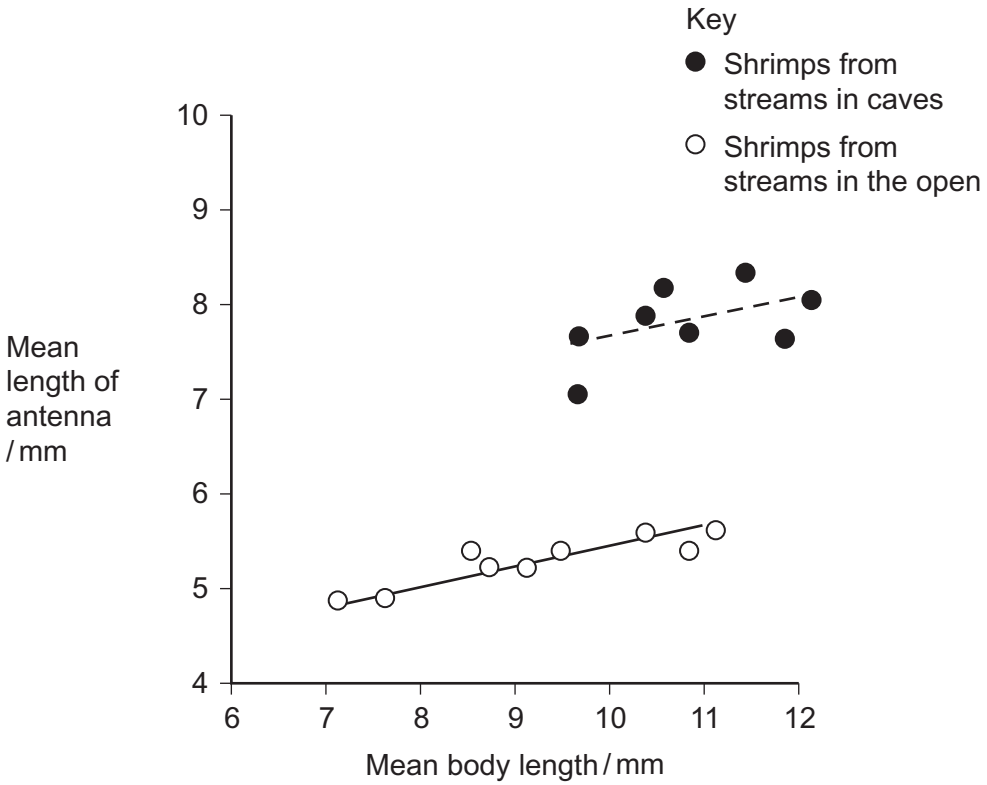
(2 marks)

Question 9 continues on the next page

Do not write outside the box

9 (c) The biologists investigated shrimps living in other streams. They measured the length of the antennae of these shrimps. They also measured their body length. **Figure 3** shows the mean antenna length plotted against mean body length for each site.

Figure 3



9 (c) (i) What does the information in the graph suggest about the body lengths of shrimps living in caves and living in the open?

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(2 marks)

9 (c) (ii) Do the data in the graph support the conclusion that shrimps with longer bodies have longer antennae? Give the reason for your answer.

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(1 mark)

Other biologists investigated the genetic diversity of these shrimps.
Figure 4 shows some of the data they collected.

Figure 4

Gene	Allele	Percentage of shrimps with this allele in stream	
		inside a cave	in the open
PGI	**A**	0.9	2.5
	B	0.0	3.3
	C	98.2	66.4
	D	0.9	6.6
	E	0.0	21.3
ACO2	**J**	0.0	5.6
	K	0.0	76.7
	L	100.0	17.8

9 (d) The biologists concluded that the shrimps in the open had a higher genetic diversity than those in the cave. Explain how the data in **Figure 4** support this conclusion.

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(1 mark)

9 (e) The percentage of shrimps with allele **L** in the cave is different from the percentage of shrimps with allele **L** in the open. Use your knowledge of the founder effect to suggest a reason for this difference.

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(3 marks)

(Extra space) .....

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Question 9 continues on the next page

9 (f) The biologists who studied these shrimps wanted to know if the shrimps living in the cave were the same species as those living in the open. They used breeding experiments to investigate this.

9 (f) (i) Describe how the biologists should carry out these breeding experiments.

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9 (f) (ii) The results of breeding experiments would help the biologists to decide whether the shrimps were the same species. Explain how.

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(3 marks)

15

END OF QUESTIONS

Practice 4

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 All organisms are made up of one or more cells.

(a) For each of the descriptions below, put a cross ☒ in the box that corresponds to the correct statement about the features of animal, plant and prokaryotic cells.

(6)

(i) Genetic material is

☒ **A** separate strands in animal and prokaryotic cells

☒ **B** separate strands in animal and plant cells

☒ **C** circular in animal and prokaryotic cells

☒ **D** circular in animal and plant cells

(ii) Centrioles are present in

☒ **A** plant cells only

☒ **B** animal cells only

☒ **C** prokaryotic cells only

☒ **D** animal, plant and prokaryotic cells

(iii) The cell surface membrane is present in

☒ **A** plant cells only

☒ **B** animal cells only

☒ **C** prokaryotic cells only

☒ **D** animal, plant and prokaryotic cells

(iv) Pits are found in the cell walls of

☒ **A** plant cells only

☒ **B** prokaryotic cells only

☒ **C** plant and prokaryotic cells

☒ **D** animal, plant and prokaryotic cells

(v) The tonoplast may be present in

☒ **A** plant cells only

☒ **B** prokaryotic cells only

☒ **C** plant and prokaryotic cells

☒ **D** animal, plant and prokaryotic cells

(vi) Cell walls are found in

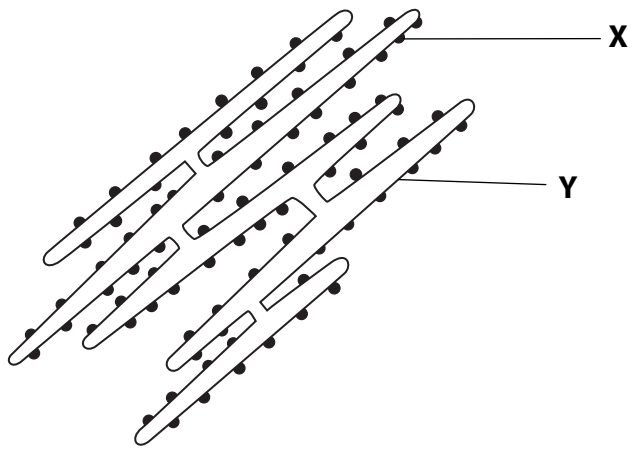
☒ **A** plant cells only

☒ **B** prokaryotic cells only

☒ **C** plant and prokaryotic cells

☒ **D** animal, plant and prokaryotic cells

(b) The diagram below shows a structure found in the cytoplasm of both plant and animal cells, as seen using an electron microscope.



(i) Name the structure shown in the diagram.

(1)

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(ii) Name the parts labelled **X** and **Y**.

(2)

X .....

Y .....

(Total for Question 1 = 9 marks)

Turn over ▶

2 The phenotype of an organism is affected by its genotype and its environment.

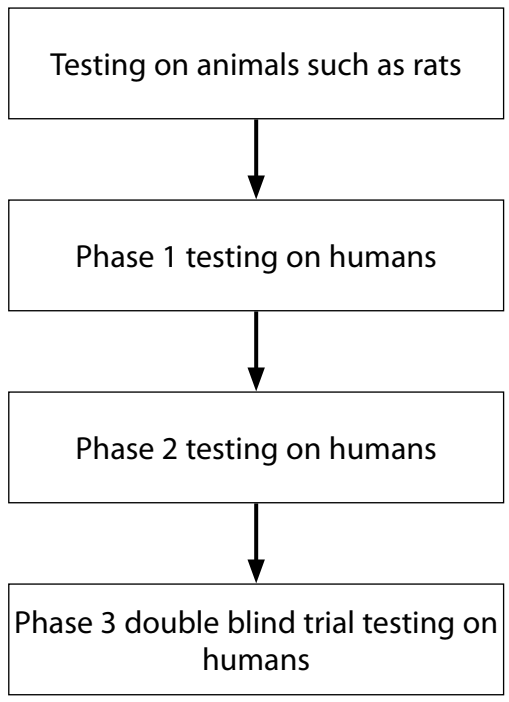
(a) The table below shows the mean difference in two phenotypes, height and mass, from a study on several human identical twins and non-identical twins. Each pair of twins was brought up together.

	Type of twins	
Phenotype	**Identical**	**Non-identical**
Mean height difference / cm	1.7	4.4
Mean mass difference / kg	1.9	4.6

Explain how the data in the table show the effects that genotype and the environment have on the phenotypes.

(3)

(b) When a drug is being developed, it goes through a series of different test stages.
Some of these are shown below.



(i) Suggest why a drug can be tested on rats before testing on humans.

(2)

Turn over ▶

(ii) State what is done during each of the following phases of testing on humans.

(3)

Phase 1 .....

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Phase 2 .....

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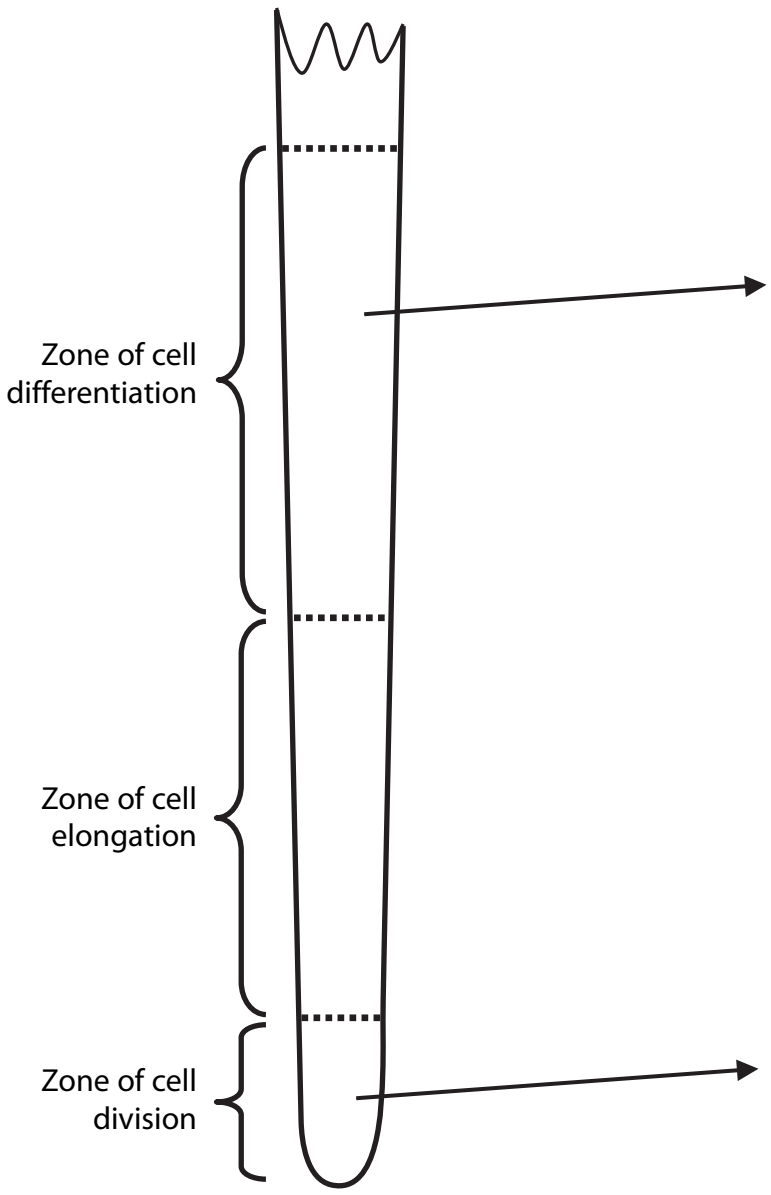
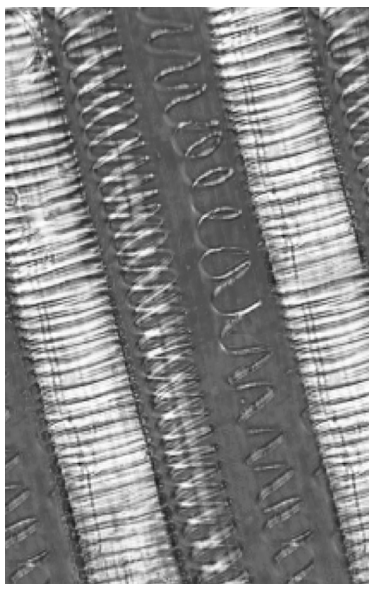
(Total for Question 2 = 8 marks)

3 In the roots of plants, cell division, cell elongation (growth) and cell differentiation occur in different zones near the root tip.

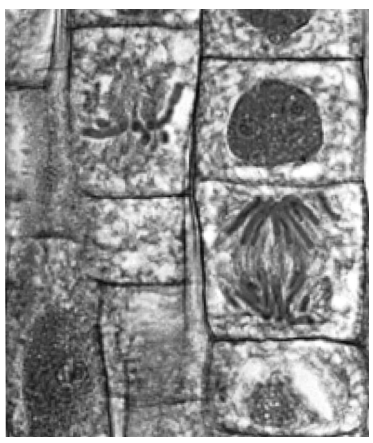
The diagram below show the three different zones in a root. Photographs **A** and **B** show some of the tissues present in two of these zones.



Photograph A



Photograph B



(a) (i) Name the specialised tissue shown in photograph **A**.

(1)

*(ii) Describe and explain how this tissue is adapted for the transport of water and support in a plant.

(4)

(b) Explain how differential gene expression could result in the specialisation of cells.

(3)

(c) Only one of the two tissues shown in the photographs **A** and **B** is totipotent. Describe how you could use a plant tissue culture technique to show which of the two tissues is totipotent.

(4)

(Total for Question 3 = 12 marks)

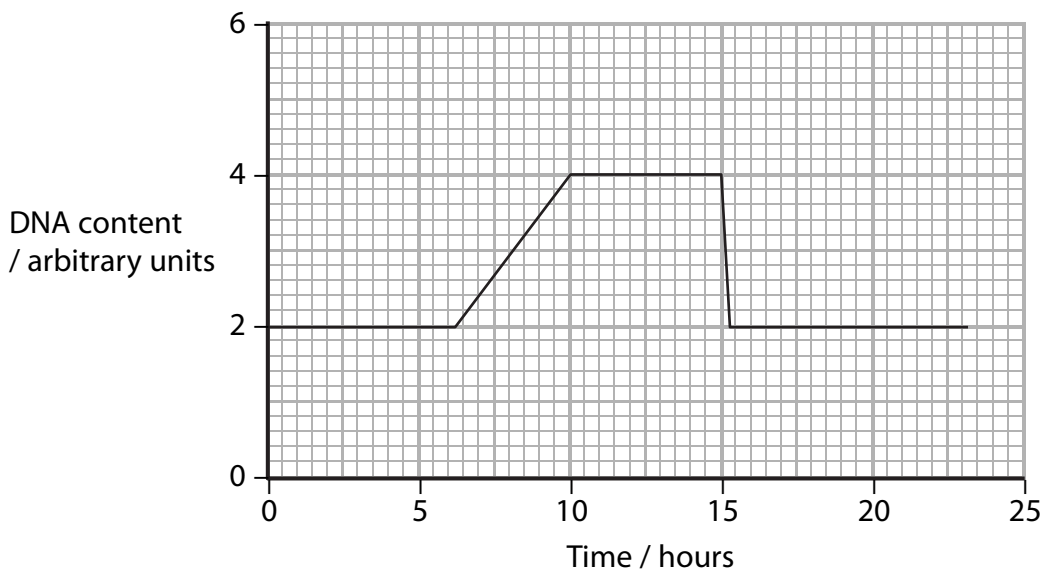
Turn over ▶

4 Cell division produces more cells. Groups of cells become organised into tissues and further organisation results in the formation of a multicellular organism.

(a) Complete the diagram below by writing in the boxes the missing levels of organisation in the correct order.

(2)

(b) The graph below shows the changes in the DNA content of an onion cell, during one cell cycle.



(i) Explain why the DNA content of the cell doubles.

(2)

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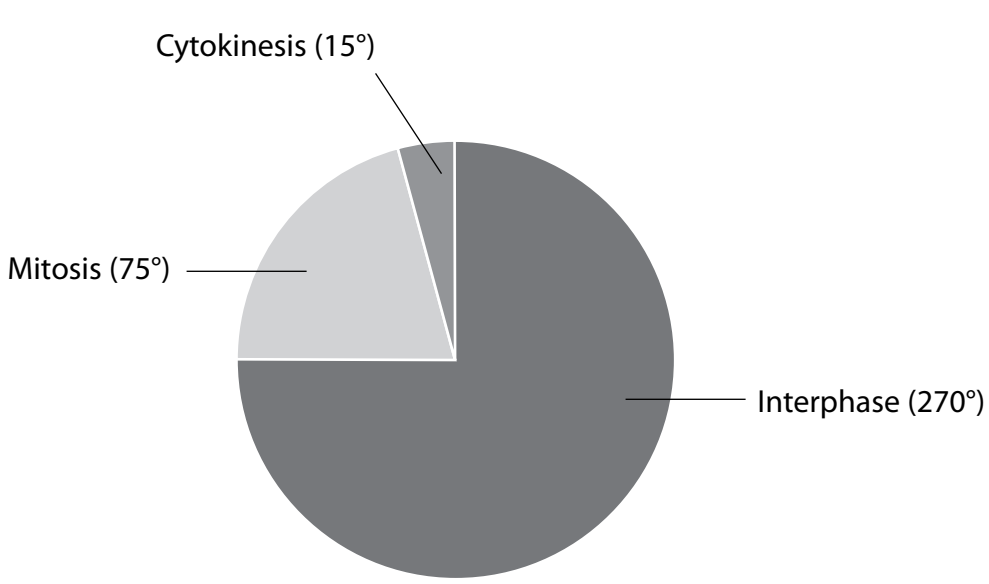
(ii) Using the graph, state how long the S phase (DNA synthesis) takes.

(1)

..... hours

(iii) In onion cells, interphase lasts an average of 18 hours. Using this information and the diagram below, calculate how long mitosis takes. The figures in brackets show the number of degrees for each sector of the circle. Show your working.

(2)



Answer ..... hours

Turn over ▶

*(c) Prophase is a stage in mitosis. Describe the events that occur during prophase.

(3)

(Total for Question 4 = 10 marks)

5 Meiosis is involved in producing gametes such as sperm cells and egg cells.

(a) Describe **three** structural differences between a human sperm cell and a human egg cell.

(3)

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(b) When a sperm cell reaches an egg cell, enzymes are released from the head of the sperm. Explain the reasons for the release of these enzymes.

(2)

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(c) Describe what happens in the egg cell once the sperm cell nucleus has entered it.

(2)

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(d) In plants, a double fertilisation occurs.

(i) One fertilisation involves a male gamete nucleus fusing with the egg cell nucleus. Give **two** functions of this fertilisation.

(2)

1 .....

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2 .....

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(ii) In the second fertilisation, the other male gamete nucleus fuses with two polar nuclei forming a triploid structure. Name the triploid structure formed.

(1)

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(Total for Question 5 = 10 marks)

6 The diversity of ant species in a habitat can be used as an indicator of environmental conditions and conservation status.

(a) A study of the effect of high copper levels on ant diversity was undertaken in Brazil. Ants were collected in the same way at three different sites in one habitat. The number of different species at each site was recorded. Site 1 and Site 2 were near a copper mine and had high levels of copper present. Site 3 had normal levels of copper. The amount of vegetation present at each site was also recorded.

The results are shown in the table below.

Site	Number of ant species found	Amount of vegetation present
1	14	Very little
2	16	Little
3	45	Rich and dense

(i) Using the information in the table, what is the evidence that ant diversity can be used as an indicator of environmental conditions?

(1)

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(ii) It has been suggested that there is no **direct** effect of copper on ants. Suggest how the data in the table support this suggestion.

(2)

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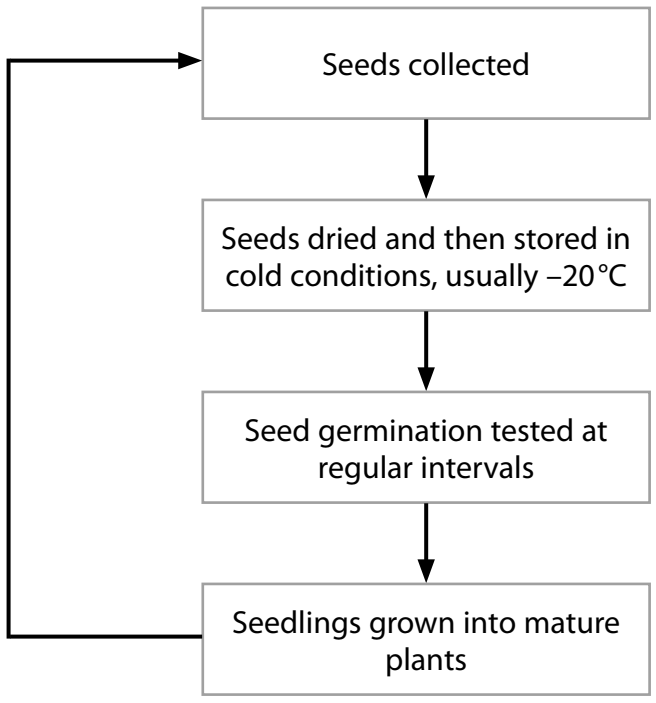
(b) Seedbanks have been set up around the world to help conserve rare plant species.
The process for storing seeds includes the following stages.



(i) Suggest **two** reasons why the seeds need to be dried and then stored in cold conditions.

(2)

1 .....

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2 .....

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(ii) Suggest why seed germination is tested at regular intervals.

(2)

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(c) One of the aims of both seedbanks and zoos is to conserve endangered species.

Give **two** ways in which zoos help to conserve endangered species.

(2)

1 .....

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2 .....

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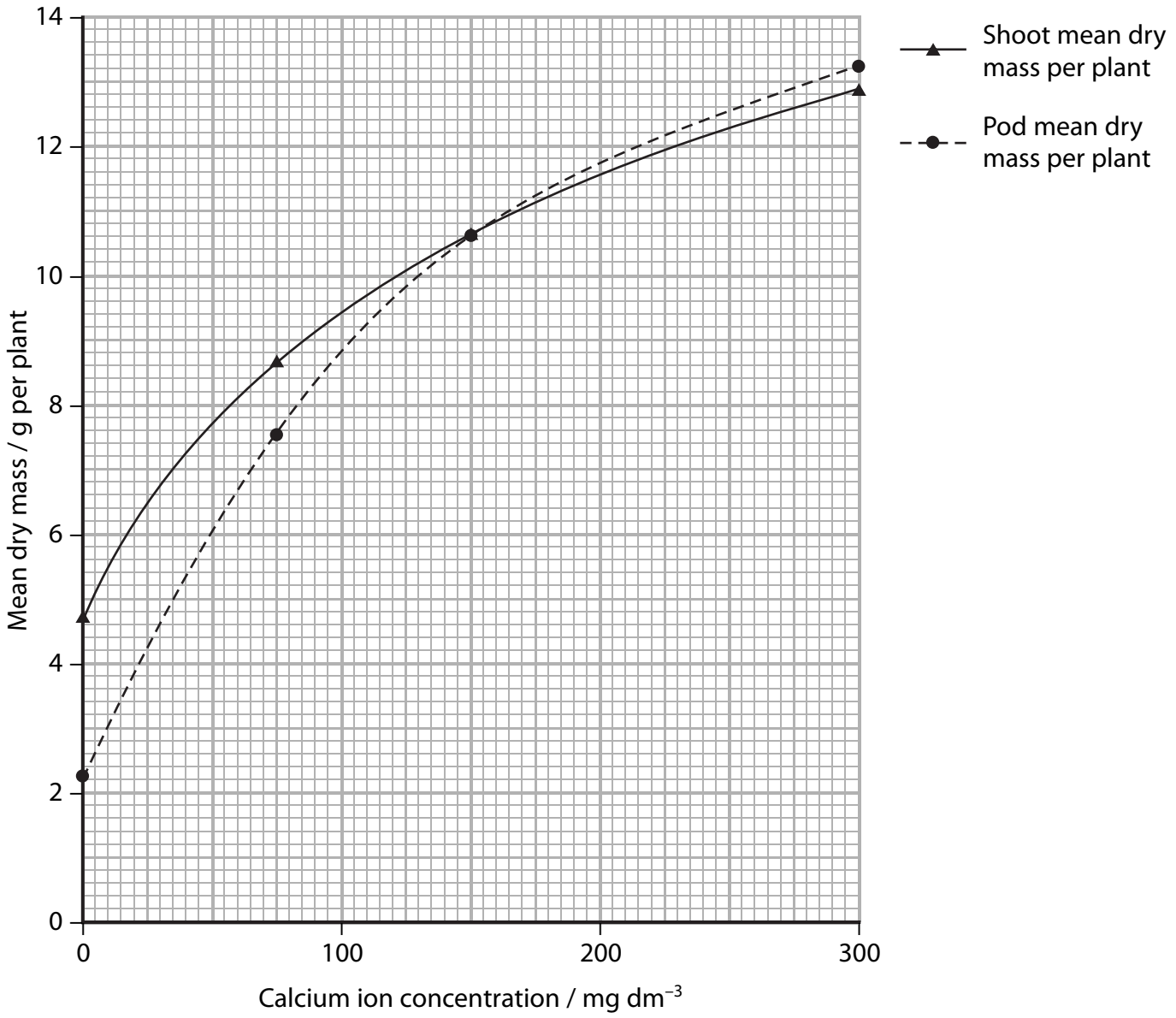
(Total for Question 6 = 9 marks)

7 A study was undertaken to investigate the effect of calcium ion concentration on the mass of shoots and the mass of pods of bean plants.

Two bean plants were grown in a pot and watered regularly with a solution containing all the required mineral ions except calcium. When the plants had produced mature bean pods, the shoots and the pods were dried and the mean dry masses were recorded.

This experiment was repeated three times, each with a different calcium ion concentration added to the watering solution.

The results are shown in the graph below.



(a) (i) Using the information in the graph, compare the effect of calcium ion concentration on the mean dry mass of shoots and the mean dry mass of pods in bean plants.

(3)

(ii) Suggest how calcium ions contributed to the change in mass in the shoot of the bean plant.

(1)

(b) During this investigation, it was found that there was a relationship between calcium ion concentration in the watering solution and total nitrogen uptake by the bean pods. The data are shown below.

Calcium ion concentration in the watering solution / mg dm^{-3}	**Total nitrogen uptake by the bean pods / mg**
0	70
75	220
150	290
300	350

(i) Describe the relationship between calcium ion concentration and total nitrogen uptake by the bean pods.

(2)

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(ii) Suggest the form in which the nitrogen was supplied in the watering solution.

(1)

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*(iii) Suggest how the protein content of the bean pods from plants grown in the watering solution containing a calcium ion concentration of 300 mg dm^{-3} would differ from those watered with a lower calcium ion concentration.

Give an explanation for your answer.

(3)

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(Total for Question 7 = 10 marks)

8 A student investigated the antimicrobial properties of tea tree oil.

She cut three identical discs of blotting paper. She soaked disc 1 in 100% tea tree oil, disc 2 in 50% tea tree oil and 50% vegetable oil and disc 3 in 100% vegetable oil. She then placed all three discs onto a single suitably-prepared Petri dish as shown in diagram 1.

She incubated the Petri dish at 25 °C for 24 hours. The results of the incubation are shown below in diagram 2.

Diagram 1

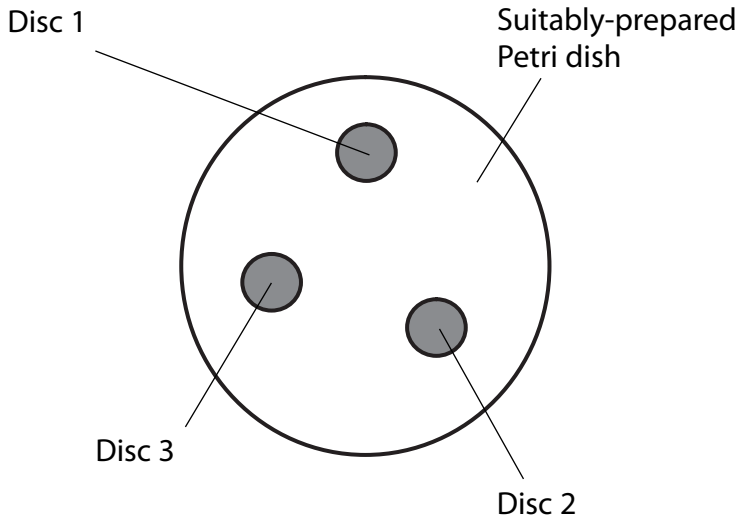
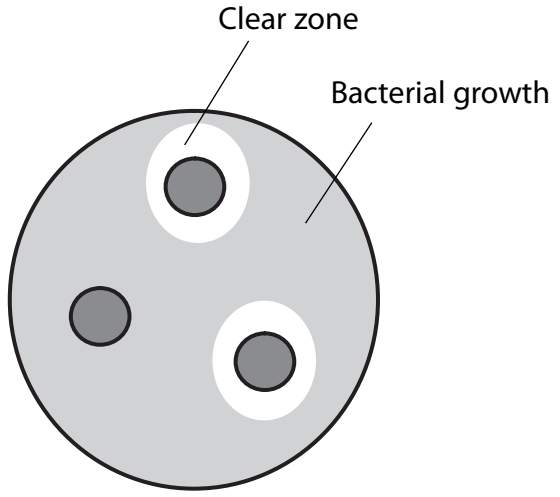


Diagram 2



(a) Suggest what is meant by the phrase **suitably-prepared Petri dish**.

(2)

(b) (i) Describe the function of disc 3.

(1)

(ii) Explain why clear zones are found around disc 1 and disc 2.

(2)

(iii) The clear zone around disc 1 is not a circle. Suggest how you would calculate the mean diameter of this clear zone.

(2)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(c) The mean diameters of the clear zones around disc 1 and disc 2 were found to be the same. This suggests that both strengths of tea tree oil had equally effective antimicrobial properties.

Describe how you would determine the minimum strength of tea tree oil that would be as effective as the 100% tea tree oil.

(3)

(d) Suggest **one** reason why it was good safety practice to incubate the Petri dish at 25 °C rather than at 37 °C.

(2)

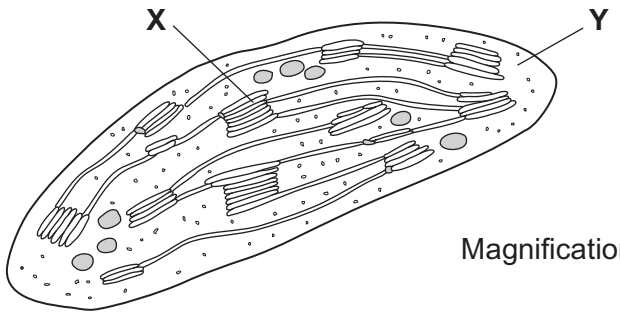
(Total for Question 8 = 12 marks)

TOTAL FOR PAPER = 80 MARKS

Do not write outside the box

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

1 The diagram shows a chloroplast as seen with an electron microscope.



Magnification × 30 000

1 (a) Name **X** and **Y**.

X .....

Y .....

(2 marks)

1 (b) Describe the function of a chloroplast.

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(2 marks)

1 (c) Calculate the maximum length of this chloroplast in micrometres (μm). Show your working.

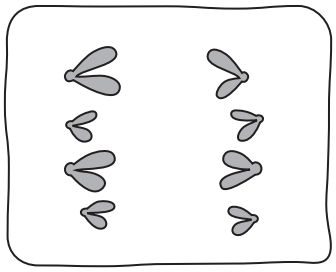
Answer ..... μm

(2 marks)

6

Do not write outside the box

2 (a) The diagram shows a stage of mitosis in an animal cell.



2 (a) (i) Name this stage.

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(1 mark)

2 (a) (ii) Describe what happens during this stage that results in the production of two genetically identical cells.

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(2 marks)

2 (b) A sample of epithelial tissue from the small intestine of an animal was analysed. Some of the cells had 8.4 units of DNA, others had only 4.2 units.

2 (b) (i) Use your knowledge of the cell cycle to explain why some cells had 8.4 units of DNA and others had only 4.2 units.

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(2 marks)

2 (b) (ii) How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

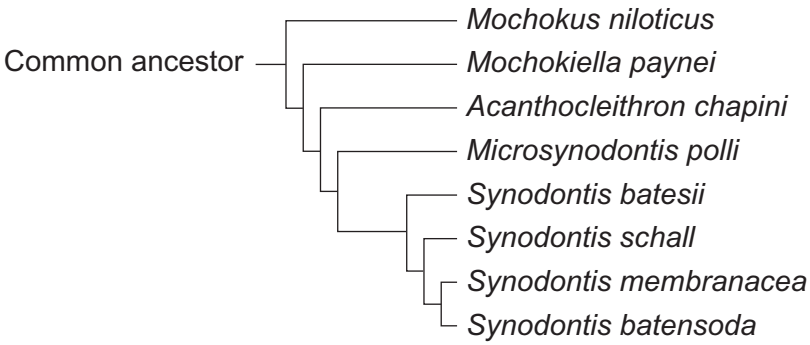
(1 mark)

6

Turn over for the next question

Do not write outside the box

3 There are over 200 species of catfish. All catfish evolved from a common ancestor. The diagram shows how some species of catfish are classified. This diagram is based on the evolutionary links between these species.



3 (a) (i) Which species of catfish is most closely related to *Synodontis membranacea*?

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(1 mark)

3 (a) (ii) Which species of catfish is most distantly related to *Synodontis membranacea*?

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(1 mark)

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

(1 mark)

3 (c) (i) A scientist carried out breeding experiments with catfish from different populations. Describe how the results could show that the catfish belong to the same species.

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(1 mark)

3 (c) (ii) The variety of colours displayed by catfish is important in courtship. Give **two** ways in which courtship increases the probability of successful mating.

1 .....

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2 .....

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(2 marks)

6

Turn over for the next question

4 Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

4 (a) (i) What is the maximum number of amino acids for which this base sequence could code?

(1 mark)

4 (a) (ii) Explain how this mutation leads to the formation of non-functioning PAH.

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(3 marks)

(Extra space) .....

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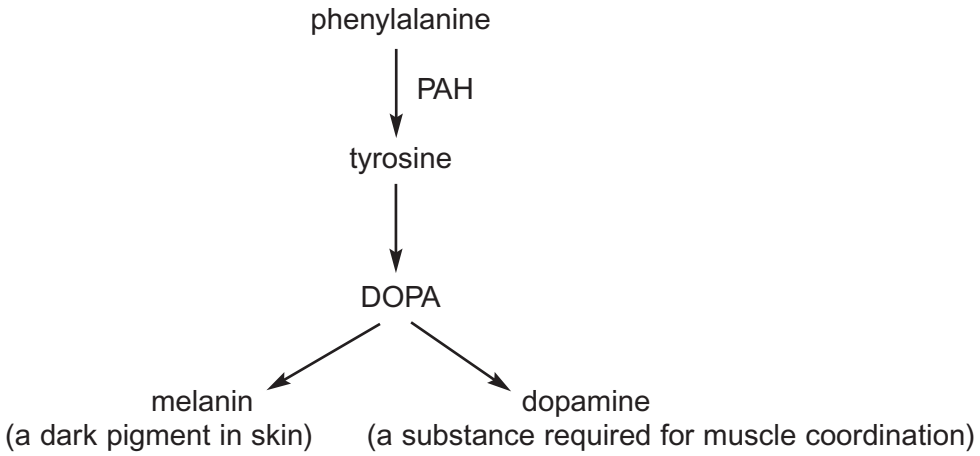
PAH catalyses a reaction at the start of two enzyme-controlled pathways. The diagram shows these pathways.



4 (b) Use the information in the diagram to give **two** symptoms you might expect to be visible in a person who produces non-functioning PAH.

1 .....

2 .....

(2 marks)

4 (c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how the spread of this mutation may have occurred.

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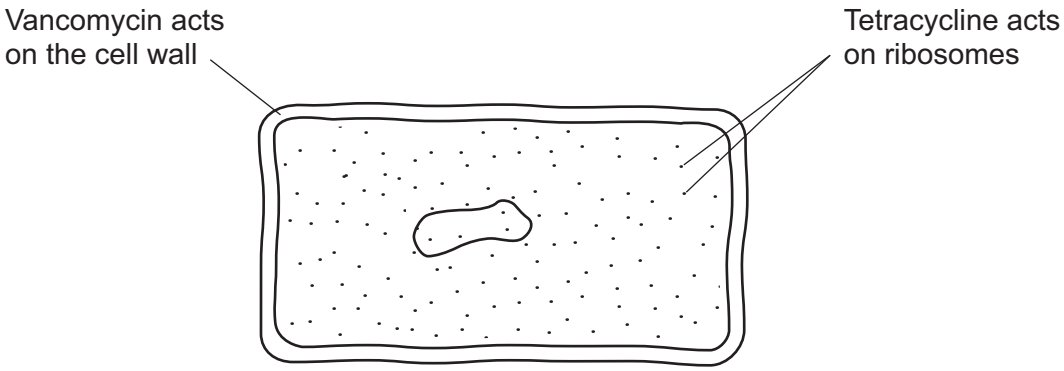
(1 mark)

7

Do not write outside the box

5 The diagram shows the structure of a bacterium and the sites of action of two antibiotics.



5 (a) (i) Use information in the diagram to explain why vancomycin does **not** affect human cells.

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(1 mark)

5 (a) (ii) Use information in the diagram to explain how tetracycline prevents bacterial growth.

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(1 mark)

5 (b) Frequent treatment with vancomycin can result in resistant strains of bacteria. Explain how.

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(3 marks)

(Extra space) .....

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5 (c) The gene for resistance to vancomycin is very common in the bacterium *Enterococcus faecalis*. The same gene has now been found in the bacterium *Staphylococcus aureus*.

Use your knowledge of gene transmission to explain how the gene was passed from one species of bacterium to another.

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(3 marks)

(Extra space) .....

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8

6 (a) Scientists can use protein structure to investigate the evolutionary relationships between different species. Explain why.

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(2 marks)

6 (b) Comparing the base sequence of genes provides more evolutionary information than comparing the structure of proteins. Explain why.

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(2 marks)

6 (c) The proteins of different species can be compared using immunological techniques. The protein albumin obtained from a human was injected into a rabbit. The rabbit produced antibodies against the human albumin. These antibodies were extracted from the rabbit and then added to samples of albumin obtained from four different animal species. The amount of precipitate produced in each sample was then measured. The results are shown in the table.

Species from which albumin was obtained	Amount of precipitate / arbitrary units
Rat	23
Chimpanzee	96
Marmoset	65
Trout	11

What do the results suggest about the evolutionary relationship between humans and the other species?

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(2 marks)

6

Turn over for the next question

Do not write outside the box

7 (a) A student investigated the diversity of plants at several sites on a golf course. At each site she took a large number of random samples.

7 (a) (i) Explain the importance of taking a large number of samples at each site.

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(1 mark)

7 (a) (ii) Explain the importance of taking samples at random.

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(1 mark)

The student collected data from one part of the golf course and calculated an index of diversity.

The table shows her data.

Species	Number of plants per m^2
Sheep's fescue	11
Creeping buttercup	6
Clover	5
Dandelion	2
Sheep's sorrel	1
Lady's bedstraw	7
Stemless thistle	4

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

7 (b) Use the formula to calculate the index of diversity for the plants on this part of the golf course. Show your working.

Answer .....

(2 marks)

7 (c) The golf course was surrounded by undeveloped grassland from which it had been produced.
The golf course had

- some areas of very short grass which was cut frequently
- some areas of longer grass which was cut less frequently
- some areas of long grass and shrubs which were never cut.

The index of diversity for the insects on the golf course was higher than that for the surrounding undeveloped grassland.

Explain the effect of developing this golf course on the index of diversity of insects.

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(3 marks)

(Extra space) .....

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7

Do not write outside the box

8 (a) Root pressure moves water through the xylem. Describe what causes root pressure.

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(3 marks)

(Extra space) .....

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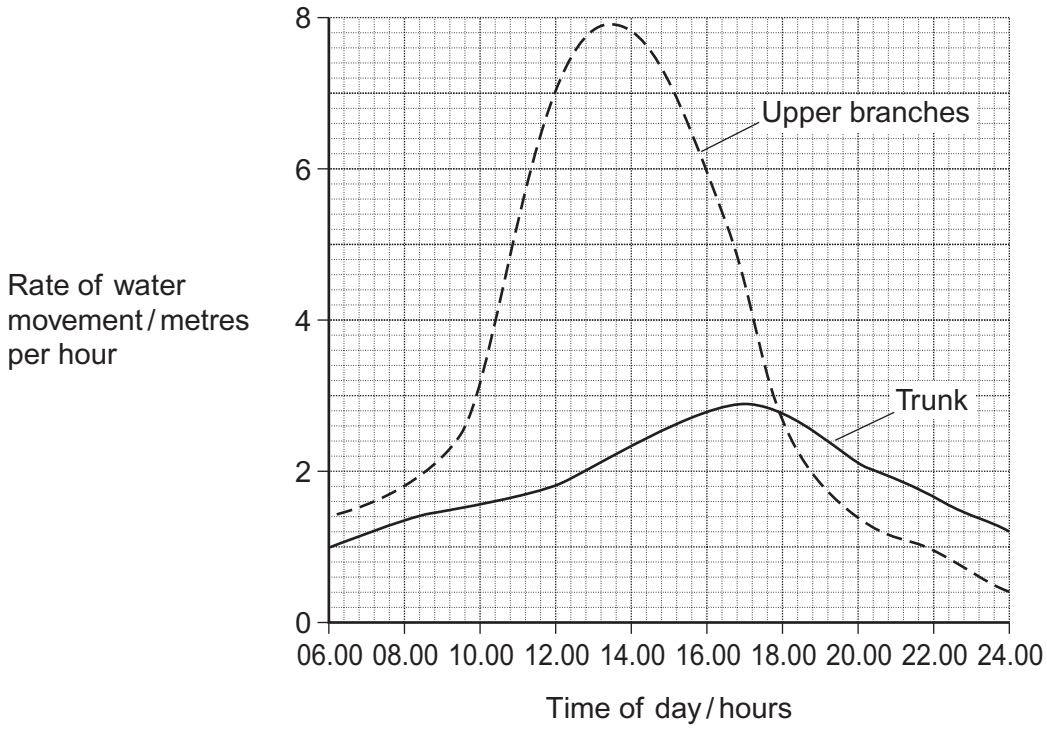
8 (b) A biologist investigated the rate of water movement during the day in different parts of a tree. The results are shown in the graph.



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8 (b) (i) Describe how the rate of water movement in the upper branches changed over the period shown in the graph.

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(2 marks)

8 (b) (ii) The rate of water movement in the upper branches was different from the rate of water movement in the trunk. Describe how.

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(2 marks)

8 (b) (iii) The results of this investigation support the cohesion tension theory. Explain how.

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(2 marks)

9

Do not write outside the box

9 (a) Explain how oxygen is loaded, transported and unloaded in the blood.

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(6 marks)

(Extra space) .....

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Midges are very small insects. The early stages of the life cycle of midges are called larvae. Midge larvae live in water. A biologist investigated the uptake of oxygen by the larvae of two species of midge. He measured the rate of uptake of oxygen by the larvae in water containing different concentrations of oxygen. The table shows his results.

Concentration of oxygen in water / $cm^3\ dm^{-3}$	**Mean rate of oxygen uptake / $cm^3\ g^{-1}\ h^{-1}$**	
	Chironomus longistylus	*Tanytarsus brunnipes*
1	220	141
2	285	246
3	304	342
4	313	362
5	320	367
6	318	430
7	320	469

9 (b) The larvae in this investigation were kept at a temperature of 17 °C. Why was it important that the larvae of both species were kept at the same temperature?

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(2 marks)

9 (c) Describe the effect of an increase in oxygen concentration on the mean rate of oxygen uptake in *Chironomus longistylus*.

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(2 marks)

Question 9 continues on the next page

Do not write outside the box

9 (d) *Chironomus longistylus* lives in still water whereas *Tanytarsus brunnipes* lives in fast running streams. The water in fast running streams has a higher concentration of oxygen than in still water. Use the table on page 19 to suggest how *Chironomus longistylus* is better adapted than *Tanytarsus brunnipes* to living in still water.

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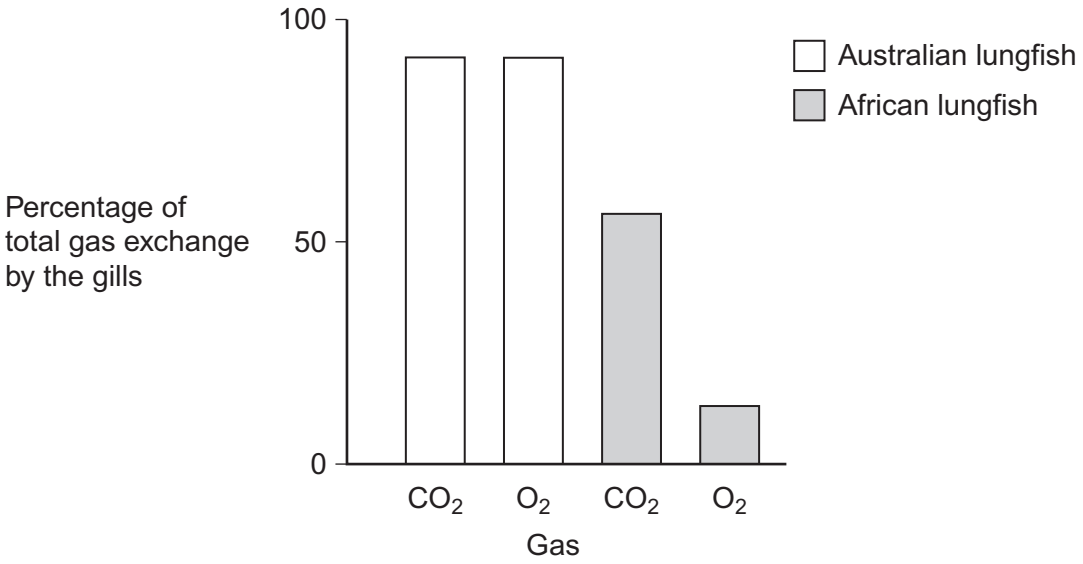
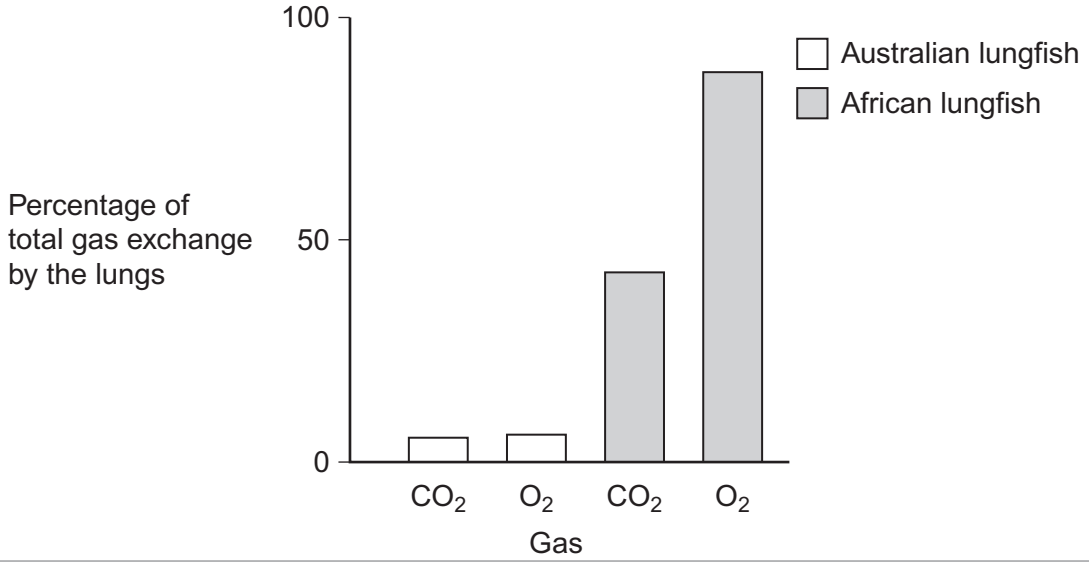
(2 marks)

9 (e) Lungfish are freshwater fish which have gills and lungs. Scientists investigated how Australian and African lungfish use their lungs and gills for gas exchange. The graphs show the results of this investigation.





9 (e) (i) Describe the difference in the way carbon dioxide is lost from the body of an Australian lungfish and an African lungfish.

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(1 mark)

9 (e) (ii) African lungfish are likely to survive for longer than Australian lungfish when living in pools that dry up. Explain why.

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(2 marks)

15

Turn over for the next question

10 Scientists investigated the effect of drinking tea and coffee on reducing the risk of developing one type of brain cancer. The investigation involved 410 000 volunteers and was conducted in 10 European countries over a period of 8.5 years.

10 (a) (i) Apart from age, suggest **two** factors that the scientists should have considered when selecting volunteers for this trial.

1 .....

2 .....

(2 marks)

10 (a) (ii) Give **two** features of the design of this investigation that would ensure the reliability of the results obtained.

1 .....

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2 .....

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(2 marks)

10 (b) The incidence for this type of brain cancer is 6 cases per 100 000 per year.
Use this information to calculate the expected number of volunteers developing this cancer during the 8.5 year period of this investigation. Show your working.

Answer .....

(2 marks)

10 (c) In analysing the results of this investigation, the scientists took into account the age of the volunteers. Suggest why.

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(1 mark)

10 (d) During the investigation, the volunteers were asked to estimate the volume of tea and/or coffee that they drank each day. The types of tea and coffee consumed in different countries varied. When the data from all the countries were collected there was a correlation between drinking more than 100 cm^3 of tea or coffee each day and a reduced risk of developing this type of brain cancer.

Tea and coffee contain caffeine. A newspaper reported the results of this investigation under the headline 'Caffeine helps cut cancer risk'. Explain why scientists could **not** support this view solely on the basis of this investigation.

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(4 marks)

(Extra space) .....

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Question 10 continues on the next page

10 (e) Another group of scientists investigated the effect of caffeine on blood flow to certain parts of the brain. Volunteers were given different concentrations of caffeine solution to drink. A control group was also set up.

10 (e) (i) Describe how the control group should have been treated.

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(2 marks)

10 (e) (ii) Volunteers who drank the same concentration of caffeine solution often had different concentrations of caffeine in their blood. Suggest **one** reason for the difference in concentration of caffeine in the blood of volunteers.

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(1 mark)

10 (e) (iii) The investigation showed that caffeine reduces the blood flow to certain parts of the brain. Suggest **one** way in which this could lead to a reduced risk of brain cancers.

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(1 mark)

15

END OF QUESTIONS