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

1 (a) (i) What is atheroma?

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(2 marks)

(Extra space) ....

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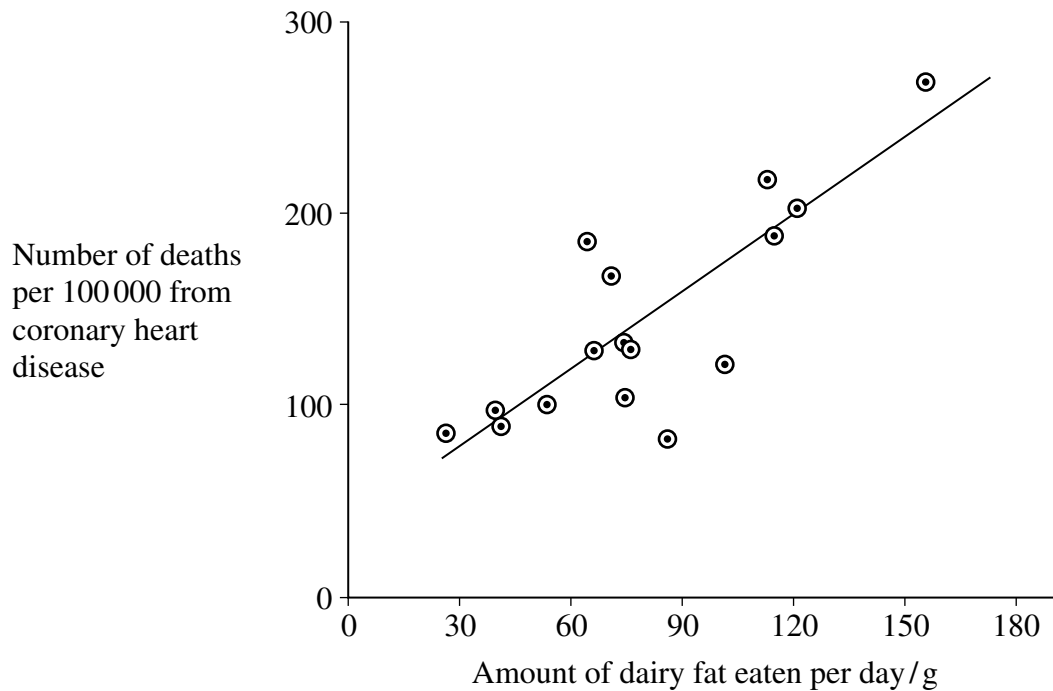
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(3 marks)

(Extra space) ....

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

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

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(2 marks)

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

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(2 marks)

9

Turn over ▶

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

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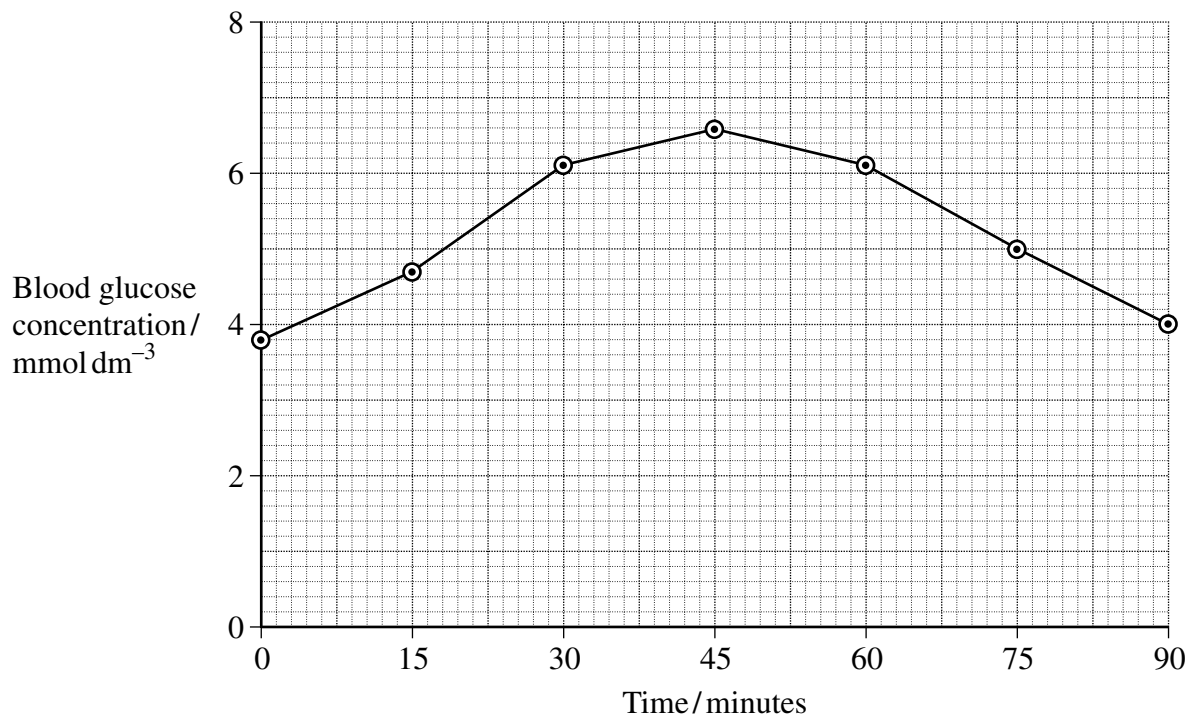
.... and ....
(2 marks)

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

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(2 marks)

(Extra space) ....

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

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

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(2 marks)

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

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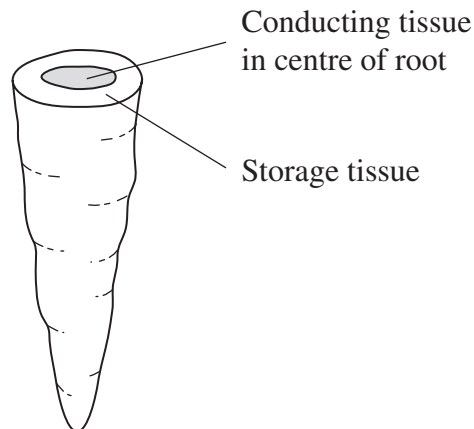
(2 marks)

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

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

9

Turn over ▶

3   The diagram shows a carrot.

Conducting tissue
in centre of root

Storage tissue

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

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

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(2 marks)

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

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(2 marks)

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

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

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

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(2 marks)

(Extra space) ....

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

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(1 mark)

7

Turn over ▶

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

A ——————— Lumen of alveolus
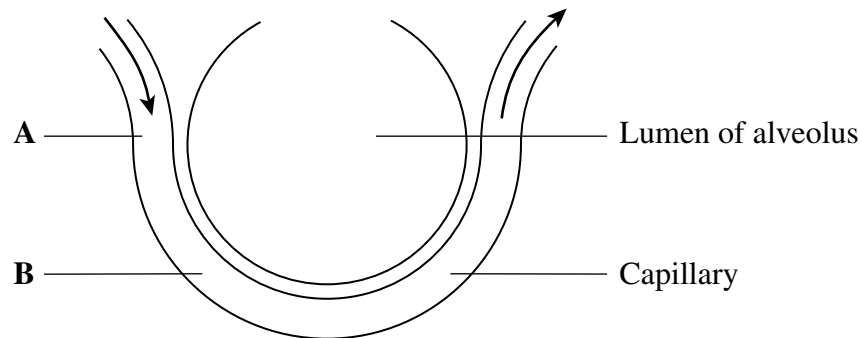
B ——————— Capillary

10 μm

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

Answer .... seconds
(2 marks)

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

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

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(1 mark)

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

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(2 marks)

(Extra space) ....

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

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

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(1 mark)

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

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(2 marks)

(Extra space) ....

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8

Turn over ▶

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

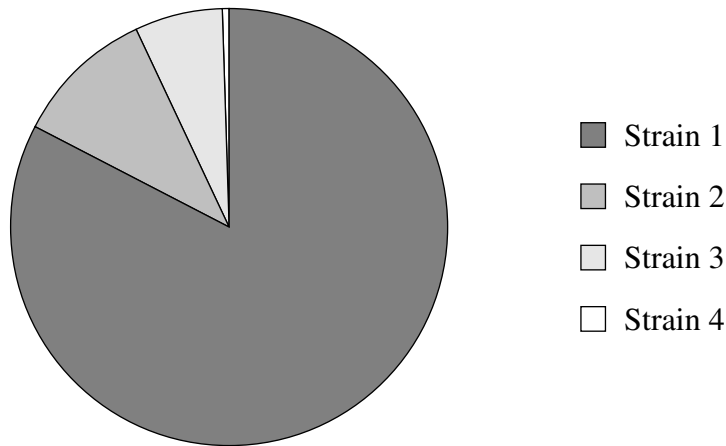...

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(3 marks)

(Extra space) ....

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

■ Strain 1
■ Strain 2
□ Strain 3
□ Strain 4

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

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(2 marks)

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

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(2 marks)

7

Turn over ▶

6 Read the following passage.

Campylobacter jejuni is a bacterium. It is one of the commonest causes of diarrhoea
in humans. The illness that it causes does not usually last very long and many sufferers
do not even go to the doctor. The only treatment required is the use of oral rehydration
solutions to replace the water lost by diarrhoea. In 1998, laboratory tests confirmed
60 000 cases of diarrhoea caused by this bacterium in the UK. The bacterium was   5
more frequently found in males than in females with a ratio of 1.5 : 1.

In rare cases, the nervous system may be affected. Scientists are now beginning to
understand the cause of this. Sugars in the antigens on the surface of the bacteria are
identical to some of the sugars on the surface of nerve cells. Antibodies produced
against the bacteria may therefore attack the body's nerve cells. There can be serious   10
problems if this leads to paralysis of the diaphragm. Breathing difficulties result and
the patient may die.

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

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

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(1 mark)

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

Answer ....
(1 mark)

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

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(3 marks)

(Extra space) ....

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

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(3 marks)

(Extra space) ....

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

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(2 marks)

10

Turn over ▶

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

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(5 marks)

(Extra space) ....

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

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(5 marks)

(Extra space) ....

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10

END OF QUESTIONS

mock papers 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 Read through the following passage that describes the process of blood clotting, then write on the dotted lines the most appropriate word or words to complete the passage.

(6)

A blood clot may form when a blood vessel wall becomes damaged.

Cell fragments called .... stick to the wall of the damaged

blood vessel forming a plug. A series of chemical changes occur in the blood,

resulting in .... being converted into thrombin.

Thrombin is an .... that catalyses the conversion

of .... into long insoluble strands of

.... These strands form a mesh that trap

.... to form the clot.

(Total for Question 1 = 6 marks)

2 Transcription and translation are two main stages in protein synthesis.

(a) Complete the table below by writing the word **transcription** or **translation** next to the appropriate statement about protein synthesis.

(5)

Statement	Stage of protein synthesis
Ribosomes are involved	
DNA acts as a template	
tRNA is involved	
Peptide bonds are made	
mRNA is made	

3

Turn over ▶

(b) The table below shows some amino acids and their corresponding DNA triplet codons. The DNA triplet codons for a stop signal are also shown.

Amino acid / stop signal	DNA triplet codons
Proline	GGT GGG GGA
Alanine	CGG CGA CGT CGC
Cysteine	ACA ACG
Serine	AGG AGA AGT AGC
Leucine	GAA GAG GAT GAC
Arginine	GCA GCG GCT GCC
Glutamine	CTT CTC
Glycine	CCT CCG CCA CCC
Threonine	TGC TGA TGT TGG
Stop signal	ATT ATC ACT

The diagram below shows part of a DNA molecule.

codon 84	codon 85	codon 86	codon 87	codon 88	codon 89

A   C   A   C   T   T   A   C   A   G   C   C   G   G   T   G   G   G
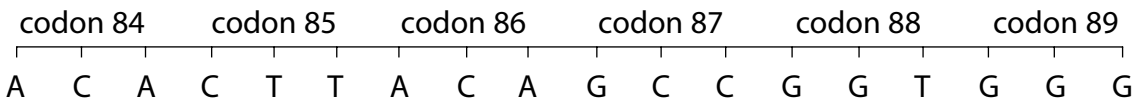
(i) Place a cross ☒ in the box next to the amino acid coded for by codon 85.

(1)

Leucine ☒

Glutamine ☒

Glycine ☒

Serine ☒

(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 DNA strand.

(1)

cysteine glutamine cysteine arginine proline proline ☒

threonine leucine threonine alanine glycine glycine ☒

cysteine glutamine cysteine arginine glycine glycine ☒

cysteine proline cysteine arginine proline proline ☒

4

(iii)   If codon 89 coded for the last amino acid in the polypeptide chain, place a cross ☒ in the box next to codon 90.

(1)

GGG   ☒

ATC   ☒

TAG   ☒

AGT   ☒

(iv)   Place a cross ☒ in the box next to the sequence of bases on a molecule of messenger RNA (mRNA) synthesised from this part of the DNA molecule.

(1)

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

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

U G U G A A U G U C G G C C A C C C   ☒

A G A C U U A G A C G G C C U G G G   ☒

(v)   Place a cross ☒ in the box next to the statement that best describes what the polypeptide chain would be like if the 90th codon was ACT and the 91st codon was CTT on the DNA molecule.

(1)

The polypeptide chain would be no more than 89 amino acids long   ☒

The 89th amino acid would be threonine and the 90th amino acid would be leucine   ☒

The polypeptide chain would be more than 90 amino acids long   ☒

The polypeptide chain would be more than 91 amino acids long   ☒

(Total for Question 2 = 10 marks)

3 Starch is a storage carbohydrate found in plants. Starch is composed of many α-glucose molecules that bond together by condensation reactions.

(a) The diagram below shows the structure of α-glucose.

$$CH_2OH$$
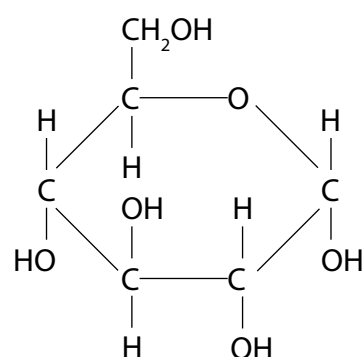
(i) In the space below, draw a diagram to show the products formed when two α-glucose molecules join together by means of a condensation reaction to form maltose.

(3)

(ii) Name the bond that joins the two α-glucose molecules together.

(1)

6

(b) Describe the structure of starch and explain why this structure makes it a suitable molecule for storing energy.

(4)

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(Total for Question 3 = 8 marks)

4   The diagram below represents the structure of the cell surface membrane.
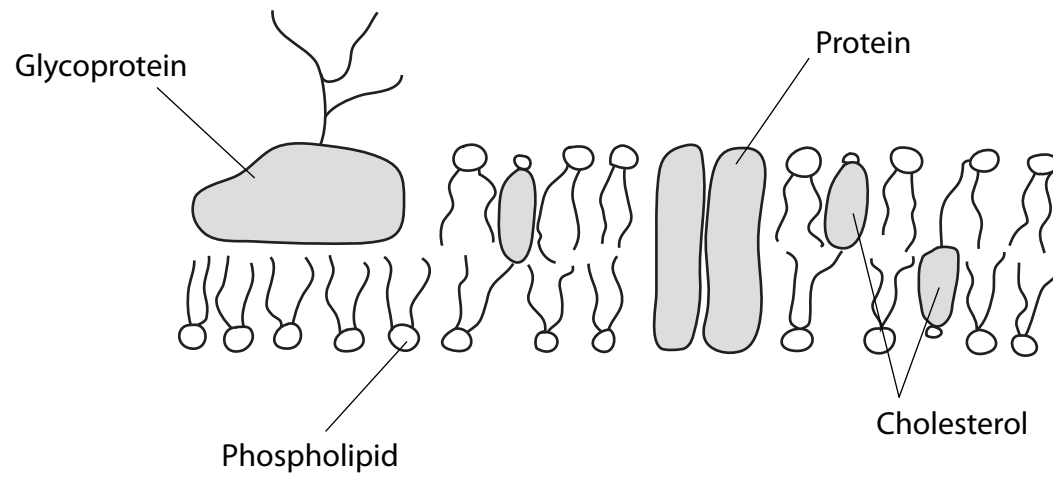
(a) Explain why the phospholipid molecules form a bilayer.

(3)

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(b) A student carried out an experiment to investigate the effect of alcohol concentration on the permeability of beetroot membranes. Beetroots are root veg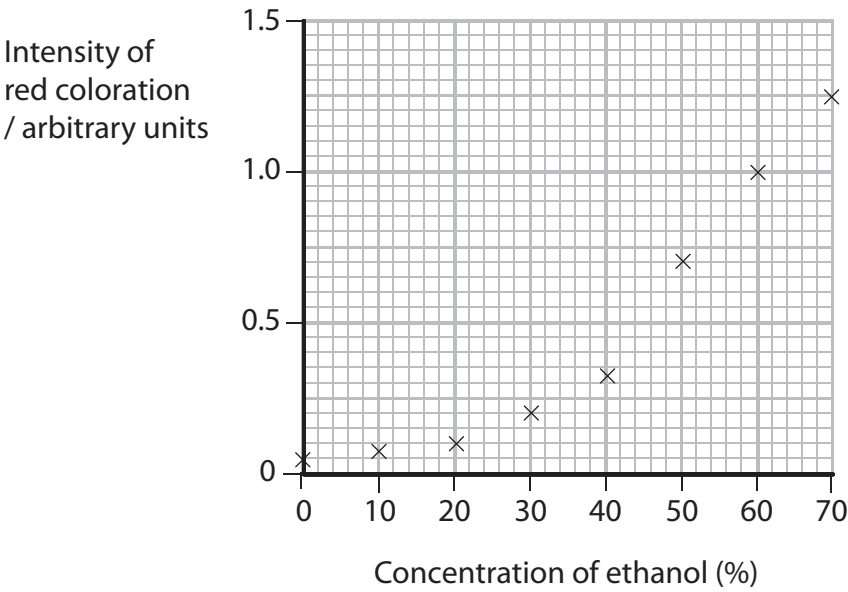etables that appear red because the vacuoles in their cells contain a water-soluble red pigment. This pigment cannot pass through membranes.

Eight pieces of beetroot were cut. One piece of beetroot was placed into a tube containing 15 cm³ of water and left for 15 minutes. The procedure was repeated for seven different concentrations of ethanol.

After 15 minutes, each piece of beetroot was removed from the tubes and a sample of the fluid removed and placed in a colorimeter. The colorimeter was used to determine the intensity of red coloration of the fluid.

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

Intensity of
red coloration
/ arbitrary units

(graph: y-axis Intensity of red coloration / arbitrary units from 0 to 1.5; x-axis Concentration of ethanol (%) from 0 to 70. Plotted points rising from near 0 at 0% to about 1.25 at 70%.)

Concentration of ethanol (%)

(i) Suggest **two** variables, other than those stated above, which should be kept constant during this experiment.

(2)

1 ....

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2 ....

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10

(ii) There was some red coloration in the tube containing only water. Suggest an explanation for this.

(2)

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(iii) Describe what the student should have done to reduce the red coloration in the tube containing only water.

(1)

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(c) The graph on page 10 shows that ethanol has an effect on the permeability of beetroot.

(i) State the effect that the ethanol concentration has on the intensity of the red coloration.

(1)

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(ii) Suggest an explanation for this effect.

(2)

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(Total for Question 4 = 11 marks)

5 (a) In the space below, draw a labelled diagram to show the structure of an artery.

(3)

(b) Explain how the structure of an artery relates to its function.

(2)

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(c) Give **two** differences between the structure of a vein and the structure of a capillary.

(2)

1 ....

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2 ....

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(Total for Question 5 = 7 marks)

6 High blood cholesterol levels are associated with an increased risk of developing cardiovascular disease (CVD). There are cholesterol-reducing drugs available to lower this risk.

(a) Two groups of patients were treated with a different type of cholesterol-reducing drug, Drug A or Drug B.

The graphs below show the percentage changes of total cholesterol (TC), low-density lipoproteins (LDL) and high-density lipoproteins (HDL) in the blood of these patients, after treatment.

Patients treated with Drug A   Patients treated with Drug B
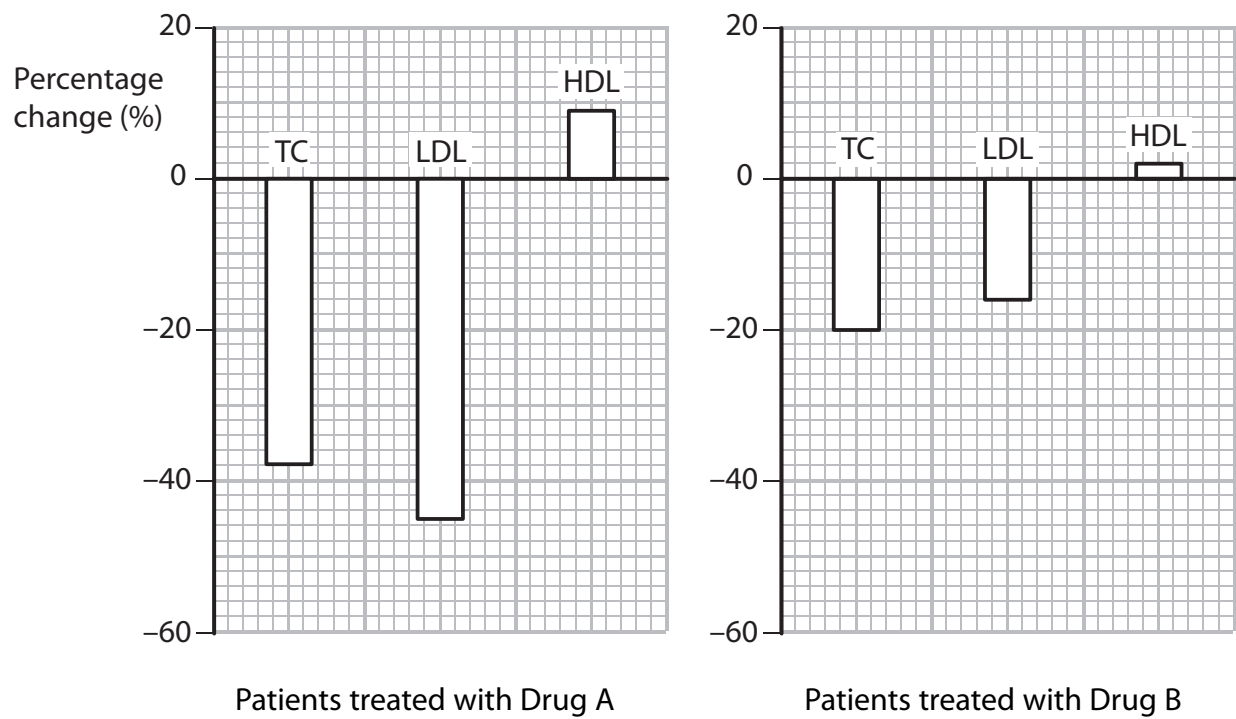
(i) Compare the effects of Drug A and Drug B on the percentage changes in total cholesterol (TC), LDL and HDL in the blood of these two groups of patients.

(3)

13

Turn over ▶

(ii) The enzyme HMG-CoA reductase catalyses the synthesis of cholesterol. When this enzyme is active, there are fewer LDL receptors on liver cells. These receptors are needed to remove LDL from the blood.

Statins are a group of cholesterol-reducing drugs that act by inhibiting this enzyme. Suggest which of the two drugs, Drug A or Drug B, is more likely to be a statin. Give reasons for your answer.

(3)

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(b) State **two** risks of treatments using statins.

(2)

1 ....

2 ....

(c) Age and gender are two other factors that may influence the development of heart disease in an individual.

The graph below shows the results of a survey in America, on the incidence of heart disease in adults aged 18 and older.

(i) Using the information in the graph, describe how the incidence of heart disease is affected by age and gender.

(3)

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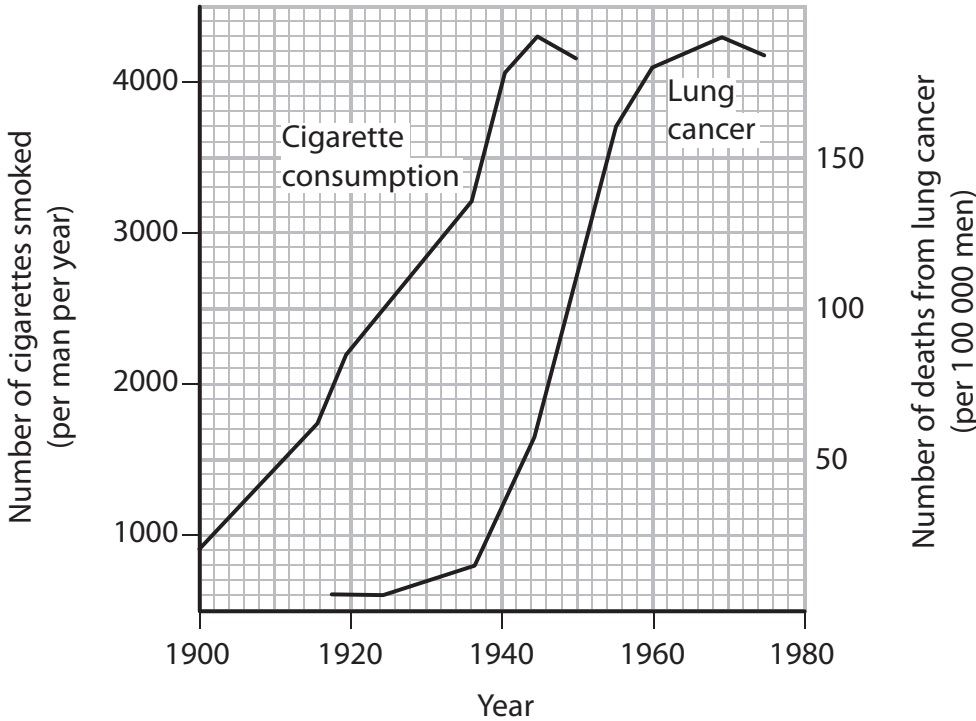
(ii) Calculate the increased risk that a man who is 75 or older has of developing heart disease, compared to a man aged between 18 and 44 years old.

(2)

Answer ....

(Total for Question 6 = 13 marks)

Turn over ▶

7 A study was carried out into the number of cigarettes smoked by men per year and the number of deaths from lung cancer.

The graph below shows the results of this study.

(a) Describe the changes in the number of deaths from lung cancer between 1920 and 1975.

(3)

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(b) The results of this study indicate that there is a correlation between cigarette smoking and lung cancer.

(i) Explain the meaning of the term **correlation**.

(1)

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(ii) Describe the evidence shown in this graph that suggests there is a correlation between cigarette smoking and the number of deaths from lung cancer.

(2)

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(iii) Give **two** additional pieces of information that would increase the **validity** of any conclusions made from this study.

(2)

1 ....

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2 ....

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(c) Emphysema is another lung disease associated with cigarette smoking. One symptom of emphysema is shortness of breath. This is due to the damage to the alveoli and destruction of capillaries surrounding the alveoli.

The diagram below show alveoli from a lung of a person with emphysema and some alveoli from a healthy person.

Alveoli from a lung of a person with emphysema
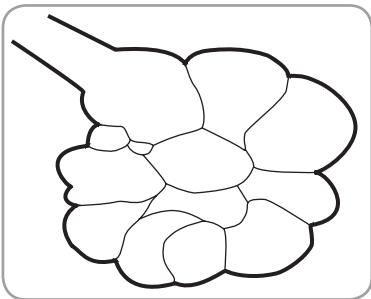
Alveoli from a healthy person
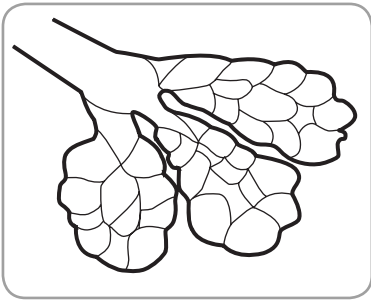
Use your knowledge of the structure of the lung and its adaptations for gas exchange to explain why a person with emphysema has problems with gas exchange.

(4)

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(Total for Question 7 = 12 marks)

8 Phenylketonuria is a recessive genetic disorder characterised by a lack of the enzyme phenylalanine hydroxylase. When there is an excess of phenylalanine in the diet, this enzyme converts the amino acid phenylalanine into the amino acid tyrosine.

(a) The diagram below shows the structure of the R group of phenylalanine and tyrosine.
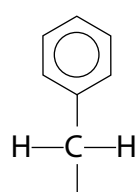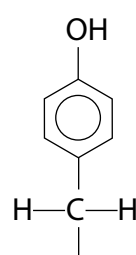
Phenylalanine   **Tyrosine**

(i) In the space below draw a diagram to show the structure of the amino acid phenylalanine.

(3)

Turn over ▶

(ii) The enzyme phenylalanine hydroxylase converts its substrate, phenylalanine, into the product, tyrosine. Using the information shown in the diagram and your knowledge of the mechanism of action of enzymes, suggest how this reaction takes place.

(4)

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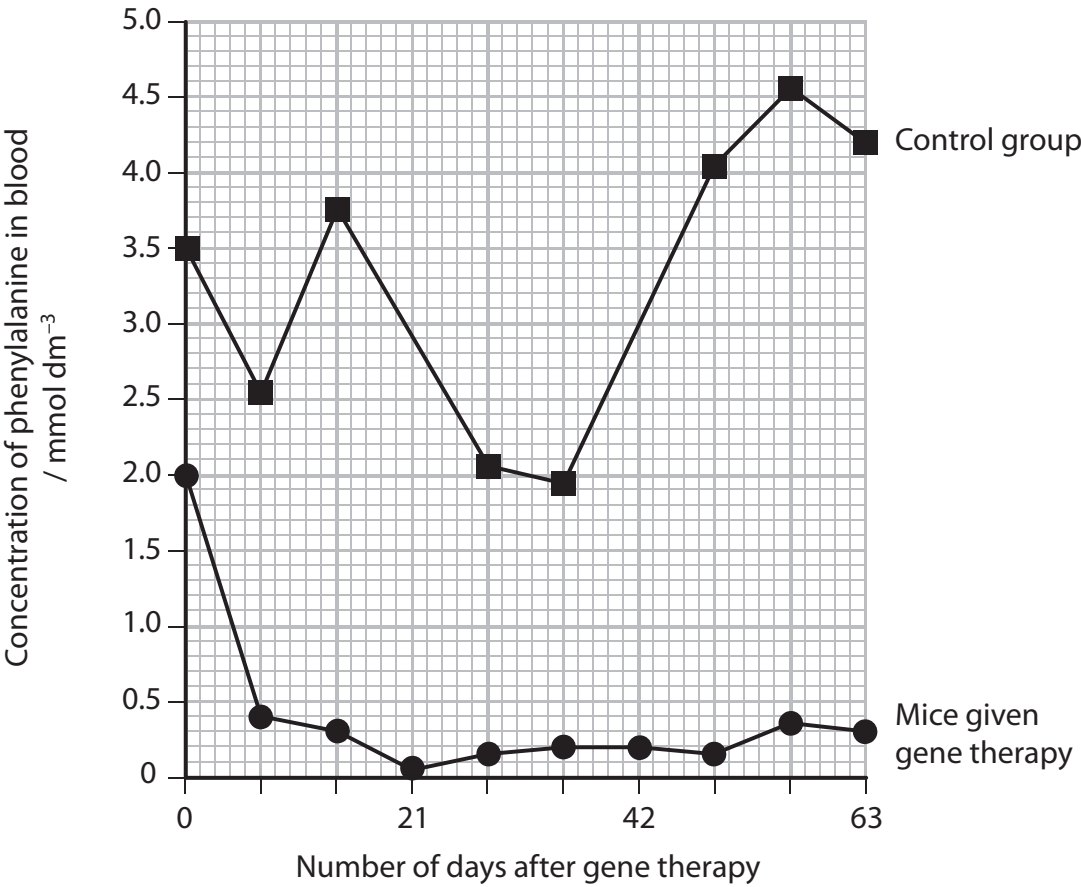...

(b) A number of investigations have been carried out into the use of somatic gene therapy to treat mice that have phenylketonuria.
The graph below shows the results of one such investigation.

(i) Use the graph to describe the effect that gene therapy has on the phenylalanine concentration in the blood of these mice.

(2)

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(ii) Describe how somatic gene therapy may have been carried out to treat phenylketonuria in these mice.

(3)

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(iii) Suggest what treatment the control group of mice may have been given in this investigation.

(1)

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(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 80 MARKS

mock papers 3

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.
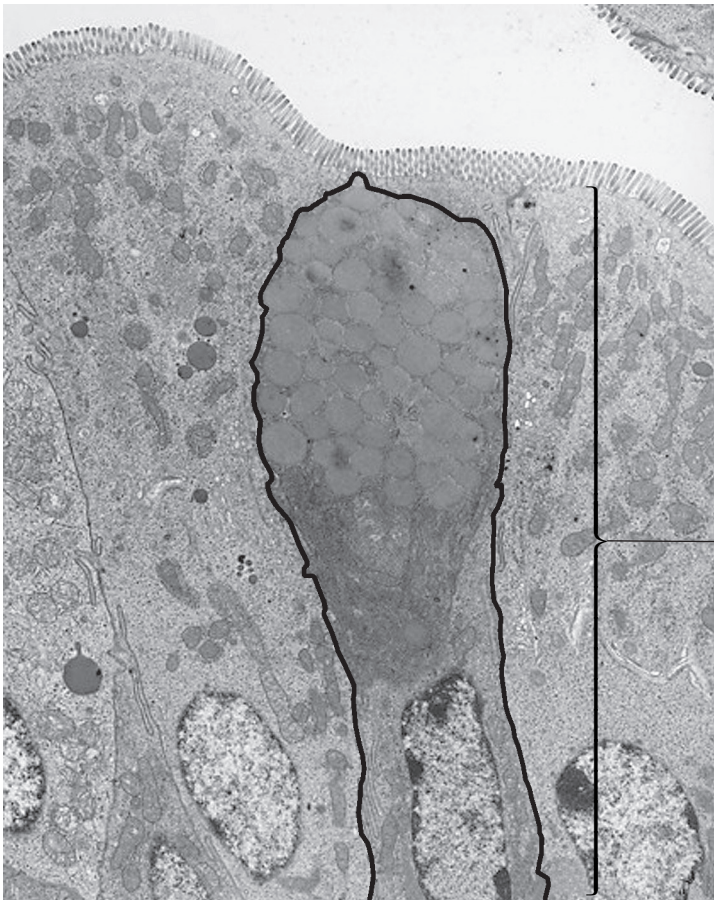
goblet cell

magnification ×5000

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

(2)

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(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)

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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)

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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)

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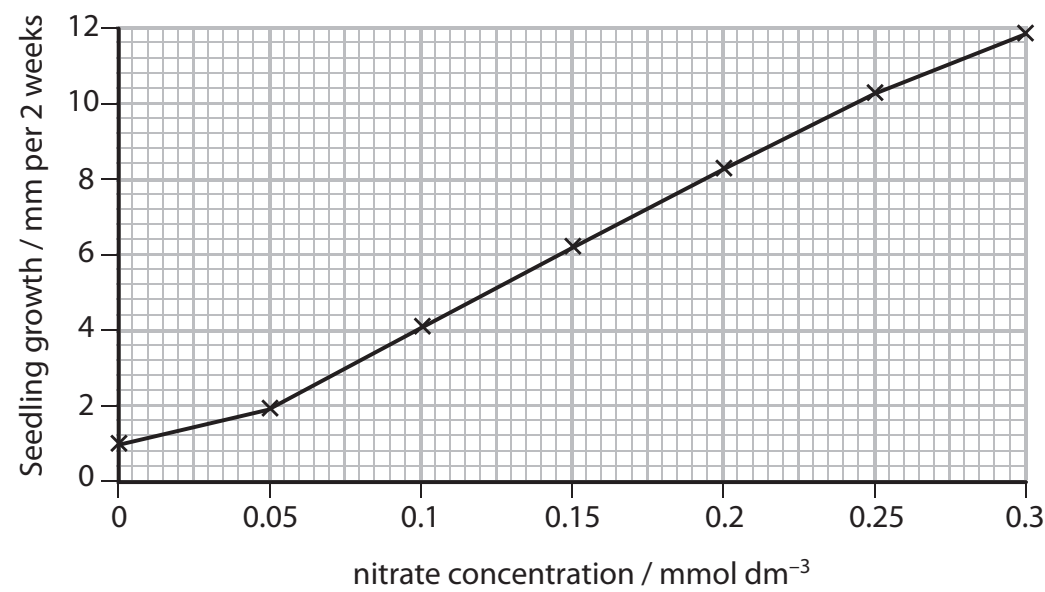
(a) After her investigation, she said "I conclude that nitrates are needed for seedling growth and the higher the nitrate concentration the greater the growth."

(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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....

6

(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)

....

....

....

....

(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)

....

....

....

....

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

Stem cell A **Stem cell B**

Many other cell types but not embryonic cells

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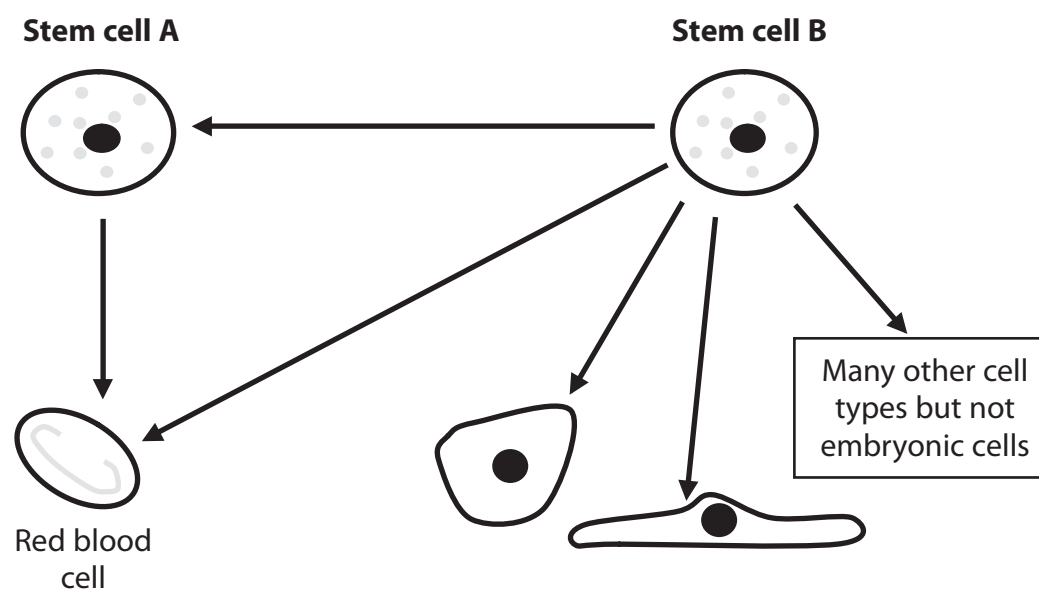
(i) Use the diagram to explain why stem cell B is described as **pluripotent**.

(2)

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....

(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)

10

5 Fertilisation involves the fusion of haploid nuclei.

(a) The diagram below shows a human sperm cell.
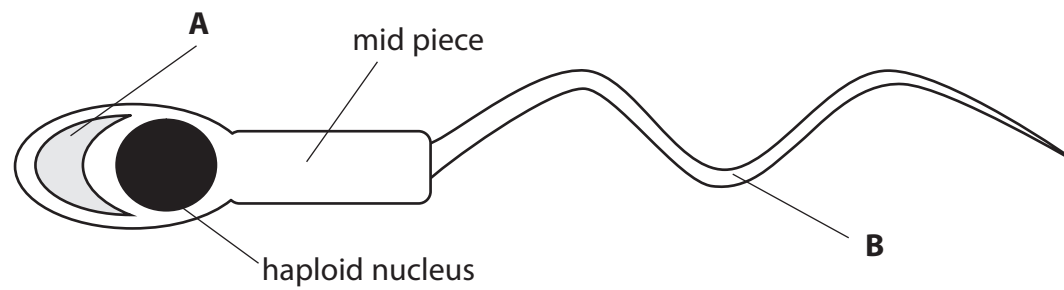
(i) Name the structures labelled **A** and **B**.

(2)

A ....

B ....

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

(2)

....

....

....

....

....

....

(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)

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(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)

....

....

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(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)

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(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.

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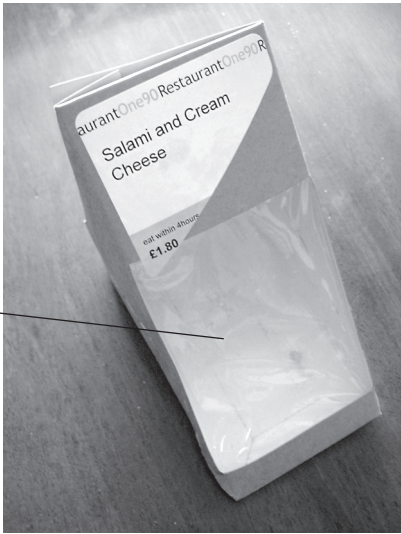
Suggest how this use of starch, rather than plastic, may contribute to **sustainability**.

(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)

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.

water surface

T

2 cm

Mayfly nymph

2 cm
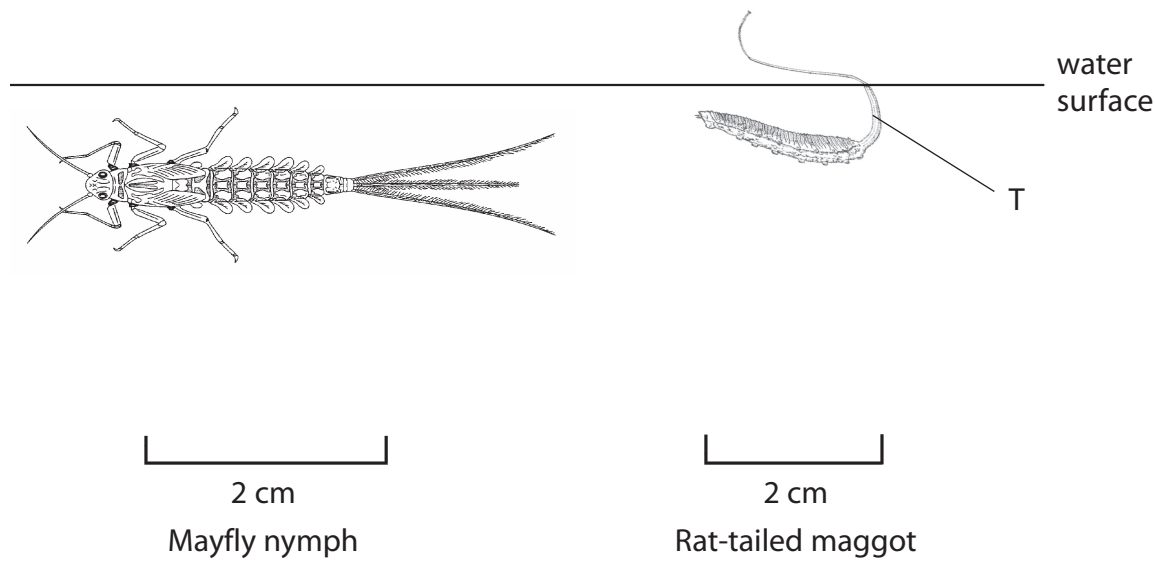
Rat-tailed maggot

(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)

1 ....

....

....

2 ....

....

....

16

(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)

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)

....

....

....

....

....

(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)

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(Total for Question 8 = 11 marks)

TOTAL FOR THE PAPER = 80 MARKS

Answer **all** the questions.

1   Fig. 1.1 is a diagram of an animal cell as seen using a transmission electron microscope.
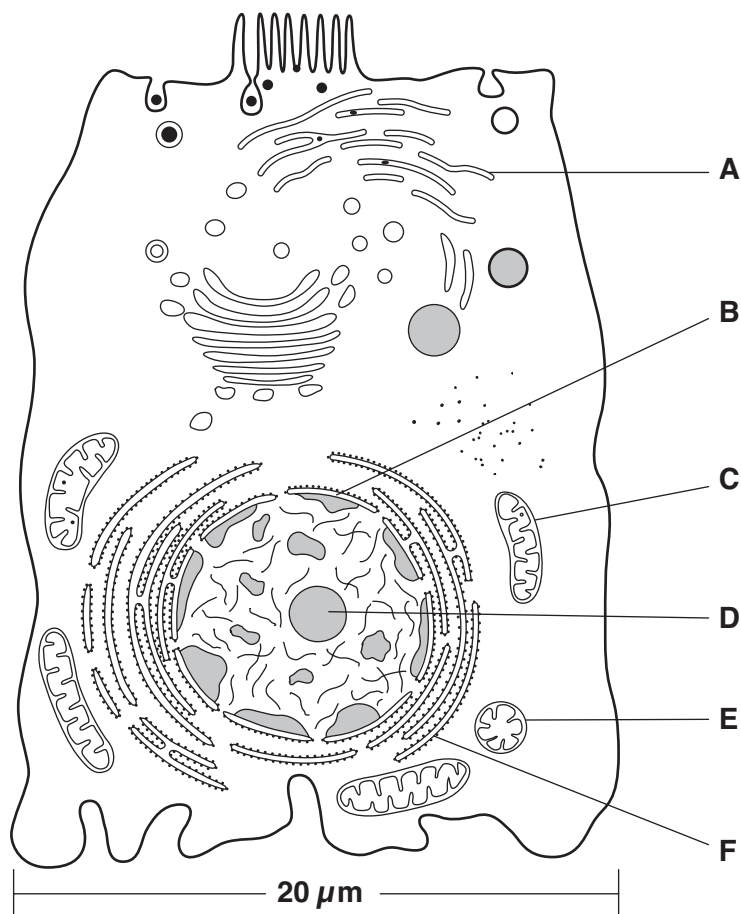
Fig. 1.1

(a) (i)   Name the structures of the cell labelled **A**, **B**, **C** and **D**.

A ……………………………………………

B ……………………………………………

C ……………………………………………

D ……………………………………………   **[4]**

(ii)   Structures **C** and **E** are examples of the same organelle.

Suggest why **E** looks so different to **C**.

………………………………………………………………………………………………………

………………………………………………………………………………………………………

………………………………………………………………………………………………………

……………………………………………………………………………………………… **[2]**

(iii) Calculate the actual length of structure **C**.

Show your working and give your answer in micrometres (μm).

Answer = ... μm **[2]**

(b) Proteins are produced by the structure labelled **F**. Some of these proteins may be **extracellular** proteins that are released from the cell.

Outline the sequence of events following the production of extracellular proteins that leads to their release from the cell.

....

....

....

....

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....

....

.... **[3]**

[Total: 11]

Turn over

2   Fig. 2.1 shows diagrams of four cells that have been placed in different solutions.

K   L   M   N
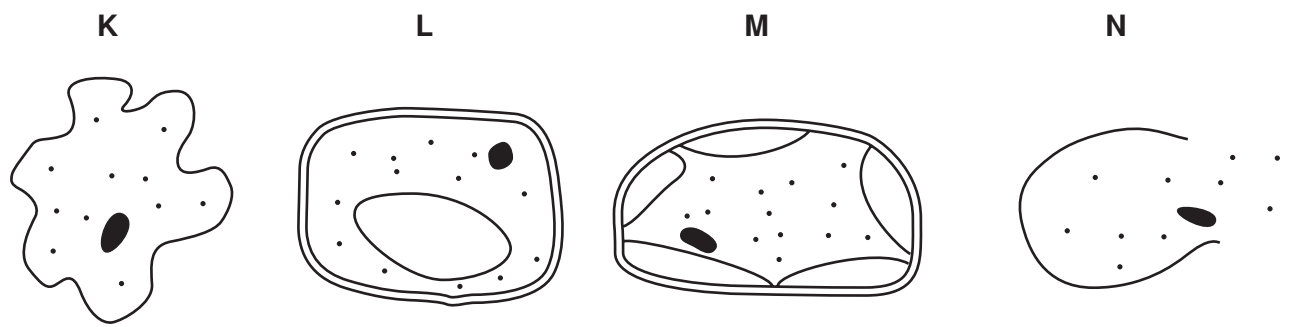
Fig. 2.1

(a) In the table below, write the letter **K**, **L**, **M** or **N** next to the description that best matches the diagram. One has been done for you.

description	letter
an animal cell that has been placed in distilled water	
an animal cell that has been placed in a concentrated sugar solution	
a plant cell that has been placed in distilled water	
a plant cell that has been placed in a concentrated sugar solution	**M**

[3]

(b) Explain, using the term **water potential**, what has happened to cell **M**.

....

....

....

....

....

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....

.... [3]

(c) Small non-polar substances enter cells in different ways to large or polar substances.

Outline the ways in which substances, **other than water**, can enter a cell through the plasma (cell surface) membrane.

In your answer, you should use appropriate technical terms, spelt correctly.

small, non-polar substances ....

....

....

....

....

....

large substances ....

....

....

....

....

polar substances ....

....

....

....

....

.... **[5]**

[Total: 11]

Turn over

3 The division of stem cells by mitosis produces cells that are genetically identical.

(a) (i) State what is meant by the term *stem cell*.

....

....

....

.... **[2]**

(ii) Name **one** tissue in **plants** that contains stem cells.

.... **[1]**

(b) State **three** reasons why mitosis is important to organisms.

1 ....

2 ....

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

(c) Traditionally, stem cells from bone marrow have been used to treat patients with leukaemia.

Recent studies have shown that stem cells taken from umbilical cord blood may be more effective in treating leukaemia than stem cells taken from bone marrow.

Table 3.1 shows the probability of a patient remaining leukaemia-free for five years after being treated with stem cells from different sources.

Table 3.1

(i) Describe, using the information in Table 3.1, the evidence that **perfectly matched** umbilical cord blood stem cells are more effective than bone marrow stem cells in treating leukaemia.

....

....

....

....

.... **[2]**

(ii) Suggest **two** advantages, **other than an increased probability of survival**, of using umbilical cord blood stem cells instead of bone marrow stem cells in transplant procedures.

....

....

....

....

.... **[2]**

[Total: 10]

Turn over

4 **(a)** Explain, using the term **surface area to volume ratio**, why large, active organisms need a specialised surface for gaseous exchange.

....

....

....

....

....

.... **[2]**

(b) Table 4.1 describes some of the features of the mammalian gas exchange system.

Complete the table by explaining how each feature improves the efficiency of gaseous exchange. The first one has been completed for you.

Table 4.1

feature of gas exchange system	how feature improves efficiency of gaseous exchange
many alveoli	this increases the surface across which oxygen and carbon dioxide can diffuse
the epithelium of the alveoli is very thin	
there are capillaries running over the surface of the alveoli	
the lungs are surrounded by the diaphragm and intercostal muscles	

[3]

(c) Outline how the diaphragm **and** intercostal muscles cause **inspiration**.

....

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.... **[4]**

(d) Fig. 4.1 shows the trace from a spirometer recorded from a 16-year-old student.
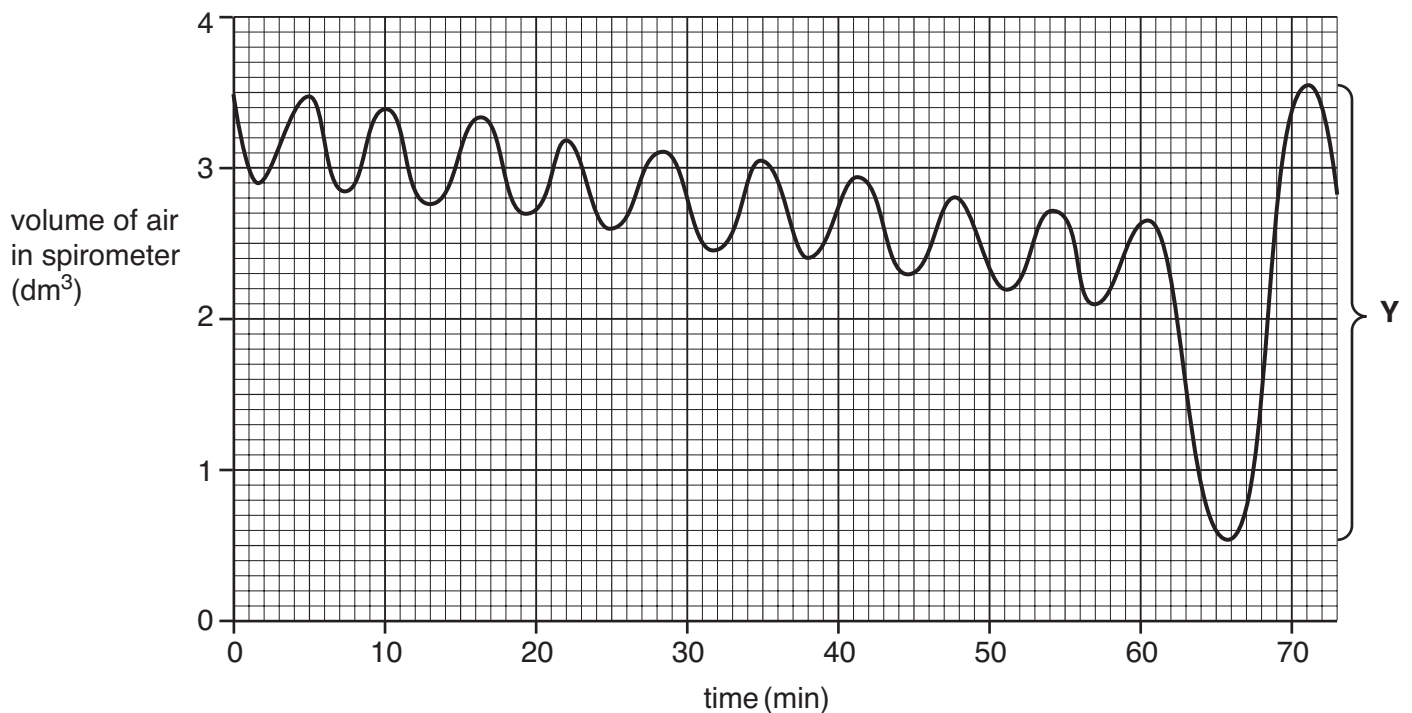
Fig. 4.1

(i) **Label on the trace**, using the letter **X**, a point that indicates when the student was inhaling. **[1]**

(ii) At the end of the trace the student measured his vital capacity. This is indicated by the letter **Y**.

State the vital capacity of the student.

.... **[1]**

[Total: 11]

Turn over

5 Fish have a single, closed circulatory system.

(a) State the meaning of the terms *single circulatory system* and *closed circulatory system.*

single circulatory system ....

....

....

closed circulatory system ....

....

.... **[2]**

(b) The heart of a mammal contains four main chambers. The action of these chambers is coordinated by electrical activity in specialised tissues.

Fig. 5.1 shows where these tissues are found in the heart.
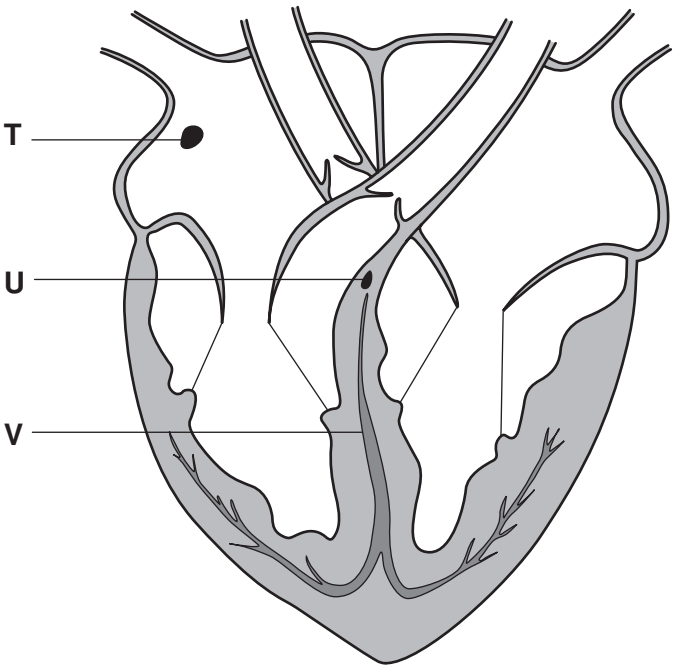
Fig. 5.1

(i) Name the tissues labelled **T**, **U** and **V**.

T ....

U ....

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

(ii) Describe how the action of the heart is initiated **and** coordinated.

In your answer, you should use appropriate technical terms, spelt correctly.

....

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....

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....

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....

....

....

.... **[5]**

[Total: 10]

Turn over

6   Translocation is the movement of the products of photosynthesis within a plant.

Translocation occurs in the phloem and involves sources and sinks.

(a) Using the outline below, draw in the position of the phloem in the root of a dicotyledonous plant.

root
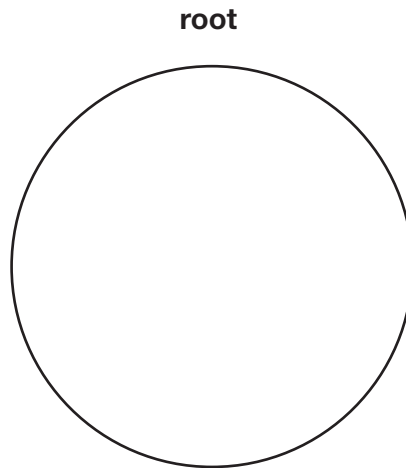
[1]

(b) Research using carbon dioxide containing a radioactive label, C^{14}, has revealed the following evidence about the mechanism of translocation:

A   labelled carbon can be observed in the phloem soon after being supplied to a well-lit plant;

B   the rate of movement of sugars in the phloem is many times faster than could be achieved by diffusion alone.

Different research has revealed that:

C   an insect such as an aphid feeds by inserting its proboscis (mouth parts) into the phloem;

D   the pH of the phloem companion cells is lower than surrounding cells;

E   the phloem companion cells contain many mitochondria.

Using the letters **A**, **B**, **C**, **D** and **E**, select **two** pieces of evidence from the list above which support the theory that translocation occurs in the phloem.

…………………………………

…………………………………   **[2]**

(c) State what is meant by the terms *source* and *sink*.

....

....

....

....

.... **[2]**

(d) When the bark is removed from a tree, the phloem is also removed. If a complete ring of bark is removed, the tree trunk can be seen to swell above the cut.

Suggest **two** reasons why the trunk swells above the cut.

....

....

....

....

....

.... **[2]**

[Total: 7]

END OF QUESTION PAPER

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

---

1 (a) Some people cannot digest lactose when they are adult. They could digest lactose when they were children.

Use your knowledge of water potential to explain why these adults get diarrhoea when they drink milk.

....

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....

(2 marks)

1 (b) (i) The equation shows the reaction catalysed by the enzyme lactase. Complete this equation.

Lactose + ... $\longrightarrow$ Glucose + ...

(2 marks)

1 (b) (ii) Name the type of chemical reaction shown in this equation.

....

(1 mark)

1 (c) Lactase is an enzyme. Lactose is a reducing sugar.

1 (c) (i) Describe how you could use the biuret test to distinguish a solution of the enzyme, lactase from a solution of lactose.

....

....

(1 mark)

1 (c) (ii) Explain the result you would expect with the enzyme.

....

....

(1 mark)

7

Turn over ▶

2 Miner's lung is a disease caused by breathing in dust in coal mines. The dust causes the alveolar epithelium to become thicker. People with miner's lung have a lower concentration of oxygen in their blood than healthy people.

2 (a) (i) Describe the path by which oxygen goes from an alveolus to the blood.

....

....

....

....

....

(2 marks)

2 (a) (ii) Explain why people with miner's lung have a lower concentration of oxygen in their blood.

....

....

(1 mark)

2 (b) In healthy lungs, a gradient is maintained between the concentration of oxygen in the alveoli and the concentration of oxygen in the lung capillaries.

2 (b) (i) Describe how ventilation helps to maintain this difference in oxygen concentration.

....

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....

....

(2 marks)

2 (b) (ii) Give **one** other way that helps to maintain the difference in oxygen concentration.

....

(1 mark)

2 (c) Scientists investigated the number of cases of miner's lung reported in Britain between 1992 and 2006.
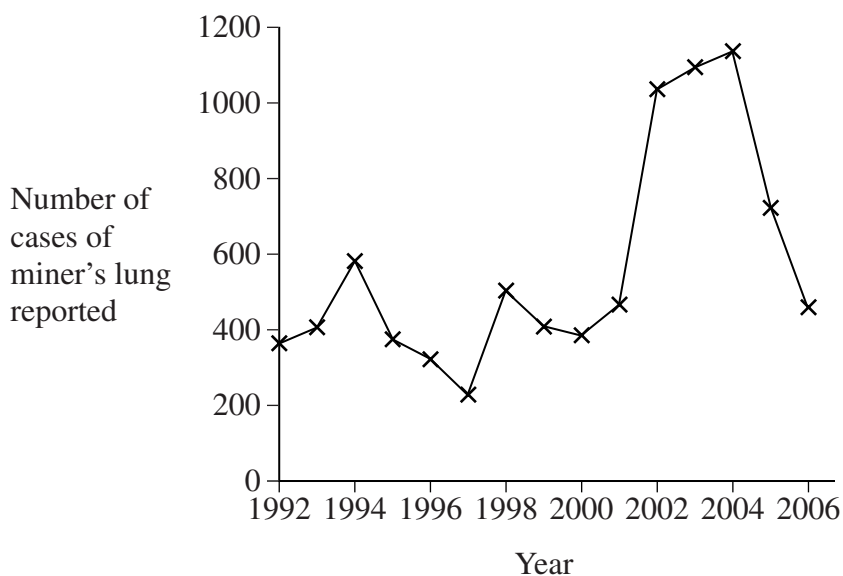
Coal mining in Britain had been dramatically reduced by 1990.

Some scientists concluded that the rise in reported cases of miner's lung after 1992 shows that the disease takes a long time to develop.

Evaluate this conclusion.

....

....

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....

....
(2 marks)

(Extra space)...

....

8

Turn over ▶

3 The graph shows the effect of substrate concentration on the rate of an enzyme-controlled reaction.

Rate of reaction

Substrate concentration / arbitrary units
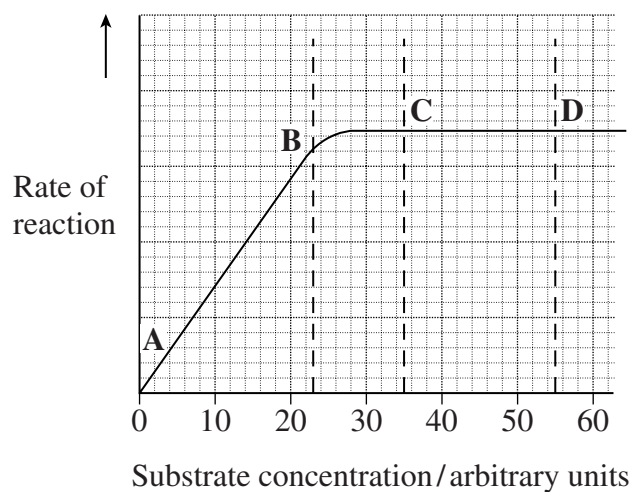
3 (a) (i) Describe what the graph shows about the effect of substrate concentration on the rate of this enzyme-controlled reaction.

....

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....

....

(2 marks)

(Extra space) ....

....

3 (a) (ii) What limits the rate of this reaction between points **A** and **B**? Give the evidence from the graph for this.

....

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....

....

(2 marks)

(Extra space) ....

....

3 (a) (iii) Suggest a reason for the shape of the curve between points **C** and **D**.

....

....

(1 mark)

3 (b) Sketch a curve on the graph to show the rate of this reaction in the presence of a competitive inhibitor.

(1 mark)

3 (c) Methotrexate is a drug used in the treatment of cancer. It is a competitive inhibitor and affects the enzyme folate reductase.

3 (c) (i) Explain how the drug lowers the rate of reaction controlled by folate reductase.

....

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....

(2 marks)

(Extra space) ....

....

3 (c) (ii) Methotrexate only affects the rate of the reaction controlled by folate reductase. Explain why this drug does not affect other enzymes.

....

....

(1 mark)

9

Turn over for the next question

Turn over ▶

4 The diagram shows an epithelial cell from the small intestine.
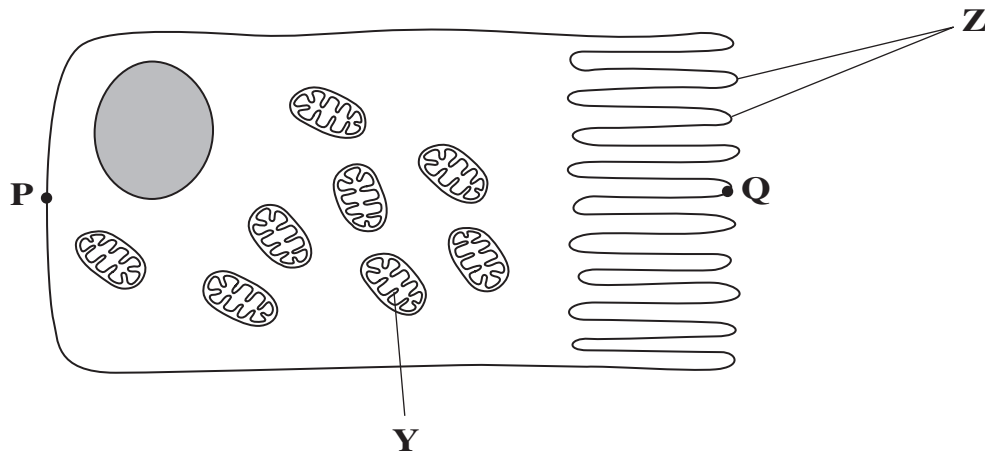
4 (a) (i) Name organelle **Y**.

....
(1 mark)

4 (a) (ii) There are large numbers of organelle **Y** in this cell. Explain how these organelles help the cell to absorb the products of digestion.

....

....

....

....

....
(2 marks)

(Extra space) ....

....

4 (b) This diagram shows the cell magnified 1000 times. Calculate the actual length of the cell between points **P** and **Q**. Give your answer in μm. Show your working.

Answer .... μm

(2 marks)

4 (c) Coeliac disease is a disease of the human digestive system. In coeliac disease, the structures labelled **Z** are damaged.

Although people with coeliac disease can digest proteins they have low concentrations of amino acids in their blood.

Explain why they have low concentrations of amino acids in their blood.

....

....

....

....

....

(2 marks)

(Extra space)...

....

7

Turn over for the next question

Turn over ▶

5 Students investigated the effect of different concentrations of sodium chloride solution on discs cut from an apple. They weighed each disc and then put one disc into each of a range of sodium chloride solutions of different concentrations. They left the discs in the solutions for 24 hours and then weighed them again. Their results are shown in the table.

Concentration of sodium chloride solution /mol dm^{-3}	Mass of disc at start/g	Mass of disc at end/g	Ratio of mass at start to mass at end
0.00	16.1	17.2	0.94
0.15	19.1	20.2	0.95
0.30	24.3	23.2	1.05
0.45	20.2	18.7	1.08
0.60	23.7	21.9	
0.75	14.9	13.7	1.09

5 (a) (i) Calculate the ratio of the mass at the start to the mass at the end for the disc placed in the 0.60 mol dm^{-3} sodium chloride solution.

Answer ....

(1 mark)

5 (a) (ii) The students gave their results as a ratio. What is the advantage of giving the results as a ratio?

....

....

....

....

....

(2 marks)

5 (a) (iii) The students were advised that they could improve the reliability of their results by taking additional readings at the same concentrations of sodium chloride. Explain how.

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....
(2 marks)

5 (b) (i) The students used a graph of their results to find the sodium chloride solution with the same water potential as the apple tissue. Describe how they did this.

....

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....

....
(2 marks)

5 (b) (ii) The students were advised that they could improve their graph by taking additional readings. Explain how.

....

....

....

....

....
(2 marks)

9

Turn over ▶

6 Read the following passage.

Pathogens affect humans. They also affect farm animals. Once pathogens have entered the body of an animal they can cause disease. Vets sometimes have difficulty identifying the disease from which a particular animal is suffering. Until recently, they have had to take blood samples and send them to a laboratory. The laboratory carries out tests on the sample.

5

New tests have been developed. Some of these new tests use monoclonal antibodies. Tests using monoclonal antibodies are fast, specific and allow vets to identify a disease while they are still on the farm.

Brucellosis is a disease of cattle. It is caused by bacteria. These bacteria can infect people who drink milk or eat dairy products from infected cattle. A test using monoclonal antibodies allows vets to identify cattle that are carriers. The carriers are cattle that carry the brucellosis bacteria but do not show any symptoms of the disease.

10

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

6 (a) Other than bacteria, name **one** type of pathogen (line 1).

....
(1 mark)

6 (b) Give **two** ways in which a pathogen may cause disease when it has entered the body (lines 1–2).

1 ....

....

2 ....

....
(2 marks)

6 (c) Some new tests use monoclonal antibodies (lines 6–7).

6 (c) (i) Explain why these antibodies are referred to as monoclonal.

....

....

....
(1 mark)

6 (c) (ii) Tests using monoclonal antibodies are specific (line 7). Use your knowledge of protein structure to explain why.

....

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....

....

....
(3 marks)

(Extra space) ....

....

6 (d) The tests using monoclonal antibodies allow vets to identify brucellosis while they are still on a farm. Explain the advantages of this.

....

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....

....
(3 marks)

(Extra space) ....

....

10

Turn over ▶

7 (a) The cardiac cycle is controlled by the sinoatrial node (SAN) and the atrioventricular node (AVN). Describe how.

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(5 marks)

(Extra space) ....

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7 (b) What is atheroma and how may it cause myocardial infarction?

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....

(5 marks)

(Extra space) ....

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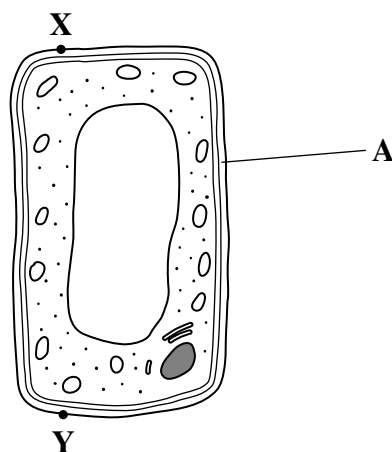
10

END OF QUESTIONS

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

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

....

(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.

....

....

....

....

(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.

....

....

(1 mark)

5

Turn over ▶

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

Figure 1
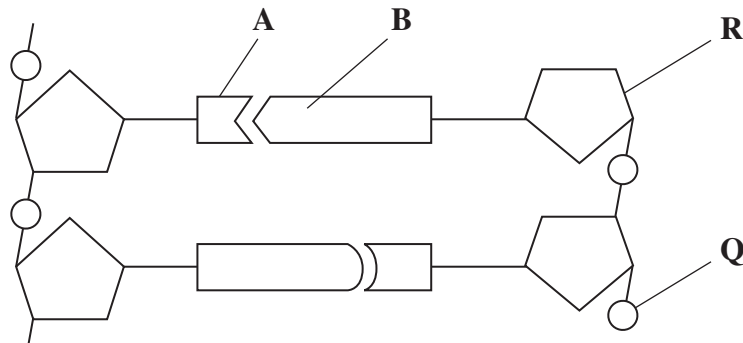
3 (a) Name parts **R** and **Q**.

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

Turn over ▶

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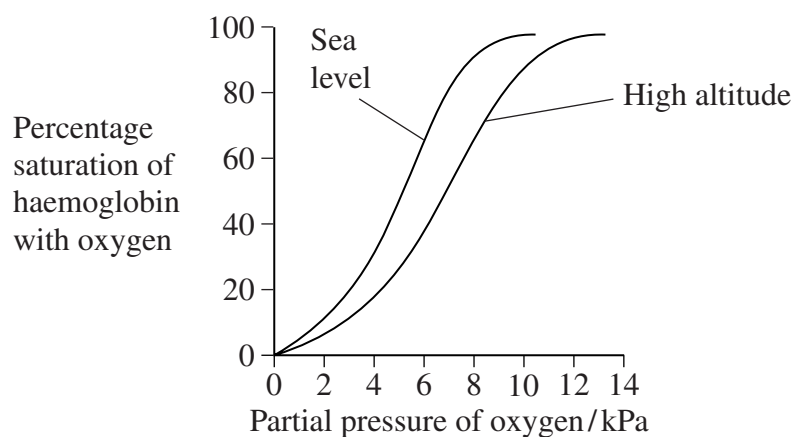
Explain the advantage to people living at high altitude of having the oxygen dissociation curve shown in the graph.

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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

Turn over ▶

6 The diagram shows tissue fluid and cells surrounding a capillary.
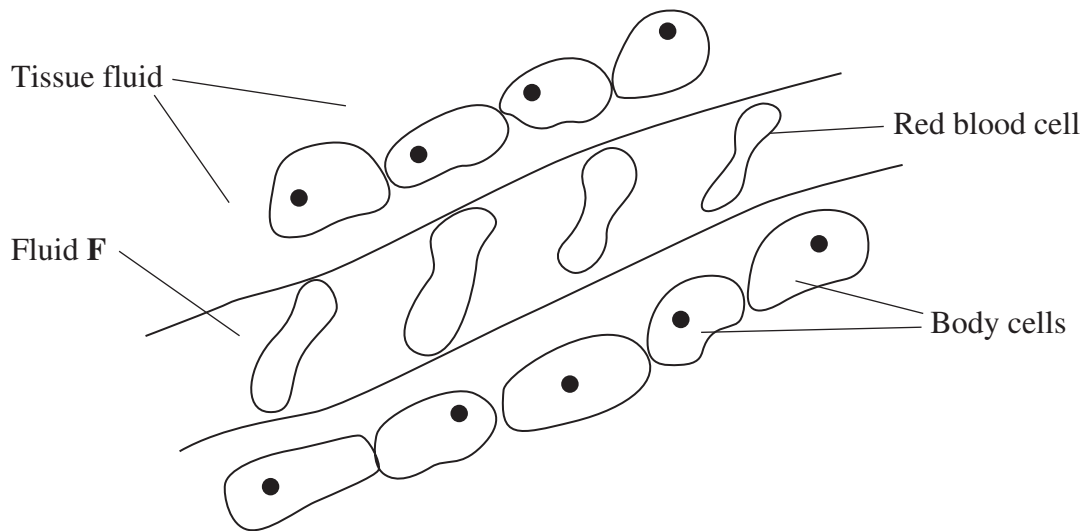
6 (a) Name fluid **F**.

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(1 mark)

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

....
(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

Turn over ▶

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

Turn over ▶

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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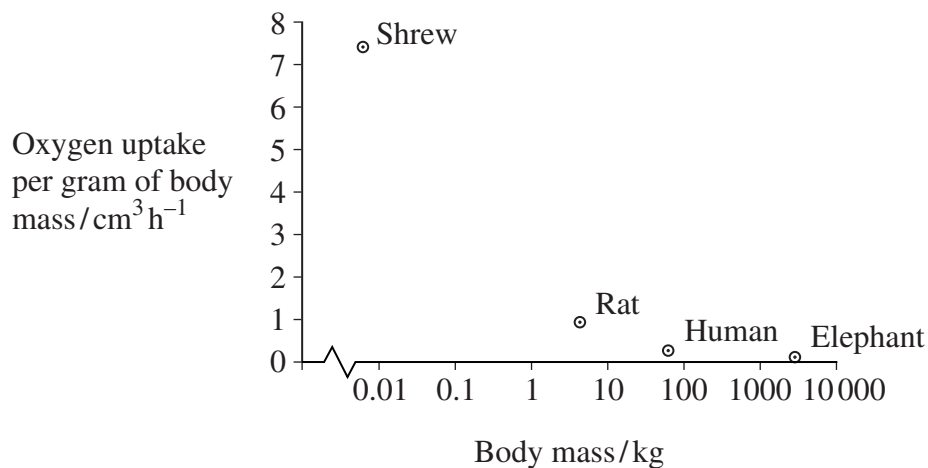
(2 marks)

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

Turn over ▶

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

Turn over ▶

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

Key
- ×—× Control
- ○—○ OGF
- △—△ Taxol
- □—□ OGF and taxol
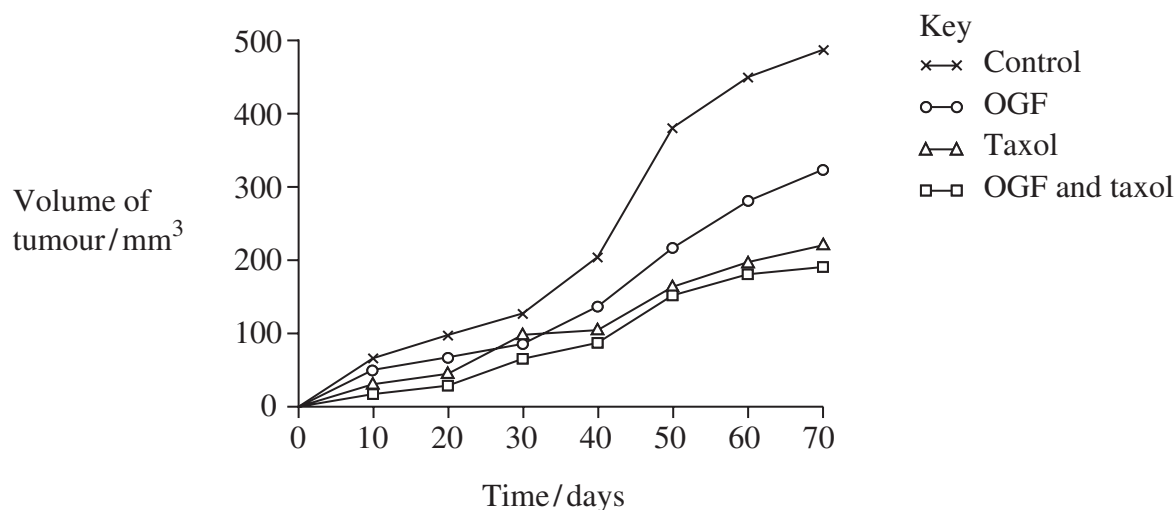
Figure 5

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.

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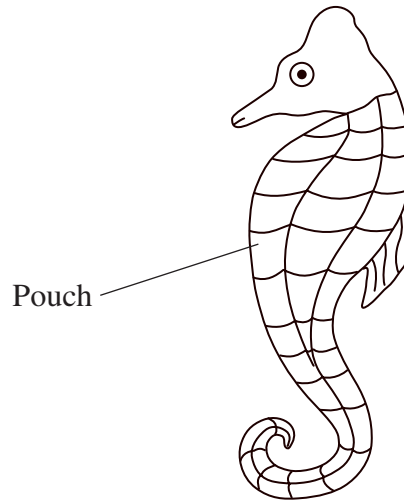
10   (a)   Give **two** ways in which courtship behaviour increases the probability of successful mating.

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.
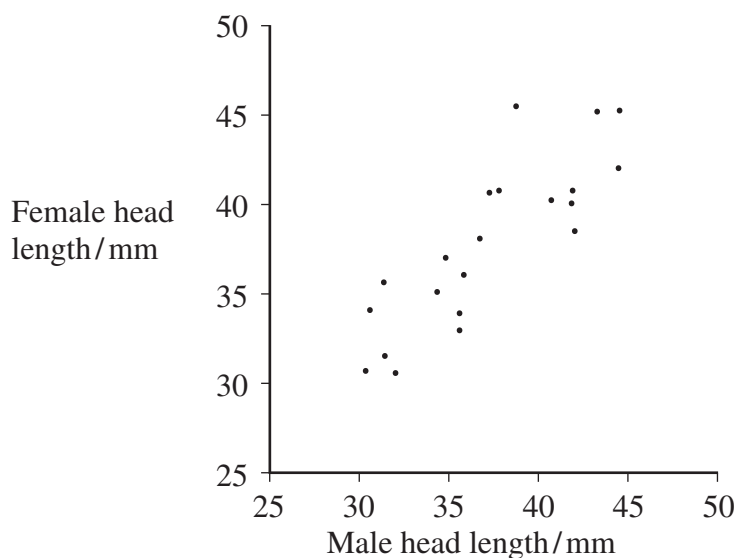
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(1 mark)

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

Turn over ▶

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