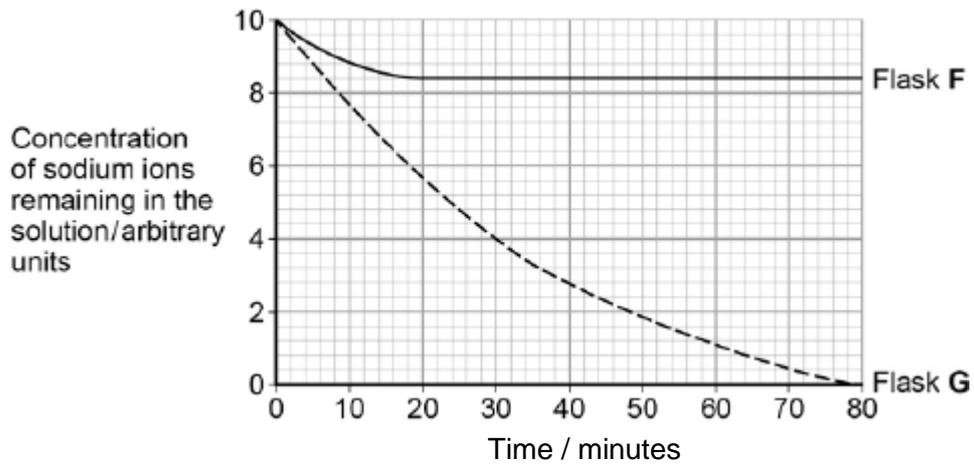


2.3 TRANSPORT ACROSS CELL MEMBRANES 3 – QUESTIONS

Q1. A scientist investigated the uptake of sodium ions by animal tissue.
To do this, he:

- used two flasks, **F** and **G**
- put equal masses of animal tissue into each flask
- added equal volumes of a solution containing sodium ions to each flask
- added to flask **F** a solution of a substance that prevents the formation of ATP by cells
- measured the concentration of sodium ions **remaining** in the solution in each flask.

The graph below shows his results.



- (a) Calculate the rate of uptake of sodium ions by the tissue in flask **G** during the first 20 minutes of this investigation.

Answer = _____ arbitrary units per minute (1)

- (b) The scientist concluded that the cells in flask **G** took up sodium ions by active transport. Explain how the information given supports this conclusion.

(Extra space) _____

_____ (4)

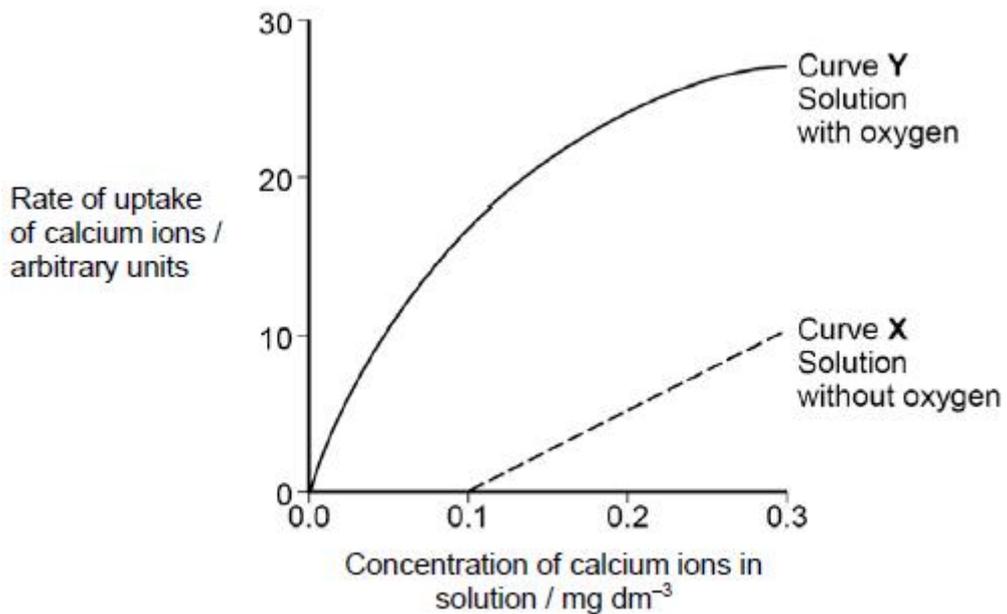
(c) The curve for flask F levelled off after 20 minutes. Explain why.

_____ (2)

(Total 7 marks)

Q2. A scientist placed plant cells in solutions containing different concentrations of calcium ions. She measured the rate of uptake of calcium ions by plant cells.

The graph below shows her results.



(a) What can you conclude from the graph about the processes involved in the uptake of calcium ions by these plant cells?
Use evidence from the graph to support your answer.

Answer _____ arbitrary units per minute (2)

(b) Adding cyanide affects the uptake of sodium ions by the tissue. Use the graph to describe how.

(2)

(c) Cyanide is a substance which affects respiration. Use information in the question to explain the effect of cyanide on the uptake of sodium ions by the tissue.

(Extra space) _____

(3)

(Total 7 marks)

Q4. Strawberries may be dehydrated by removing most of the water they contain. Dehydrated strawberries have many different uses in the food industry.

Food scientists investigated the effect of using osmosis to dehydrate strawberries.

1. The scientists weighed a sample of strawberries and then cut them into 10 mm thick slices.
2. They put the strawberry slices into a 1.2 mol dm⁻³ solution of sucrose at a temperature of 25 °C.
3. After 1 hour, they removed the slices from the sucrose solution and washed them in water. They dried the slices by blotting them and then weighed them.
4. They also measured the texture of the strawberry slices.
5. The scientists repeated steps 1 to 4, but they left the strawberry slices in the sucrose solution for different amounts of time.

The results of the investigation are shown in the table.

Length of time in sucrose solution / hours	Percentage loss in mass	Texture / arbitrary units
0	Not applicable	1.2
1	15.96	0.9
2	22.88	0.7
4	32.36	0.7
6	38.78	0.7

- (a) (i) In this investigation, the scientists cut the strawberries into slices (step 1). Explain the advantage of this.

(2)

- (ii) The scientists blotted the strawberry slices dry before weighing them (step 3). Explain why.

(2)

- (b) In the second column of the table, the percentage loss in mass for one of the values has been recorded as not applicable. Explain why.

(1)

- (c) Use the table to describe how the length of time in the sucrose solution affected the strawberries.

(Extra space) _____

(3)

- (d) You could use the data in the table to predict the time that strawberries should be left in sucrose solution to dehydrate them fully. Describe how you could use a graph to do this.

(Extra space) _____

(3)

(Total 11 marks)

- Q5.** (a) Contrast the processes of facilitated diffusion and active transport.

(Extra space) _____

(3)

Students investigated the uptake of chloride ions in barley plants. They divided the plants into two groups and placed their roots in solutions containing radioactive chloride ions.

- Group **A** plants had a substance that inhibited respiration added to the solution.

- (a) The scientists measured the rate of uptake of imatinib in μg per million cells per hour. Explain the advantage of using this unit of rate in this investigation.

(2)

- (b) Calculate the percentage increase in the mean rate of uptake of imatinib when the temperature is increased from 4°C to 37°C at a concentration of imatinib outside the cells of $1.0 \mu\text{mol dm}^{-3}$.

Give your answer to one decimal place.

Answer _____ **(2)**

- (c) Imatinib is taken up by blood cells by active transport.

- (i) Explain how the data for the two different temperatures support this statement.

(2)

- (ii) Explain how the data for concentrations of imatinib outside the blood cells at 50 and $100 \mu\text{mol dm}^{-3}$ at 37°C support the statement that imatinib is taken up by active transport.

(2)

(2)
(Total 8 marks)

Q8. Organic compounds synthesised in the leaves of a plant can be transported to the plant's roots. This transport is called translocation and occurs in the phloem tissue of the plant.

- (a) One theory of translocation states that organic substances are pushed from a high pressure in the leaves to a lower pressure in the roots.

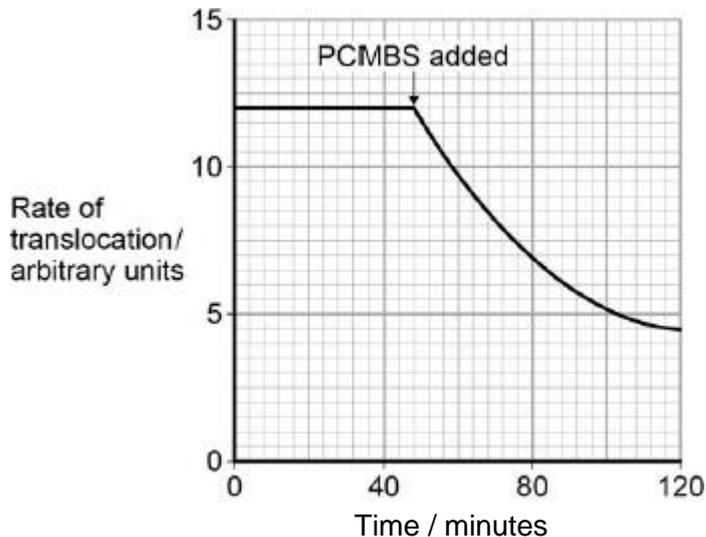
Describe how a high pressure is produced in the leaves.

(Extra space) _____

(3)

PCMBS is a substance that inhibits the uptake of sucrose by plant cells.

Scientists investigated the effect of PCMBS on the rate of translocation in sugar beet. The figure below shows their results.



- (b) During their experiment, the scientists ensured that the rate of photosynthesis of their plants remained constant. Explain why this was important.

(2)

- (c) The scientists concluded that some translocation must occur in the spaces in the cell walls.
Explain how the information in the figure above supports this conclusion.

(2)

(Total 7 marks)

Q9. The artery leaving the left ventricle is the aorta. One form of heart disease is aortic valve disease (AVD). In this disease, the valve (the aortic valve) between the left ventricle and the aorta opens normally but only partly closes. This means that when the ventricle relaxes some blood flows back into the ventricle from the aorta.

Severe AVD can be treated by replacing the aortic valve.

A surgeon investigated the effect of this treatment,

- He replaced the aortic valves of 19 patients with valves removed from donors who had recently died.
- The valves from donors were stored in an isotonic antibiotic solution before use.
- He recorded the maximum pressure reached in an artery (as the ventricles contract) and minimum pressure in the artery (as the ventricles relax) in each patient before and after valve replacement surgery.

His results are shown in **Table 1**.

Table 1

	Mean maximum pressure reached in the artery / kPa (\pm standard deviation)	Mean minimum pressure reached in the artery / kPa (\pm standard deviation)
Before surgery	21.7 (\pm 3.5)	4.8 (\pm 2.5)
After surgery	18.2 (\pm 2.2)	11.0 (\pm 1.1)

This investigation involved 19 patients.

- The mean age was 36 years (standard deviation \pm 17 years).
- The mean time after surgery that pressure readings were taken was 7 months (standard deviation \pm 5 months).

Table 2 shows the normal range of values of pressure in this artery in the UK.

Table 2

Pressure	Range of pressures / kPa
Maximum	12.0 to 18.5
Minimum	8.0 to 11.9

Aortic valves removed from donors were stored in isotonic solution containing an antibiotic before being used in valve replacement surgery.

- (a) Explain why the valves were stored in an **isotonic** solution.

(2)

- (b) Explain why the valves were stored in a solution containing an antibiotic.

(1)

- (c) There was a significant increase in the minimum blood pressure in the artery after valve replacement surgery.
Explain why the valve replacement surgery had this effect.

(1)

- (d) The surgeon concluded that there was sufficient evidence for him to continue using this treatment.

How does the information above support his conclusion?

[Extra Space] _____

(3)

(e) How does the information above **not** support his conclusion?

(2)

(f) From the data in **Table 1** it is **not** possible to determine the highest pressure measured. Explain why.

(1)

(Total 10 marks)

Q10. Many sports drinks contain water, sodium chloride and carbohydrates. The manufacturers of the sports drinks claim that carbohydrates provide an energy boost. The sodium chloride is used to increase absorption of glucose in the small intestine.

Scientists investigated the effect of a sports drink on the performance of runners in 5 km races. They recruited 100 runners who had previously run a 5 km race in similar times. During this race, Race 1, they had water they could drink.

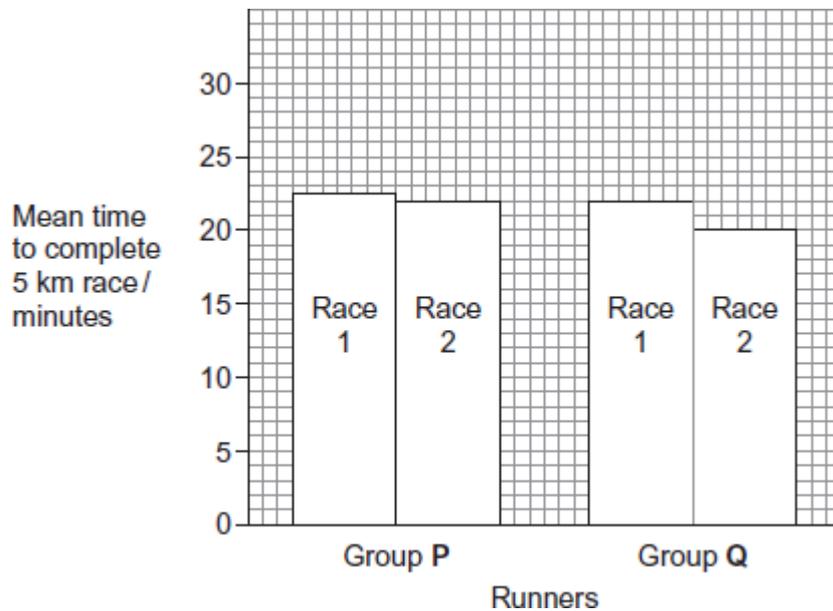
The scientists divided the runners into two equal groups, **P** and **Q**. Both groups ran a second 5 km race, Race 2. During this race:

- group **P** had water available
- group **Q** had the sports drink available.

The scientists recorded the mean time for each group to complete this race.

Figure 1 shows their results.

Figure 1

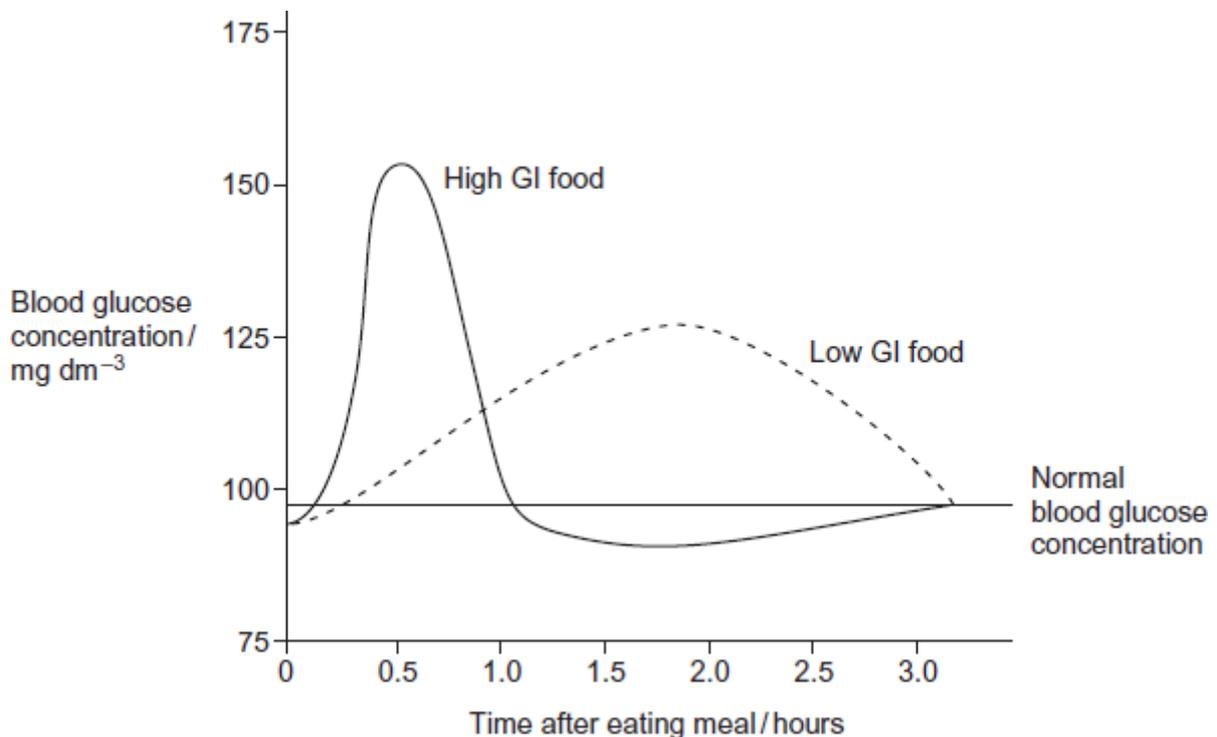


The glycaemic index (GI) is a measure of the increase in blood glucose concentration after eating a given mass of a food compared with eating the same mass of pure glucose. The GI of pure glucose has a value of 100.

The GI of a food depends on several factors such as how much starch and sugars it contains. High GI foods include those containing lots of simple sugars or white flour. The carbohydrates in these foods are rapidly digested and absorbed. Low GI foods include wholegrain bread and breakfast cereals that contain a lot of fibre. The carbohydrates in these foods are digested and absorbed more slowly.

Figure 2 shows changes in blood glucose concentration after eating meals of high GI food and meals of low GI food.

Figure 2



Explain how a sports drink could provide an energy boost when running.

(Extra space)

(3)
(Total 3 marks)

Q11. Many sports drinks contain water, sodium chloride and carbohydrates. The manufacturers of the sports drinks claim that carbohydrates provide an energy boost. The sodium chloride is used to increase absorption of glucose in the small intestine.

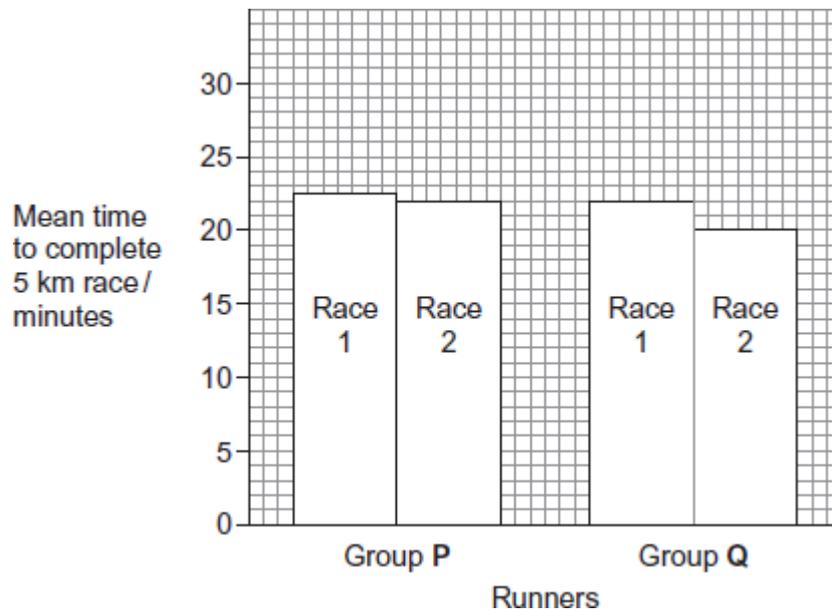
Scientists investigated the effect of a sports drink on the performance of runners in 5 km races. They recruited 100 runners who had previously run a 5 km race in similar times. During this race, Race 1, they had water they could drink.

The scientists divided the runners into two equal groups, **P** and **Q**. Both groups ran a second 5 km race, Race 2. During this race:

- group **P** had water available
- group **Q** had the sports drink available.

The scientists recorded the mean time for each group to complete this race.

The following figure shows their results.



- (a) Use the figure to calculate the percentage decrease in the mean time taken for group **Q** to complete Race 2 compared with Race 1.

Show your working.

_____ %

(2)

- (b) One of the runners concluded that the sports drink improved performance.

Do these data support his conclusion?

(3)

- (c) The runners were matched for the time taken to run the first race.

Give **three** other factors for which they should have been matched.

Factor 1 _____

Factor 2 _____

Factor 3 _____

_____ (3)

- (d) The sports drink contains sodium chloride. Sodium chloride increases uptake of glucose in the small intestine.

Explain how.

_____ (4)

(Total 12 marks)

Q12. In many parts of the world, crops have to be watered to grow enough food but fresh water is often in short supply.

Barley is a plant that grows a leafy shoot and then produces seed that is harvested for food.

Scientists investigated whether barley could be grown successfully using fresh water mixed with seawater. This would reduce the use of fresh water. However, seawater contains dissolved sodium chloride (salt).

The scientists grew barley in plots of equal size in the same large field. Each plot received one of four treatments.

- A** No watering.
- B** Watering with fresh water during growth and seed production.
- C** Watering with a 1:1 mix of fresh water and seawater during growth and seed production.
- D** Watering with fresh water during growth and with a 1:1 mix of fresh water and seawater during seed production.

At the end of the investigation, the scientists measured the concentration of salt in the soil in each plot and the yield of barley seed harvested from each plot.

The scientists' results are shown in the table below.

Watering treatment	Mean concentration of salt in soil / arbitrary units	Mean yield of barley seed / g
A	10.1	346
B	9.7	804
C	13.5	538
D	11.6	695

- (a) Watering treatment was the independent variable in this investigation. Explain what is meant by the **independent** variable.

(1)

- (b) The same variety of barley was used in all the plots. Why was this important?

(2)

- (c) When barley plants are growing, the number of cells increases. Name the process that increases the number of cells.

(1)

- (d) What do the data in the table above show about the effect of watering barley with a mixture of fresh water and seawater?

(2)

- (e) The scientists suggested that watering barley with diluted seawater might not be sustainable if repeated every year. Do these data support this suggestion?

(Extra space) _____

(3)
(Total 9 marks)

Q13. Doctors investigated the effect of the smoking habits of men on their non-smoking wives.

The doctors recruited 540 non-smoking women aged 40 or older. They divided these women into groups according to the smoking habits of their husbands. After 14 years, the doctors recorded how many of the wives had died and their cause of death.

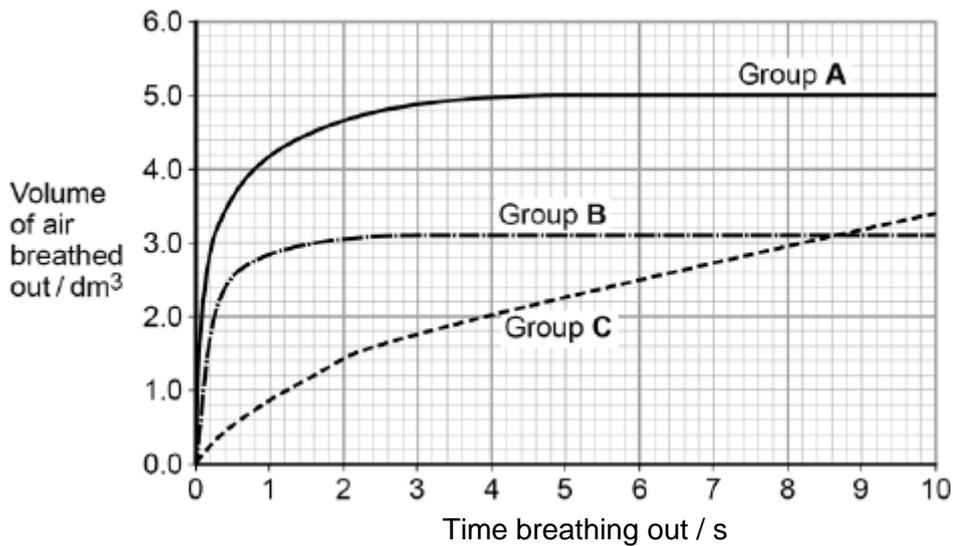
They used these data to determine the relative risk of a wife dying from a particular disease according to her husband's smoking habit.

In this comparison, they gave the relative risk to the wife of a non-smoker as 1.00. A value greater than 1.00 shows an increased risk compared to the wife of a non-smoker.

The results are shown in the table below.

Cause of death	Relative risk of wife dying		
	Husband non-smoker	Husband smokes 1 to 19 cigarettes /day	Husband smokes more than 19 cigarettes / day
Lung cancer	1.00	1.61	2.08
Emphysema	1.00	1.29	1.49
Cervical cancer	1.00	1.15	1.14
Stomach cancer	1.00	1.02	0.99
Heart disease	1.00	0.97	1.03

A journalist concluded from these data that if a husband smoked, it greatly increased the risk of his wife dying of certain diseases. Evaluate this statement.



(b) Calculate the percentage drop in FEV for group C compared with the healthy people.

Answer = _____

(1)

(c) Asthma affects bronchioles and reduces flow of air in and out of the lungs. Fibrosis does not affect bronchioles; it reduces the volume of the lungs.

Which group, B or C, was the one containing people with fibrosis of their lungs? Use the information provided and evidence from the figure above to explain your answer.

(Extra space) _____

(3)

(Total 8 marks)

Q15. If red blood cells are placed in pure water, water enters the cells by osmosis and they burst. This is called haemolysis. As red blood cells burst they release pigment.

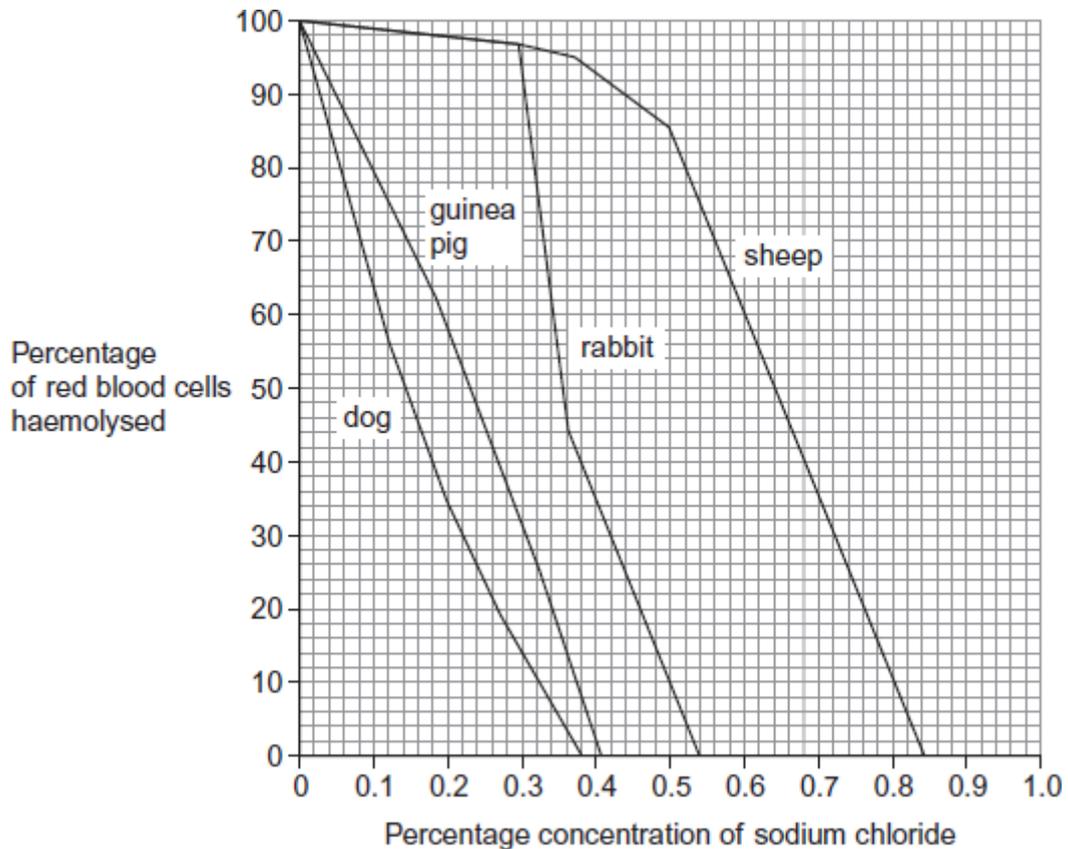
Scientists placed samples of red blood cells in different concentrations of sodium chloride

solution for the same period of time. They used red blood cells from four different mammals: dog, guinea pig, rabbit and sheep.

If haemolysis had taken place, the solution turned red. The scientists measured the intensity of the red colour using a colorimeter. The more intense the red colour, the greater the amount of haemolysis.

The scientists calculated the percentage of red blood cells that were haemolysed in each sodium chloride solution.

The following figure shows the scientists' results.



- (a) Use the figure to give **two** differences between the results for dog and sheep.

Difference 1 _____

Difference 2 _____

(2)

- (b) Calculate the difference in the percentage of haemolysed cells between sheep and rabbit at a sodium chloride concentration of 0.5%.

(c) Explain the relationship between the depth of the red colour of the solution and how much haemolysis has taken place.

(2)

(d) During treatment in a veterinary surgery, any of the mammals in the figure above may be given an infusion of sodium chloride solution directly into a vein. The concentration of sodium chloride solution used is 0.9%, rather than 0.5%, regardless of the species of mammal.

Explain the advantage to the vet of using this concentration.

(Extra space) _____

(2)

(Total 7 marks)

Q16. Scientists studied the rate of carbon dioxide uptake by grape plant leaves. Grape leaves have stomata on the lower surface but no stomata on the upper surface.

The scientists recorded the carbon dioxide uptake by grape leaves with three different treatments:

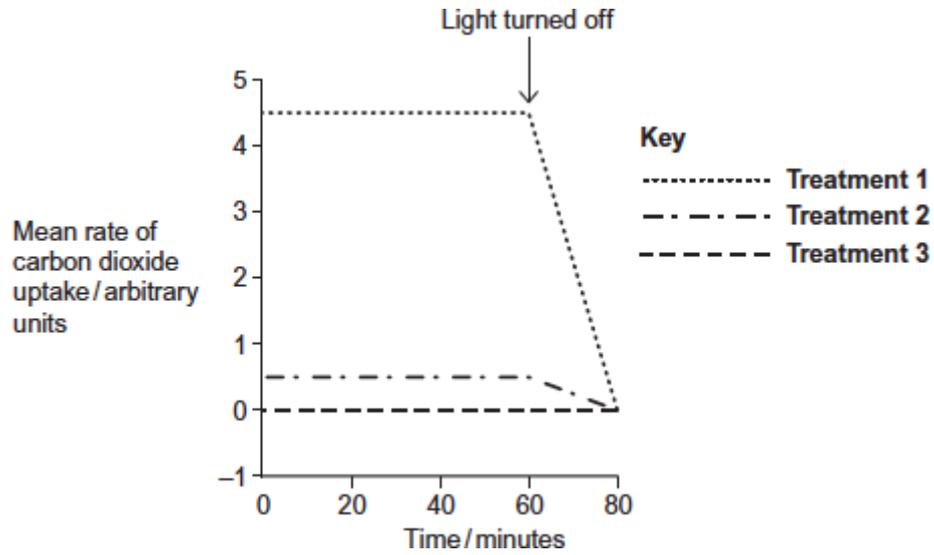
Treatment 1 – No air-sealing grease was applied to either surface of the leaf.

Treatment 2 – The lower surface of the leaf was covered in air-sealing grease that prevents gas exchange.

Treatment 3 – Both the lower surface and the upper surface of the leaf were covered in air-sealing grease that prevents gas exchange.

The scientists measured the rate of carbon dioxide uptake by each leaf for 60 minutes in light and then for 20 minutes in the dark.

The scientists' results are shown in the diagram below.



(a) Suggest the purpose of each of the three leaf treatments.

Treatment 1

Treatment 2

Treatment 3

(3)

(b) (i) Describe the results shown for **Treatment 1**.

(2)

(ii) The stomata close when the light is turned off.

Explain the advantage of this to the plant.

(2)

- (c) (i) **Treatment 2** shows that even when the lower surface of the leaf is sealed there is still some uptake of carbon dioxide.

Suggest how this uptake of carbon dioxide continues.

(1)

- (ii) In both **Treatment 1** and **Treatment 2**, the uptake of carbon dioxide falls to zero when the light is turned off.

Explain why.

(2)

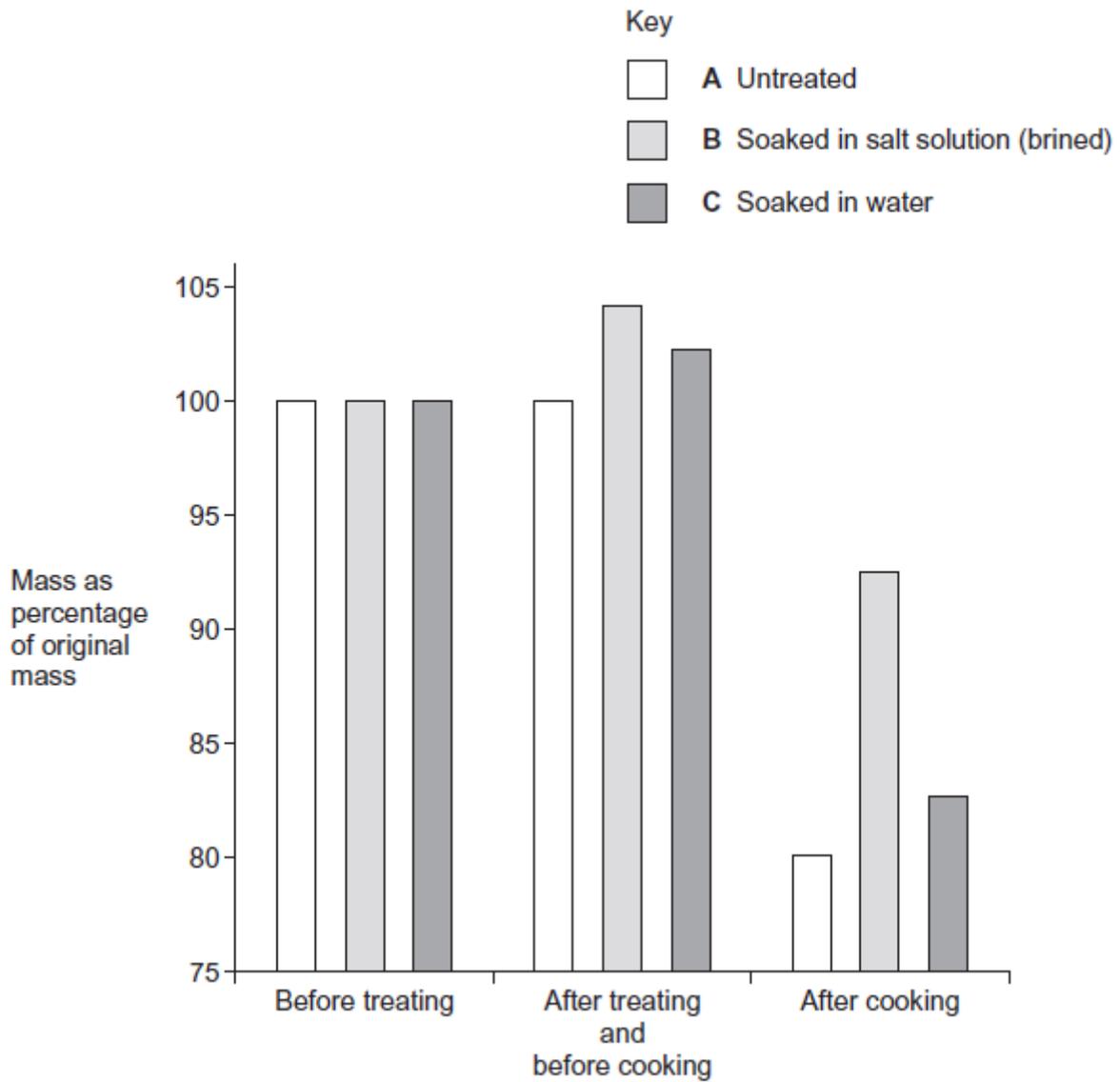
(Total 10 marks)

Q17. Turkey meat can dry out when it is cooked in an oven. One way to overcome this is to soak the meat in a salt solution before cooking it. This is called brining.

A food writer organised a demonstration. He treated three similar pieces of turkey in different ways.

- Piece **A** was untreated.
- Piece **B** was soaked overnight in a 6% solution of salt. A 6% solution of salt has a greater solute concentration than the cells in turkey meat.
- Piece **C** was soaked overnight in water.

He put all three pieces in an oven at 150 °C. He left each piece until it was cooked and the temperature in its centre was 65 °C. The writer weighed each piece at different stages in the demonstration. The graph shows his results.



(a) (i) Explain the advantage of using percentage change in mass in this investigation.

(2)

(ii) The pieces of turkey meat were cooked. Explain the advantage of leaving them in the oven until the temperature in the centre of each piece was 65 °C.

_____ (2)

- (iii) Recording mass is a valid way to measure the dependent variable in this investigation.
Evaluate this statement.

_____ (2)

- (b) Students suggested that osmosis resulted in cooked brined turkey meat containing more water than cooked untreated meat.

Use your knowledge of water potential and the data in the graph to explain why this suggestion could not be correct.

_____ (2)

(Total 8 marks)

- Q18.** (a) Describe how you would test a piece of food for the presence of lipid.

_____ (2)

The figure below shows a phospholipid.

(1)

Scientists investigated the percentages of different types of lipid in plasma membranes from different types of cell. The table shows some of their results.

Type of lipid	Percentage of lipid in plasma membrane by mass		
	Cell lining ileum of mammal	Red blood cell of mammal	The bacterium <i>Escherichia coli</i>
Cholesterol	17	23	0
Glycolipid	7	3	0
Phospholipid	54	60	70
Others	22	14	30

- (e) The scientists expressed their results as **Percentage of lipid in plasma membrane by mass**. Explain how they would find these values.

(2)

Cholesterol increases the stability of plasma membranes. Cholesterol does this by making membranes less flexible.

- (f) Suggest **one** advantage of the different percentage of cholesterol in red blood cells compared with cells lining the ileum.

(1)

- (g) *E. coli* has no cholesterol in its cell-surface membrane. Despite this, the cell maintains a constant shape. Explain why.

(2)

(Total 10 marks)

- Q19.** (a) Explain how including leguminous plants in a crop rotation reduces the need to use artificial fertilisers.

(2)

- (b) Application of very high concentrations of fertiliser to the soil causes plants to wilt. Explain why.

(2)

(Total 4 marks)

Q20. Essay

You should write your essay in continuous prose.

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

The maximum number of marks that can be awarded is

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

Write an essay on the following topic:

The membranes of different types of cells are involved in many different functions.

(Total 25 marks)