2.3 TRANSPORT ACROSS CELL MEMBRANES (2) – QUESTIONS

Q1. (a) Give **three** properties of water that are important in biology.

1. ____

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2. ____

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3. ____ **(3)**

A student investigated the effect of different concentrations of sucrose solution on “chips” cut from a potato. Each chip had the same dimensions.

The student:

- weighed each chip at the start
- placed each chip in a separate test tube, each containing 10 cm^3 of sucrose solution at a different concentration
- left the chips in the sucrose solution for 24 hours
- dried the surface of the chips and then weighed them again.

The table shows the student’s results.

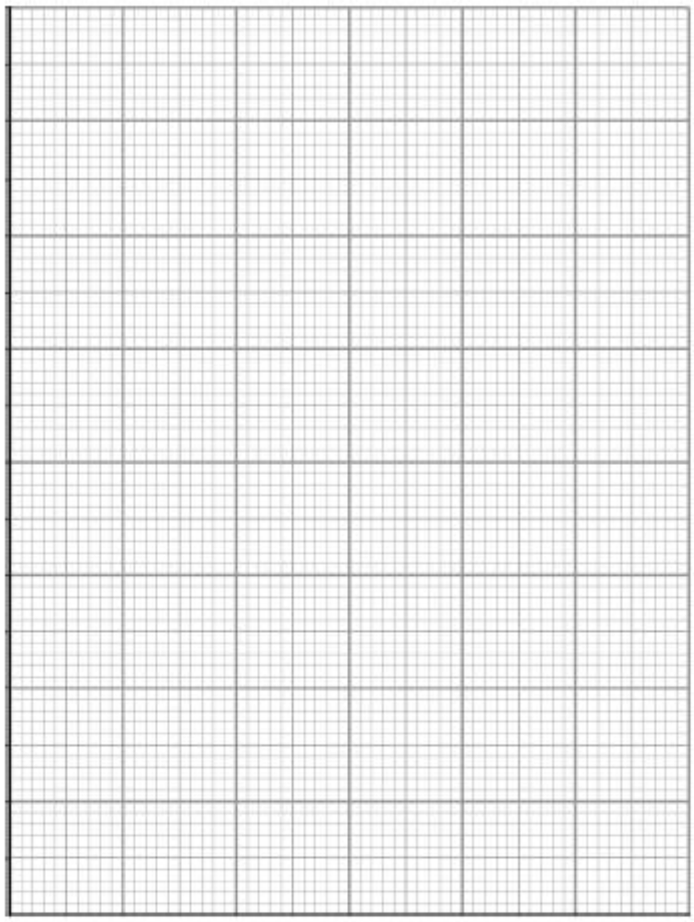
Concentration of sucrose solution / mol dm^{-3}	**Initial mass of chip / g**	**Final mass of chip / g**	**Ratio of final mass to initial mass of chips**
0.0	2.79	3.82	
0.2	2.75	2.97	
0.4	2.78	2.67	
0.6	2.69	2.31	
0.8	2.72	2.20	
1.0	2.77	1.99	

(b) The student produced the sucrose solutions with different concentrations from a concentrated sucrose solution.

Name the method she would have used to produce these sucrose solutions.

Name of method ____ **(1)**

(c) Calculate the ratio of final mass to initial mass of potato chips and plot a suitable graph of your processed data. Express the ratios in the table in part (a) as a single number (for example 5.26:1 would be expressed as 5.26).



(3)

(d) Explain the result for the chip in 0.8 mol dm^{-3} sucrose solution.

(2)

(Total 9 marks)

Q2. Read the following passage.

Low-density lipoprotein (LDL) is a substance found in blood. A high concentration of LDL in a person’s blood can increase the risk of atheroma formation. Liver cells have a receptor on their cell-surface membranes that LDL binds to. This leads to LDL entering the cell. A regulator protein, also found in blood, can bind to the same receptor as LDL. This prevents LDL entering the liver cell. People who have a high concentration of this regulator protein in their blood will have a high concentration of LDL in their blood. Scientists have made a monoclonal antibody that prevents this regulator protein working. They have suggested that these antibodies could be used to reduce the risk of coronary heart disease.

A trial was carried out on a small number of healthy volunteers, divided into two groups. The scientists injected one group with the monoclonal antibody in salt solution. The other group was a control group. They measured the concentration of LDL in the blood of each volunteer at the start and after 3 months. They found that the mean LDL concentration in the volunteers injected with the antibody was 64% lower than in the control group.

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

(a) The scientists gave an injection to a mouse to make it produce the monoclonal antibody used in this investigation (line 7).

What should this injection have contained?

(1)

(b) LDL enters the liver cells (lines 3−4).

Using your knowledge of the structure of the cell-surface membrane, suggest how LDL enters the cell.

(2)

(c) Explain how the monoclonal antibody would prevent the regulator protein from working (lines 7−8).

(2)

(d) Describe how the control group should have been treated.

(2)

(Total 7 marks)

Q3.

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

1. ____

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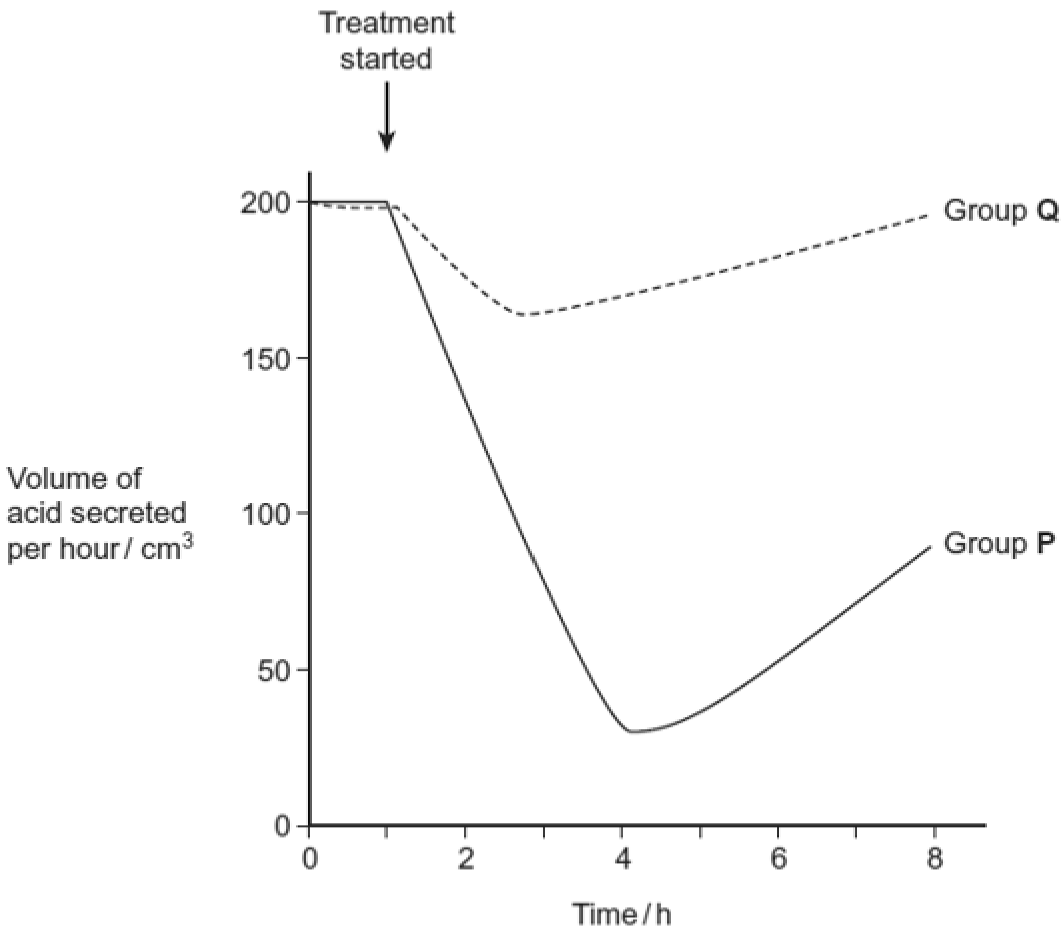
2. ____

____ (2)

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

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

The graph shows the results.



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

(1)

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

(2)

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

(1)

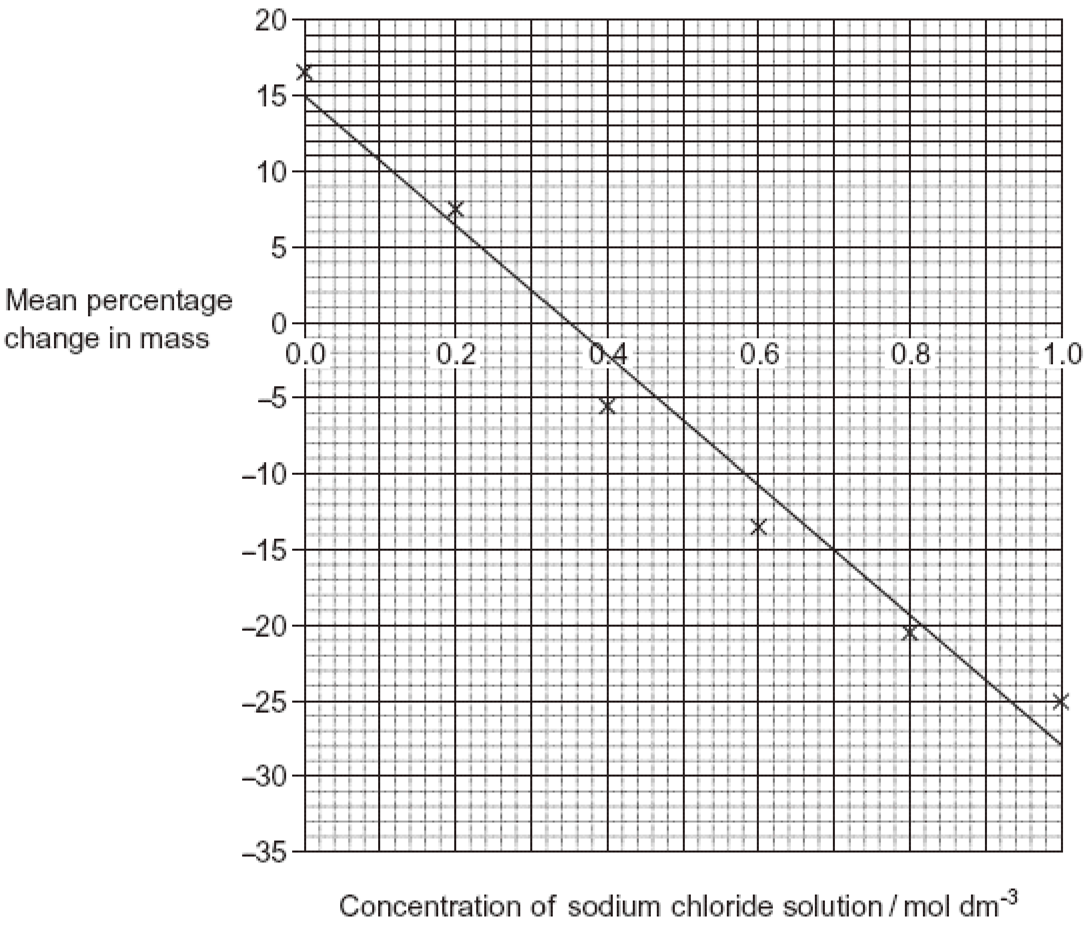
(Total 6 marks)

Q4. A student investigated the effect of putting cylinders cut from a potato into sodium chloride solutions of different concentration. He cut cylinders from a potato and weighed each cylinder. He then placed each cylinder in a test tube. Each test tube contained a different concentration of sodium chloride solution. The tubes were left overnight. He then removed the cylinders from the solutions and reweighed them.

(a) Before reweighing, the student blotted dry the outside of each cylinder. Explain why.

(2)

The student repeated the experiment several times at each concentration of sodium chloride solution. His results are shown in the graph.



(b) The student made up all the sodium chloride solutions using a 1.0 mol dm^{-3} sodium chloride solution and distilled water.

Complete the table to show how he made 20 cm^3 of a 0.2 mol dm^{-3} sodium chloride solution.

Volume of 1.0 mol dm^{-3} sodium chloride solution	**Volume of distilled water**

(1)

(c) The student calculated the *percentage* change in mass rather than the change in mass. Explain the advantage of this.

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___ **(2)**

(d) The student carried out several repeats at each concentration of sodium chloride solution. Explain why the repeats were important.

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____ **(2)**

(e) Use the graph to find the concentration of sodium chloride solution that has the same water potential as the potato cylinders.

____________________ mol dm^{-3}

(1)

(Total 8 marks)

Q5. 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

(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)

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

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(2)

(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.

(2)

(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.

(2)

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

(2)

(Total 9 marks)

Q6. (a) Name the process by which bacterial cells divide.

(1)

A microbiologist investigated the ability of different plant oils to kill the bacterium *Listeria monocytogenes*. She cultured the bacteria on agar plates. She obtained the bacteria from a broth culture.

(b) Describe **two** aseptic techniques she would have used when transferring a sample of broth culture on to an agar plate.
Explain why each was important.

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____ **(4)**

The microbiologist tested five different plant oils at two different temperatures and determined the minimum concentration of plant oil that killed the *L. monocytogenes*.

The table below shows her results.

Plant oil	**Minimum concentration of plant oil that killed *Listeria monocytogenes* / percentage**	
	4 °C	**35 °C**
Bay	0.10	0.04
Cinnamon	0.08	0.08
Clove	0.05	0.05
Nutmeg	>1.00	0.05
Thyme	0.02	0.03

(c) Which plant oil is least effective at killing *L. monocytogenes* at 35 °C?

____ **(1)**

L. monocytogenes is a pathogen of great concern to the food industry, especially in foods stored in refrigeration conditions (4 °C) where, unlike most food-borne pathogens, it is able to multiply. It has been suggested that plant oils, together with refrigeration may help to reduce the growth of *L. monocytogenes*.

(d) What conclusions can be drawn about the effectiveness of using plant oils with refrigeration to reduce food-borne infections caused by *L. monocytogenes*?

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____ **(3)**

(e) Plant oils are hydrophobic and can cross the cell-surface membrane of the bacterium. The low temperature of 4 °C can slow the rate of entry of plant oils into the cells.

Suggest how the low temperature slows the rate of entry.

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____ **(1)**

(Total 10 marks)

Q7. The cells of beetroot contain a red pigment. A student investigated the effect of temperature on the loss of red pigment from beetroot. He put discs cut from beetroot into tubes containing water. He maintained each tube at a different temperature. After 25 minutes, he measured the percentage of light passing through the water in each tube.

(a) The student put the same volume of water in each tube.

Explain why it was important that he controlled this experimental variable.

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____ **(2)**

(b) Describe a method the student could have used to monitor the temperature of the water in each tube.

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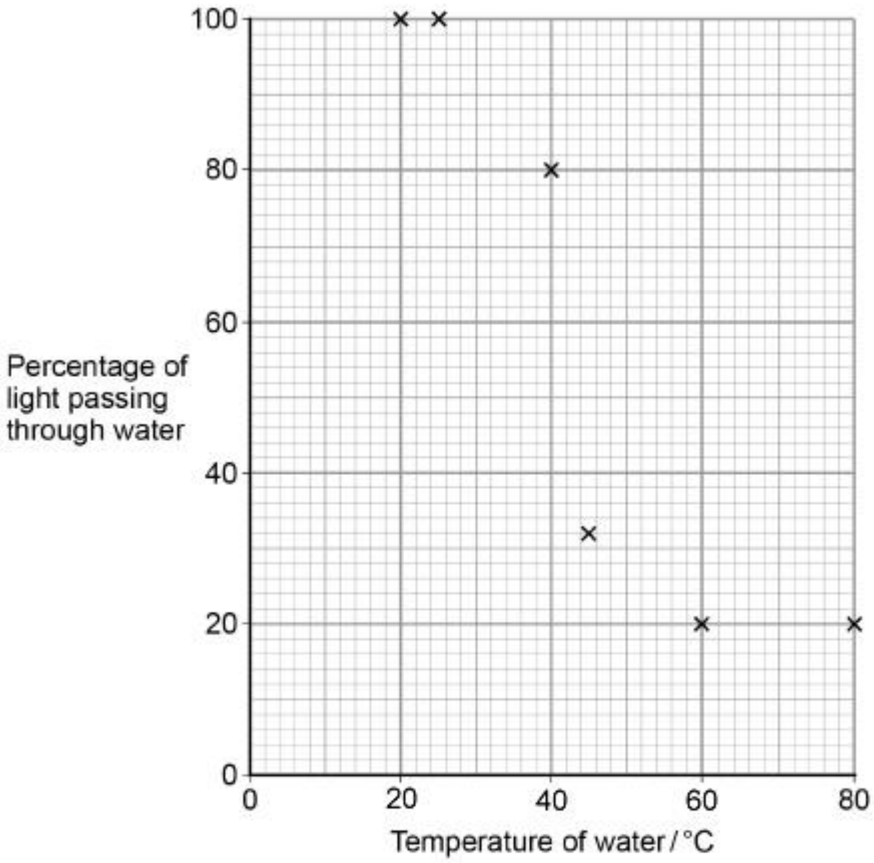
____ **(1)**

The graph shows the student's results.



(c) Draw a suitable curve on the graph above. **(1)**

(d) The decrease in the percentage of light passing through the water between 25 °C and 60 °C is caused by the release of the red pigment from cells of the beetroot.

Suggest how the increase in temperature of the water caused the release of the red pigment.

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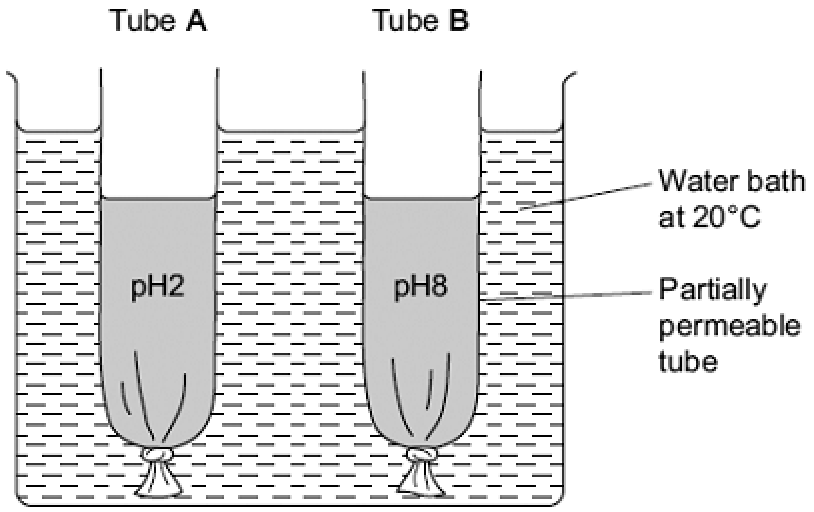
____ **(2)**

(Total 6 marks)

Q8. (a) A student investigated the effect of pH on the activity of the enzyme amylase.
She set up the apparatus shown in the diagram.



The tubes were made from Visking tubing. Visking tubing is partially permeable.
She added an equal volume of amylase solution and starch to each tube.

- She added a buffer solution at pH2 to tube **A**.
- She added an equal volume of buffer solution at pH8 to tube **B**.

After 30 minutes, she measured the height of the solutions in both tubes.
She then tested the solutions in tubes **A** and **B** for the presence of reducing sugars.

Describe how the student would show that reducing sugars were present in a solution.

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*(Extra space)*___

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___ **(3)**

(b) After 30 minutes, the solution in tube **B** was higher than the solution in tube **A**.

(i) Explain why the solution in tube **B** was higher.

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*(Extra space)*____

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____ **(3)**

(ii) The student concluded from her investigation that the optimum pH of amylase was pH8. Is this conclusion valid? Explain your answer

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____ **(1)**

(Total 7 marks)

Q9. A group of students carried out an investigation to find the water potential of potato tissue.

The students were each given a potato and 50 cm^3 of a 1.0 mol dm^{-3} solution of sucrose.

- They used the 1.0 mol dm^{-3} solution of sucrose to make a series of different concentrations.
- They cut and weighed discs of potato tissue and left them in the sucrose solutions for a set time.
- They then removed the discs of potato tissue and reweighed them.

The table below shows how one student presented his processed results.

Concentration of sucrose solution / mol dm^{-3}	Percentage change in mass of potato tissue
0.15	+4.7
0.20	+4.1
0.25	+3.0
0.30	+1.9
0.35	−0.9
0.40	−3.8

(a) Explain why the data in the table above are described as **processed** results.

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____ **(1)**

(b) Describe how you would use a 1.0 mol dm^{-3} solution of sucrose to produce 30 cm^3 of a 0.15 mol dm^{-3} solution of sucrose.

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(2)

(c) Explain the change in mass of potato tissue in the 0.40 mol dm^{-3} solution of sucrose.

(2)

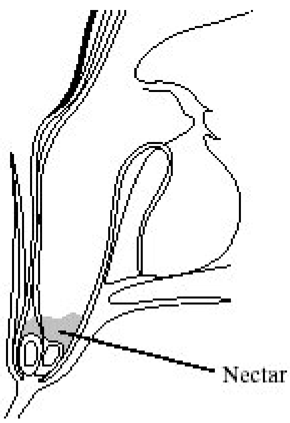
(d) Describe how you would use the student's results in the table above to find the water potential of the potato tissue.

(Extra space)

(3)

(Total 8 marks)

Q10. Penstemon plants have mechanisms that regulate the amount of nectar produced by their flowers. Nectar is a solution containing sucrose which attracts insect pollinators. The diagram shows a section through a penstemon flower.



To investigate these mechanisms the volume of nectar produced was determined. A thin strip of filter paper was dipped into the nectar until all the nectar was absorbed. The distance the nectar moved up the paper was measured. The actual volume of nectar was found by reading the value from a calibration curve on a graph. A sucrose solution similar to nectar was used to produce this calibration curve.

(a) (i) The solution contained 22% by mass of sucrose. Describe how you would make 50 cm^3 of this solution.

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____ **(1)**

(ii) Describe how you would use the solution to produce the calibration curve.

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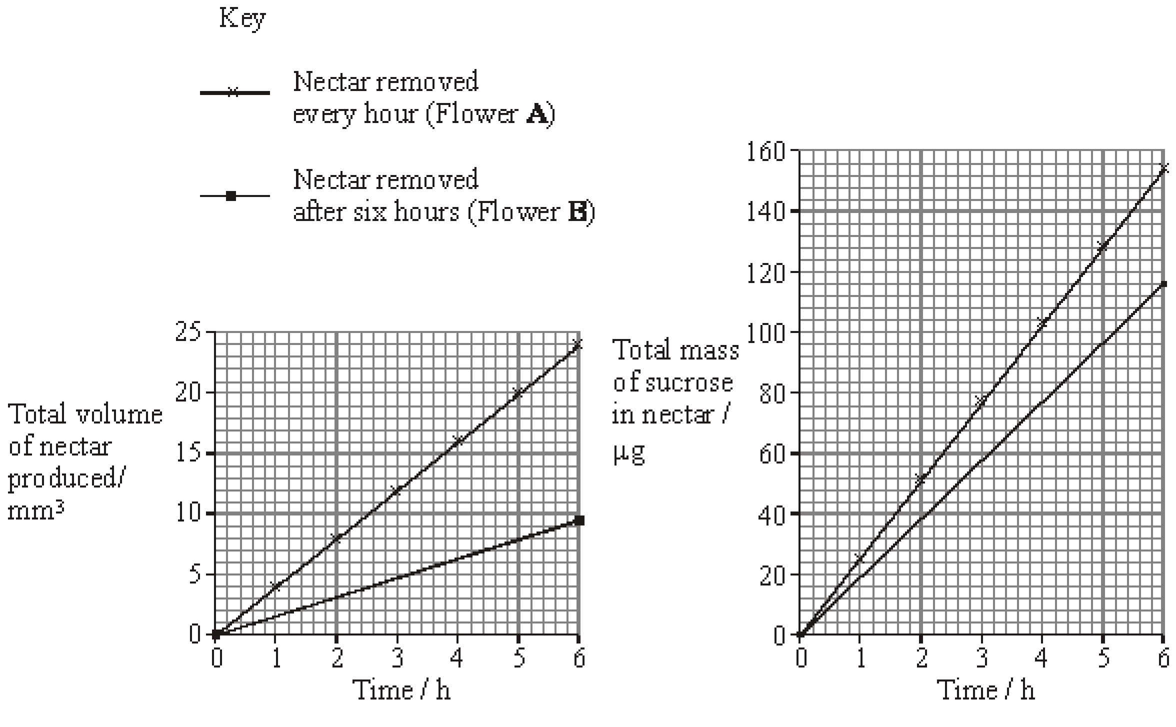
____ **(2)**

In one experiment the effect of removing nectar at regular intervals was investigated. First all the nectar was removed from two penstemon flowers. From one flower (**A**) all the nectar produced was removed each hour for the next six hours. In the second flower (**B**) the nectar was allowed to accumulate for six hours. Each time the nectar was removed, the sugar was extracted from the strip of filter paper and its mass was measured. The graphs show the results.



(b) (i) Describe the effects on nectar production and on sucrose secretion of removing the nectar every hour compared with removing it after 6 hours.

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____ **(2)**

(ii) How would the nectar collected after 6 hours from plant **B** differ from that collected after 6 hours from plant **A**.

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____ **(1)**

(iii) Pollinating insects such as bees visit flowers and collect nectar. Suggest **one** advantage for penstemon flowers of the response to regular removal of nectar.

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____ **(1)**

(c) In a different experiment the nectar was removed from two penstemon flowers. In one flower the nectar was replaced with 5 mm^3 of a solution containing a total of 120 µg of sucrose. The second flower was left empty as a control. The two flowers were protected from insects. After three hours the nectar solutions in the flowers were removed. The table shows the results.

	Volume of solution / mm^3		**Mass of sucrose in solution / µg**	
Time / h	**Experimental**	**Control**	**Experimental**	**Control**
0	5.00	0.00	120	0
3	5.75	1.65	104	20

Describe the effect of the addition of sucrose solution on the volume of nectar produced and on the movement of sucrose.

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____ **(3)**

(d) Nectar is formed by specialised cells in the flower which synthesise sucrose.
Describe how sucrose is moved against a concentration gradient from these cells into the nectar.

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(2)

(Total 12 marks)

Q11. Gorter and Grendel investigated the structure of the surface membrane of cells. They extracted the phospholipids from the surface membranes of red blood cells in 1 cm^3 of blood and placed them in the apparatus shown in **Figure 1**.

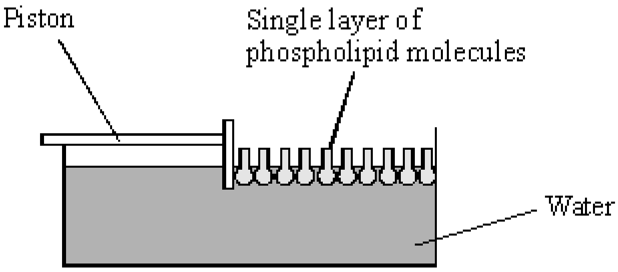

Figure 1

The piston was pushed across the surface of the water until the phospholipid molecules were tightly packed into a single layer. The area covered by the phospholipid molecules was measured. This area was compared with the estimated surface area of the red blood cells from which phospholipids were extracted.

Gorter and Grendel obtained the data shown in the table.

Number of red blood cells per cm^3 of blood	4.74×10^9
Estimated mean surface area of one red blood cell	99.4 μm^2
Surface area of membrane phospholipids extracted from 1cm^3 of blood	0.92 m^2

(a) Explain what these data suggest about the arrangement of phospholipids in the surface membranes of red blood cells. Support your explanation with suitable calculations.

Show your working.

(3)

(b) **Figure 2** shows a red blood cell and a white blood cell.

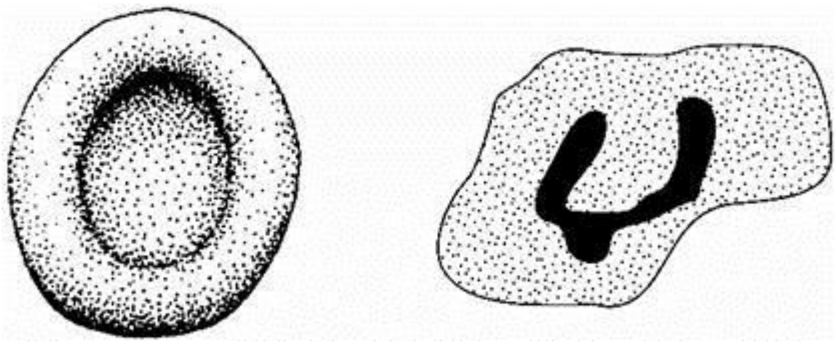

Figure 2

Explain why red blood cells were used in this investigation rather than white blood cells.

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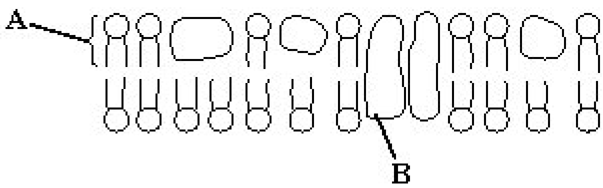
____ **(2)**

(Total 5 marks)

Q12. (a) The diagram shows the fluid-mosaic model of a cell surface membrane.



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

A ____

B ____ **(1)**

(ii) How does the bilayer formed by substance **A** affect entry and exit of substances into and out of a cell?

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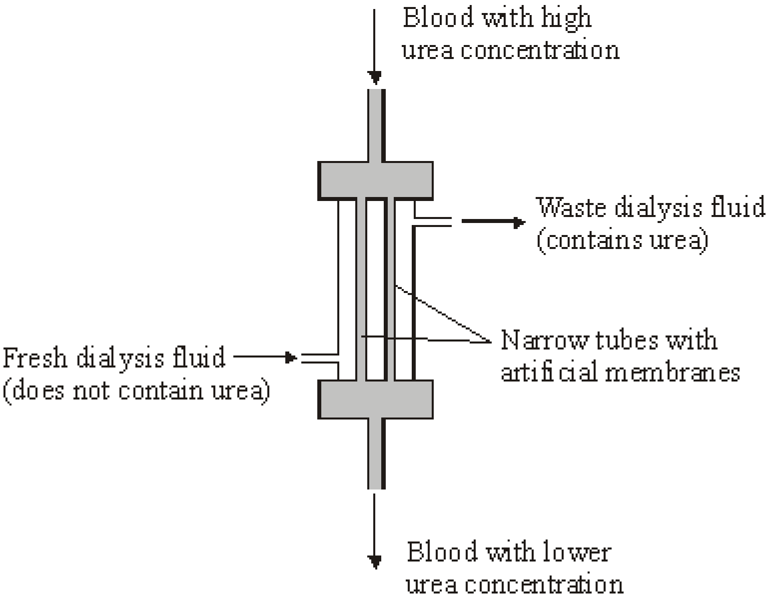
____ **(2)**

(b) A dialysis machine contains artificial membranes which enable urea to be removed from the blood of a person with kidney failure. The diagram shows a dialysis machine.



(i) By what process does urea pass from the blood into the dialysis fluid?

____ **(1)**

(ii) Suggest **two** reasons for keeping the fluid in the dialysis machine at 40 °C rather than room temperature.

1. ____

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2. ____

____ **(2)**

(iii) The blood and the dialysis fluid flow in opposite directions in the dialysis machine. Explain the advantage of this.

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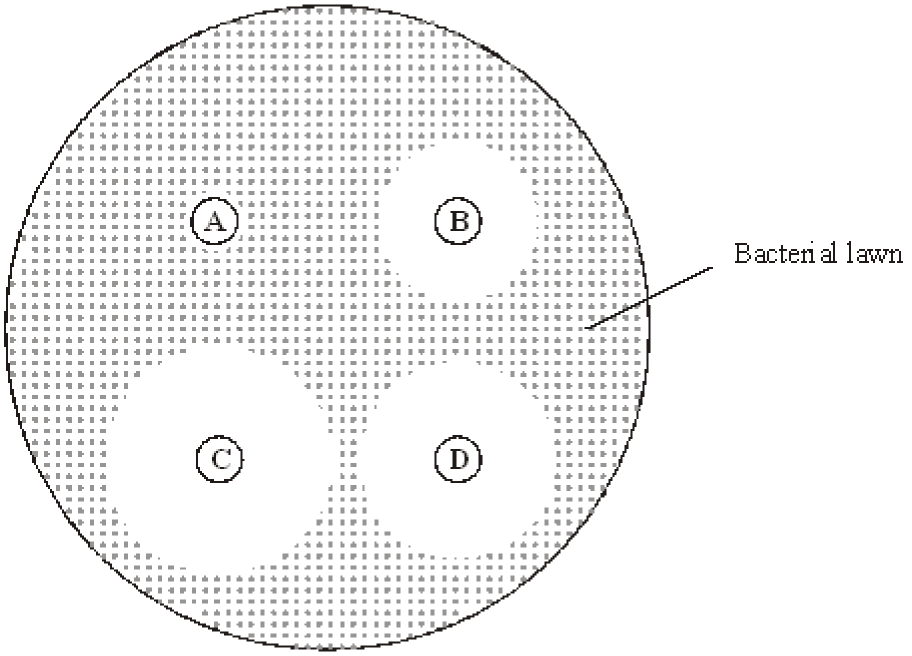
____ **(2)**

(iv) Blood flows through the dialysis machine at a rate of 200 cm^3 per minute. Calculate the total volume which passes through the machine in 5 hours. Give your answer in dm^3 and show your working.

Answer ____________________ dm^3 **(2)**

(Total 10 marks)

Q13. An agar plate was flooded with a culture of a species of bacterium usually found in the mouth. Four sterile paper discs, **A**, **B**, **C** and **D**, each containing a different brand of mouthwash, were then placed on the agar plate. The drawing shows the appearance of the plate after it had been incubated at 37°C for three days.



(a) Describe the aseptic techniques that would be used when flooding the agar plate with bacteria.

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____ **(3)**

(b) The effectiveness of a mouthwash can be measured by calculating the total area of a paper disc and the clear zone around it. The area of a circle is given by πr^2, where r is the radius of the circle. Calculate how many times more effective mouthwash **C** is than mouthwash **B**. Show your working.

Mouthwash **C** is __________________ times more effective than mouthwash **B**.

(2)

(c) Several factors affect the rate at which the antiseptic in the mouthwash from each paper disc diffuses through the agar. Describe the effect of **three** named factors on this rate.

1. ____

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2. ____

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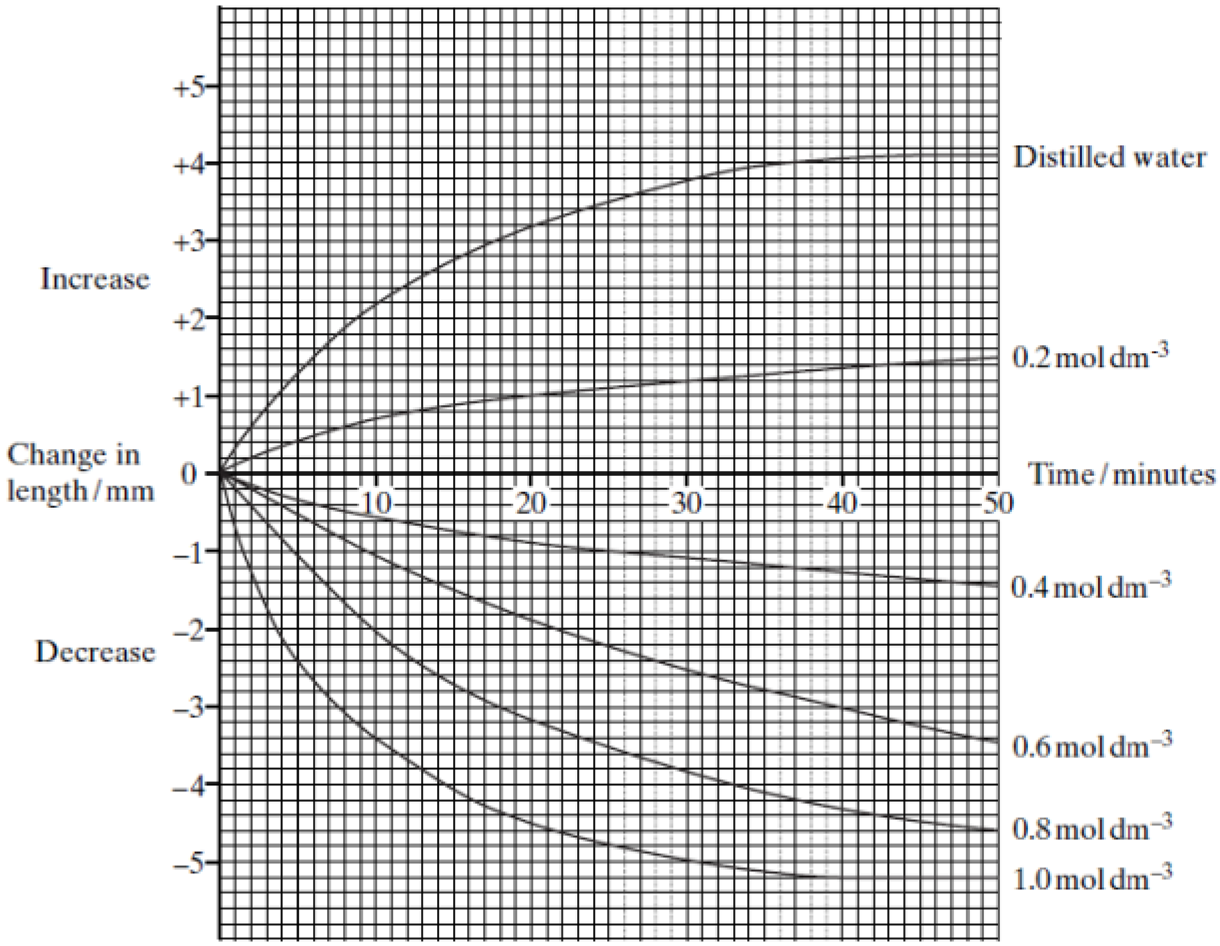
3. ____

____ **(3)**

(Total 8 marks)

Q14. Six cylinders of a standard size were cut from a single large potato. One cylinder was placed in distilled water and the others were placed in sucrose solutions of different concentrations. The length of each cylinder was measured every 5 minutes for the next 50 minutes.

The graph shows the changes in length at each sucrose concentration.



(a) Explain why

(i) the potato cylinder in distilled water increased in length;

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____ **(2)**

(ii) the potato cylinder in the 1.0 mol dm^{-3} sucrose solution showed no further decrease in length after 40 minutes.

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____ **(2)**

(b) (i) Describe the difference in the rate of decrease in length during the first 10 minutes between the cylinder in the 0.4 mol dm^{-3} and the cylinder in the 0.8 mol dm^{-3} solution.

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____ **(1)**

(ii) Use your knowledge of water potential to explain this difference.

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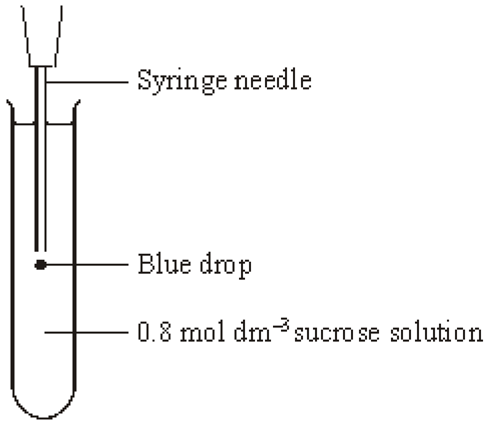
____ **(1)**

(c) After 45 minutes the potato cylinder in the 0.8 mol dm^{-3} solution was removed and blue dye added to this solution. Some of this blue-stained solution was drawn into a syringe. A drop was then released, slowly, halfway down a test tube of fresh 0.8 mol dm^{-3} sucrose solution as shown in the diagram. The blue drop quickly moved to the surface of the liquid in the test tube.



(i) The density of a solution depends on its concentration. The more concentrated the solution the greater its density. Explain why the blue drop had a lower density and therefore moved up.

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____ **(2)**

(ii) A sucrose solution of concentration 0.3 mol dm^{-3} has a water potential which is equivalent to that of the potato cells. Describe and explain what would happen to the blue drop from this solution.

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____ **(2)**

(Total 10 marks)

Q15. Tradescantia is a house plant. There are small hairs on its flowers. These hairs are made of cells. **Figure 1** shows the appearance of cells from one of these hairs after 20 minutes in distilled water. **Figure 2** shows cells from another hair after 20 minutes in a solution of potassium nitrate.

Figure 1 (in distilled water)

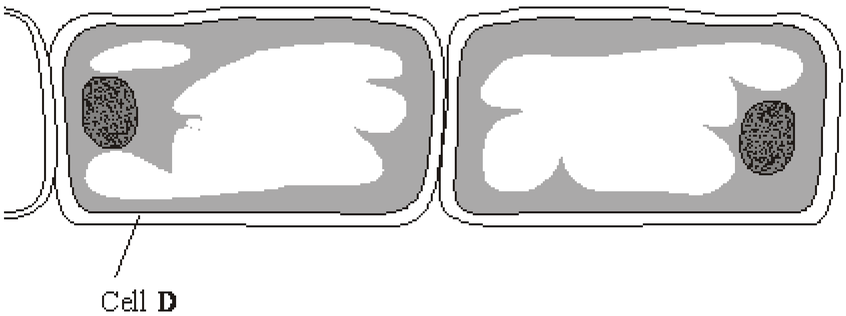
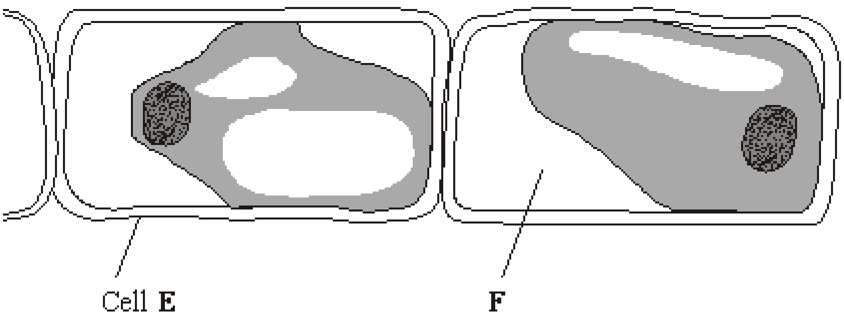


Figure 2 (in potassium nitrate solution)



(a) What does **Figure 2** suggest about the permeability of the plasma membranes surrounding these cells?

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____ **(1)**

(b) What is present in the space labelled **F**? Explain your answer.

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(2)

(c) How would the water potential of the sap in the vacuole of cell **E** differ from the water potential of the sap in the vacuole of cell **D**? Explain your answer.

(3)

(Total 6 marks)

Q16. (a) A plant cell was observed with an optical microscope. Describe how the length of the cell could be estimated.

(2)

(b) The water potential of a plant cell is –400 kPa. The cell is put in a solution with a water potential of –650 kPa. Describe and explain what will happen to the cell.

(3)

(c) A group of students investigated the effect of sucrose concentration on the change in length of cylinders of tissue cut from a young carrot. They measured the initial lengths of the carrot cylinders, then placed one in each of a number of sucrose solutions. After 18 hours, they removed the carrot cylinders and measured their final lengths. Some of the results are shown in the table.

Concentration of sucrose / mol dm^{-3}	Percentage decrease in length of carrot cylinder
0.4	4.2
0.5	8.7

0.6	13.0
0.7	16.8
0.8	18.1
0.9	18.1
1.0	18.1

(i) The carrot cylinders were left for 18 hours in the sucrose solutions. Explain why they were left for a long time.

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____ **(1)**

(ii) Explain how you would use a graph to predict the concentration of sucrose that would result in no change in length of the carrot cylinders.

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____ **(2)**

(iii) Young carrots store sugars in their tissues but, in older carrots, some of this is converted to starch. How would using cylinders of tissue from older carrots affect the results obtained for a sucrose solution of 0.6 mol dm^{-3}? Give a reason for your answer.

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____ **(2)**

(Total 10 marks)

Q17. (a) Cells lining the ileum of mammals absorb the monosaccharide glucose by co-transport with sodium ions. Explain how.

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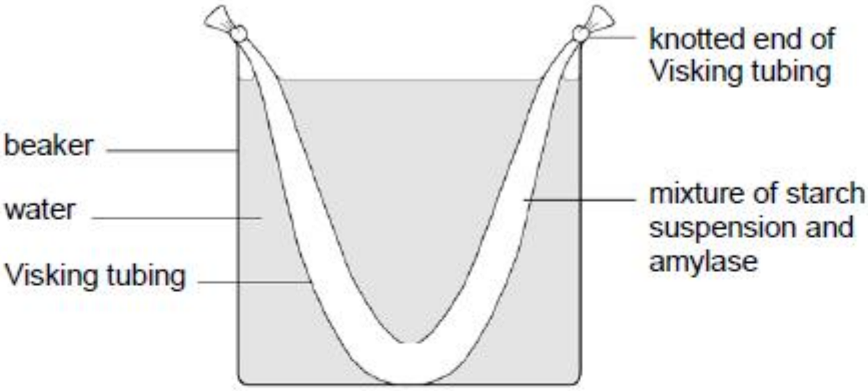
____ **(3)**

A student set up the experiment shown in the diagram below.



The material from which Visking tubing is made is partially permeable.

After 15 minutes, the student removed samples from the liquid in the beaker and from the liquid inside the Visking tubing. She carried out biochemical tests on these samples. She drew the table below to record her results.

(b) Complete the table by placing a tick (✔) in each box that you expect to have shown a positive result.

Biochemical test	**Liquid from beaker**	**Liquid inside Visking tubing**
Biuret reagent		
Iodine in potassium iodide		
Benedict's solution		

(3)

(c) Justify your answers to part **(b)**.

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____ **(3)**

(Total 9 marks)

Q18. 2,4-D is a selective herbicide that kills some species of plants but not others. 2,4-D disrupts cell-surface membranes but the extent of disruption differs in different species.

Scientists investigated the effect of 2,4-D on wheat plants (a crop) and on wild oat plants (a weed).

They grew plants of both species in glasshouses. They put plants of each species into one of two groups, **W** and **H**, which were treated as follows:

- Group **W** – leaves sprayed with water
- Group **H** – leaves sprayed with a solution of 2,4-D.

After spraying, they cut 40 discs from the leaves of plants in each group and placed them in flasks containing 10 cm^3 de-ionised water. After 5 minutes, they calculated the disruption to cell-surface membranes by measuring the concentration of ions released into the water from the leaf discs.

Their results are shown in the table below.

The lowest significant difference (LSD), is the smallest difference between two means that would be significant at $P \leq 0.05$

Group	**Treatment**	**Mean concentration of ions in water / arbitrary units**	
		Wheat	**Wild oats**
W	Water	26	45
H	2,4-D	27	70
Lowest significant difference (LSD)		7	10

(a) Give **three** environmental variables that should be controlled when growing the plants before treatment with the different sprays.

1. ____

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2. ____

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3. ____

____ **(2)**

(b) Evaluate the use of 2,4-D as a herbicide on a wheat crop that contains wild oats as a weed. Use all the information provided.

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(4)

(c) The scientists incubated the flasks containing the leaf discs at 26 °C and gently shook the flasks.

Suggest **one** reason why the scientists ensured the temperature remained constant and **one** reason why the leaf discs were shaken.

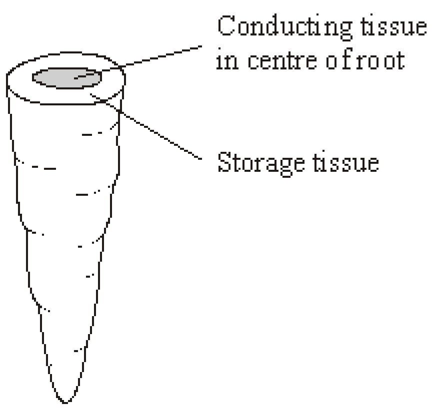
Temperature ____

Shaken ____

(2)
(Total 8 marks)

Q19.

The diagram shows a carrot.



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

(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)**

(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)**

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

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

(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)**

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

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___ **(1)**

(Total 7 marks)

Q20. Read the following passage.

The plasma membrane plays a vital role in microorganisms. It forms a barrier between the cell and its environment, controlling the entry and exit of solutes.
This makes bacteria vulnerable to a range of antiseptics and antibiotics.

When bacteria are treated with antiseptics, the antiseptics bind to the proteins in the membrane and create tiny holes. Bacteria contain potassium ions at a concentration many times that outside the cell. Because of the small size of these ions and their concentration in the cell, the first observable sign of antiseptic damage to the plasma membrane is the leaking of potassium ions from the cell. Some antibiotics damage the plasma membrane in a similar way. One of these is tyrocidin. This is a cyclic polypeptide consisting of a ring of ten amino acids. Tyrocidin and other polypeptide antibiotics are of little use in medicine.

Other antibiotics also increase the rate of potassium movement from cells. It is thought that potassium ions are very important in energy release and protein synthesis, and a loss of potassium ions would lead to cell death. Gramicidin A coils to form a permanent pore passing through the plasma membrane. This pore enables potassium ions to be conducted from the inside of the cell into the surrounding medium. Vanilomycin also facilitates the passage of potassium ions from the cell.
A molecule of vanilomycin forms a complex with a potassium ion and transports it across the membrane. The potassium ion is released on the outside and the vanilomycin is free to return and pick up another potassium ion. Vanilomycin depends on the fluid nature of the plasma membrane in order to function.

Polyene antibiotics have flattened ring-shaped molecules. The two sides of the ring differ from each other. One side consists of an unsaturated carbon chain. This part is strongly hydrophobic and rigid. The opposite side is a flexible, strongly hydrophilic region. It has been shown that polyene antibiotics bind only to sterols. Sterols are lipids found in the membranes of eukaryotes but not in the membranes of prokaryotic organisms. It is thought that several sterol-polyene complexes come together.
The plasma membranes of eukaryotic cells treated with these polyene antibiotics lose the ability to act as selective barriers and small ions and molecules rapidly leak out.

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

(a) By what process do potassium ions normally enter a bacterial cell? Explain the evidence for your answer.

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____ **(2)**

(b) (i) Draw a peptide bond showing how the COOH group of one amino acid joins to the NH_2 group of another.

(1)

(ii) How many peptide bonds are there in a molecule of tyrocidin (lines 9 - 10)?

____ **(1)**

(c) Experiments have shown that vanilomycin is unable to transport potassium ions across a membrane when it is cooled. Gramicidin A continues to facilitate the movement of potassium ions at these low temperatures. Explain these results.

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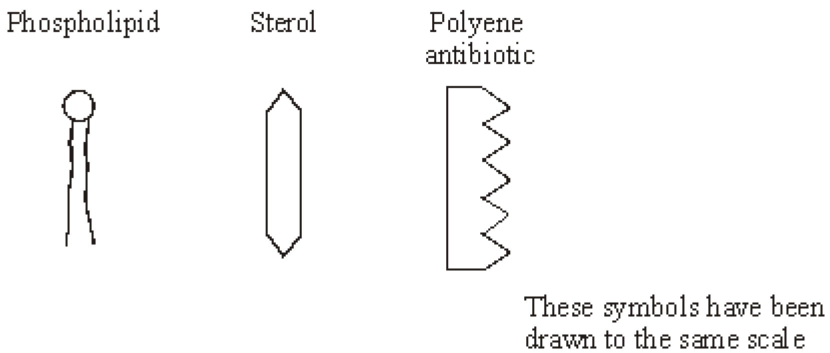
____ **(3)**

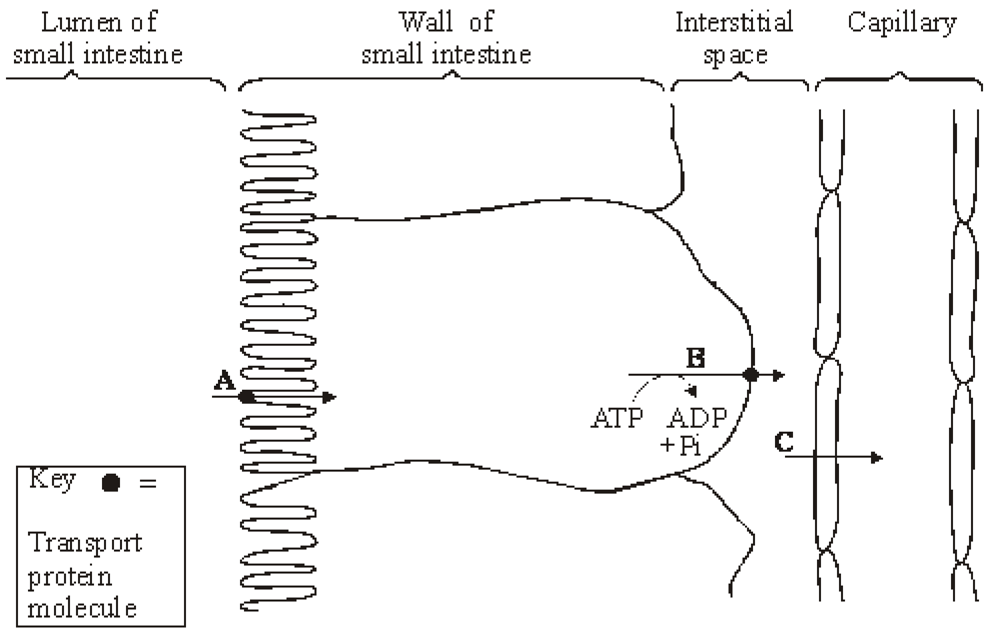
(d) Draw a simple diagram of one of the phospholipid layers to show how polyene antibiotics allow small ions and molecules to leak rapidly through a plasma membrane. Use the following symbols to represent the different molecules.

Note that the zigzag line on the symbol for the polyene antibiotic represents its hydrophobic region.



(2)
(Total 9 marks)

Q21. The figure below shows the processes involved in absorbing amino acids into a capillary from the small intestine.



(i) Name processes **A**, **B** and **C**. In each case, give the evidence for your answer.

A Process ______________________________

Evidence ______________________________

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B Process ______________________________

Evidence ______________________________

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C Process ______________________________

Evidence ______________________________

______________________________ **(3)**

(ii) Explain how process **B** creates the conditions for process **A** to occur.

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(2)

(Total 5 marks)

Q22. Read the following passage.

Human milk contains all the nutrients a young baby needs in exactly the right proportions. It is formed in the mammary glands by small groups of milk-producing cells. These cells absorb substances from the blood and use them to synthesise the lipids, carbohydrates and proteins found in milk. Milk-producing cells are roughly cube-shaped and have a height to breadth ratio of approximately 1.2 : 1.

The main carbohydrate in milk is lactose. Lactose is a disaccharide formed by the condensation of two monosaccharides, glucose and galactose. (A molecule of galactose has the same formula as a molecule of glucose – the atoms are just arranged in a different way.)

Lactose is synthesised in the Golgi apparatus and transported in vesicles through the cytoplasm. Because lactose is unable to escape from these vesicles, they increase in diameter as they move towards the plasma membrane. The vesicle membranes fuse with the plasma membrane and the vesicles empty their contents out of the cell.

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

(a) (i) The breadth of a milk-producing cell is 26 µm. Calculate the height of this cell.

Height = ____________________ µm

(1)

(ii) Describe and explain how you would expect the height to breadth ratio of an epithelial cell from a lung alveolus to differ from the height to breadth ratio of a milk-producing cell.

(2)

(b) How many oxygen atoms are there in a molecule of

(i) galactose;

(1)

(ii) lactose?

(1)

(c) The lactose-containing vesicles increase in diameter as they move towards the plasma membrane of the milk-producing cell (lines 11-12). Use your knowledge of water potential to explain why.

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____ **(2)**

(d) Suggest **one** advantage of milk-producing cells containing large numbers of mitochondria.

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____ **(2)**

(e) Some substances pass through the plasma membrane of a milk-producing cell by diffusion. Describe the structure of a plasma membrane and explain how different substances are able to pass through the membrane by diffusion.

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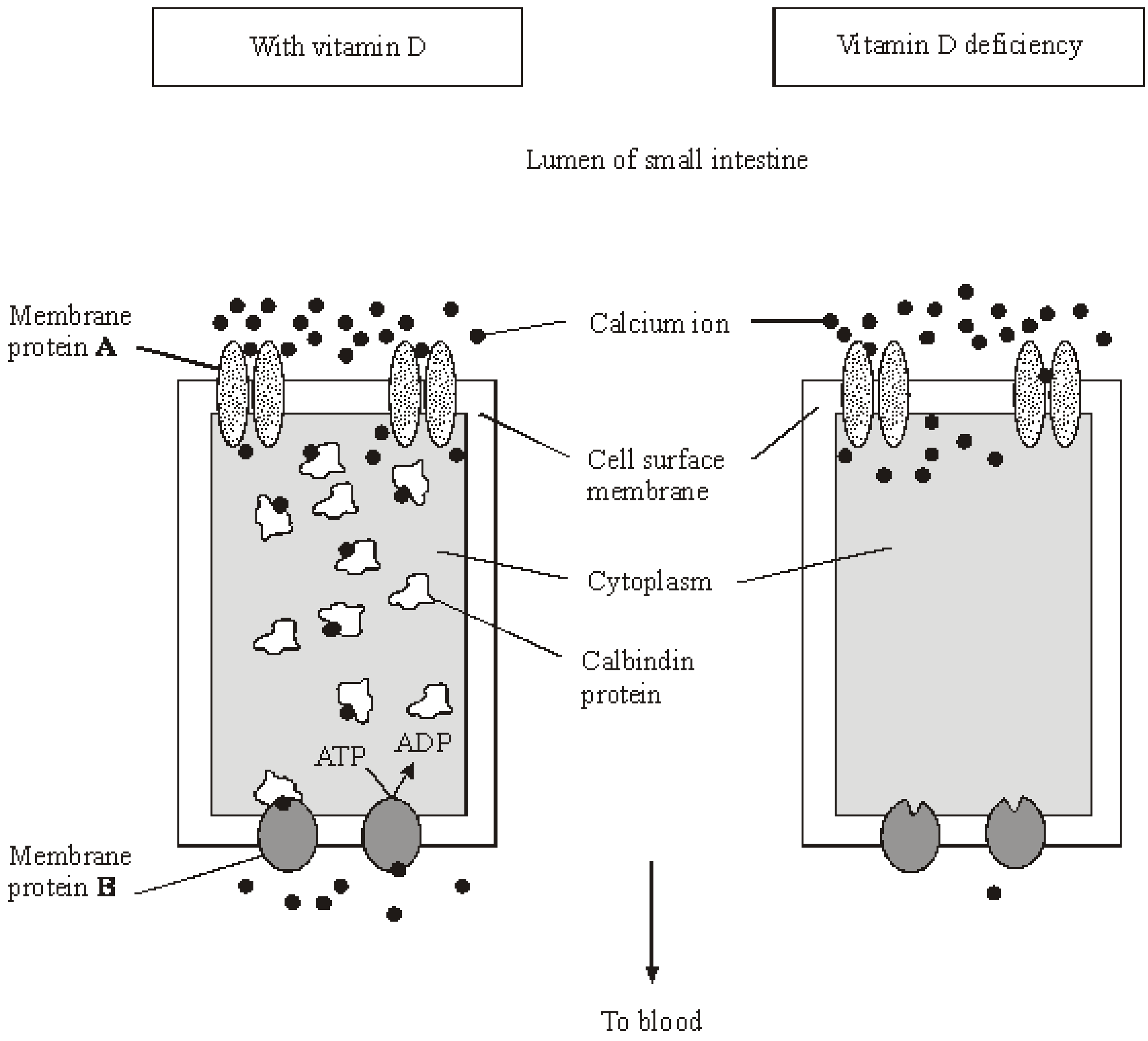
____ **(6)**

(Total 15 marks)

Q23. Vitamin D deficiency reduces the uptake of calcium ions by epithelial cells lining the small intestine. The diagrams show how calcium ions are transported through normal epithelial cells and those deficient in vitamin D.



(i) Use the information in the diagrams to explain how vitamin D deficiency reduces calcium ion uptake through gut epithelial cells.

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____ **(2)**

(ii) Membrane proteins **A** and **B** transport calcium ions through cell surface membranes. Explain how each type of membrane protein transports calcium ions.

Protein **A** ____

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Protein **B** ____

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(4)

(Total 6 marks)

Q24. Read the following passage.

Gluten is a protein found in wheat. When gluten is digested in the small intestine, the products include peptides. Peptides are short chains of amino acids. These peptides cannot be absorbed by facilitated diffusion and leave the gut in faeces

Some people have coeliac disease. The epithelial cells of people with coeliac disease do not absorb the products of digestion very well. In these people, some of the peptides from gluten can pass between the epithelial cells lining the small intestine and enter the intestine wall. Here, the peptides cause an immune response that leads to the destruction of microvilli on the epithelial cells.

Scientists have identified a drug which might help people with coeliac disease. It reduces the movement of peptides between epithelial cells. They have carried out trials of the drug with patients with coeliac disease.

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

(a) Name the type of chemical reaction which produces amino acids from proteins.

(1)

(b) The peptides released when gluten is digested cannot be absorbed by facilitated diffusion (lines 2 – 3). Suggest why.

(Extra space)

(3)

(c) Explain why the peptides cause an immune response (lines 7 – 8).

(1)

(d) Scientists have carried out trials of a drug to treat coeliac disease (lines 10 – 11).

Suggest **two** factors that should be considered before the drug can be used on patients with the disease.

1. ____

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2. ____

____ **(2)**

(Total 7 marks)

Q25. (a) Many different substances enter and leave a cell by crossing its cell surface membrane. Describe how substances can cross a cell surface membrane.

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____ **(5)**

(b) Describe and explain how the lungs are adapted to allow rapid exchange of oxygen between air in the alveoli and blood in the capillaries around them.

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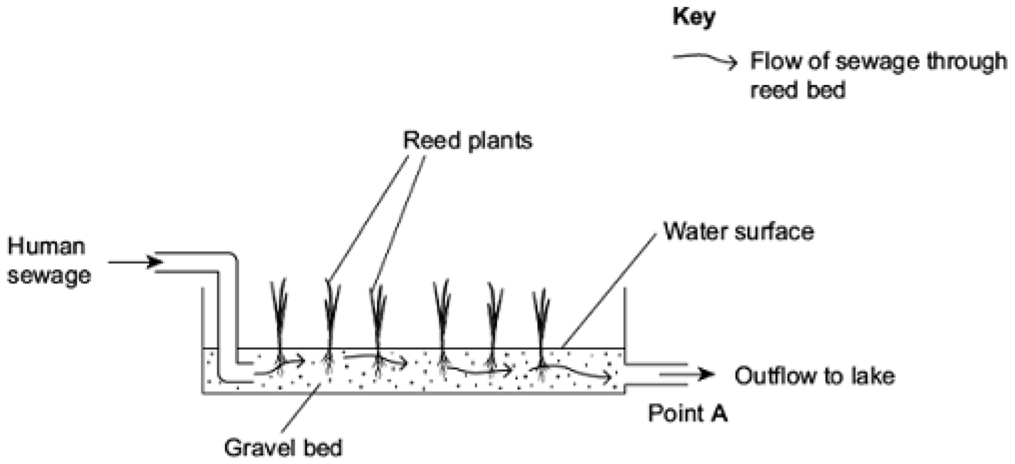
____ **(5)**

(Total 10 marks)

Q26. (a) Name the process by which some bacteria oxidise ammonia to nitrate.

____ **(1)**

Reeds are plants that grow with their roots under water. A reed bed contains a large number of growing reeds. Reed beds may be used to absorb nitrates produced when bacteria break down human sewage. The diagram shows a reed bed.



(b) Reeds have hollow, air-filled tissue in their stems which supplies oxygen to their roots. Explain how this enables the roots to take up nitrogen-containing substances.

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____ **(2)**

(c) (i) There is an optimum rate at which human sewage should flow through the reed bed. If the flow of human sewage is too fast, the nitrate concentration at point **A** falls. Explain why.

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____ **(2)**

(ii) An increase in nitrate concentration in the water entering the lake could affect algae and fish in the lake. Explain how.

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(Extra space)

(3)

(Total 8 marks)

Q27. Read the following passage.

Microfold cells are found in the epithelium of the small intestine. Unlike other epithelial cells in the small intestine, microfold cells do not have adaptations for the absorption of food.

Microfold cells help to protect against pathogens that enter the intestine. They have receptor proteins on their cell-surface membranes that bind to antigens on the surface of pathogens. The microfold cells take up the antigens and transport them to cells of the immune system. Antibodies are then produced which give protection against the pathogen.

Scientists believe that it may be possible to develop vaccines that make use of microfold cells. These vaccines could be swallowed in tablet form.

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

(a) (i) Microfold cells have receptor proteins on their cell-surface membranes that bind to antigens (line 5). What is an antigen?

(1)

(ii) Microfold cells take up the antigens and transport them to cells of the immune system (lines 6-7). Antigens are not able to pass through the cell-surface membranes of other epithelial cells. Suggest **two** reasons why.

(2)

(b) Scientists believe that it may be possible to develop vaccines that make use of microfold cells (lines 9-10). Explain how this sort of vaccine would lead to a person developing immunity to a pathogen.

(5)

(Total 8 marks)

Q28. (a) Glucose is absorbed from the lumen of the small intestine into epithelial cells. Explain how the transport of sodium ions is involved in the absorption of glucose by epithelial cells.

(5)

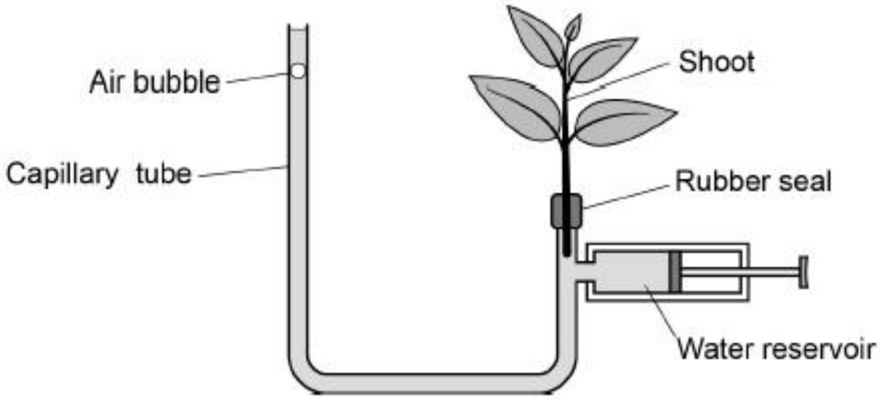
(b) Oxygen and chloride ions can diffuse across cell-surface membranes. The diffusion of chloride ions involves a membrane protein. The diffusion of oxygen does not involve a membrane protein.

Explain why the diffusion of chloride ions involves a membrane protein and the diffusion of oxygen does not.

(5)
(Total 10 marks)

Q29. A student used a potometer to measure the movement of water through the shoot of a plant. The potometer is shown in **Figure 1**. As water is lost from the shoot, it is replaced by water from the capillary tube.

Figure 1



(a) In one experiment, the air bubble moved 7.5 mm in 15 minutes. The diameter of the capillary tube was 1.0 mm.

Calculate the rate of water uptake by the shoot in this experiment.

Give your answer in mm^3 per hour. Show your working. (The area of a circle is found using the formula, area = πr^2)

_____________________ $mm^3\ hour^{-1}$

(2)

(b) The student wanted to determine the rate of water loss per mm^2 of surface area of the leaves of the shoot in **Figure 1**.

Outline a method she could have used to find this rate. You should assume that all water loss from the shoot is from the leaves.

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(3)

(c) The rate of water movement through a shoot in a potometer may not be the same as the rate of water movement through the shoot of a whole plant.

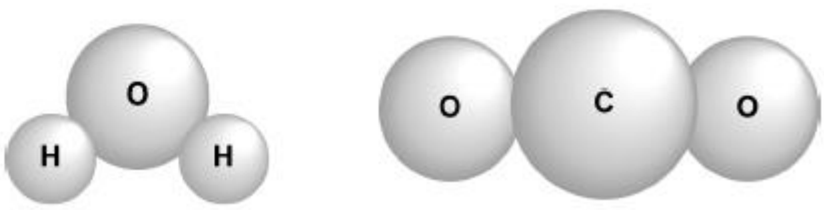
Suggest **one** reason why.

(1)

(d) Aquaporins are channel proteins that allow the diffusion of water across membranes. One type of aquaporin, called PIP1, can also transport carbon dioxide molecules across membranes.

Figure 2 shows the structure of a water molecule and of a carbon dioxide molecule. They are drawn to the same scale.

Figure 2



Water molecule (H_2O)

Carbon dioxide molecule (CO_2)

Suggest **two** reasons why water molecules **and** carbon dioxide molecules can both pass through PIP1.

1.

2.

(2)

(e) The scientists first produced transgenic poplar trees. These trees all had a length of foreign DNA inserted into them. This DNA led to the production of single-stranded RNA that specifically inhibited expression of the gene for PIP1.

The scientists then measured the difference in the amount of PIP1 in leaves of transgenic poplars and in leaves of wild type poplars without the foreign DNA. The amount of PIP1 in the transgenic poplars was approximately 15% of that in the wild type poplars.

Using this information, what can you conclude about the effect of the foreign DNA in the transgenic poplar trees?

(3)

(f) The transgenic poplars still produced some PIP1.

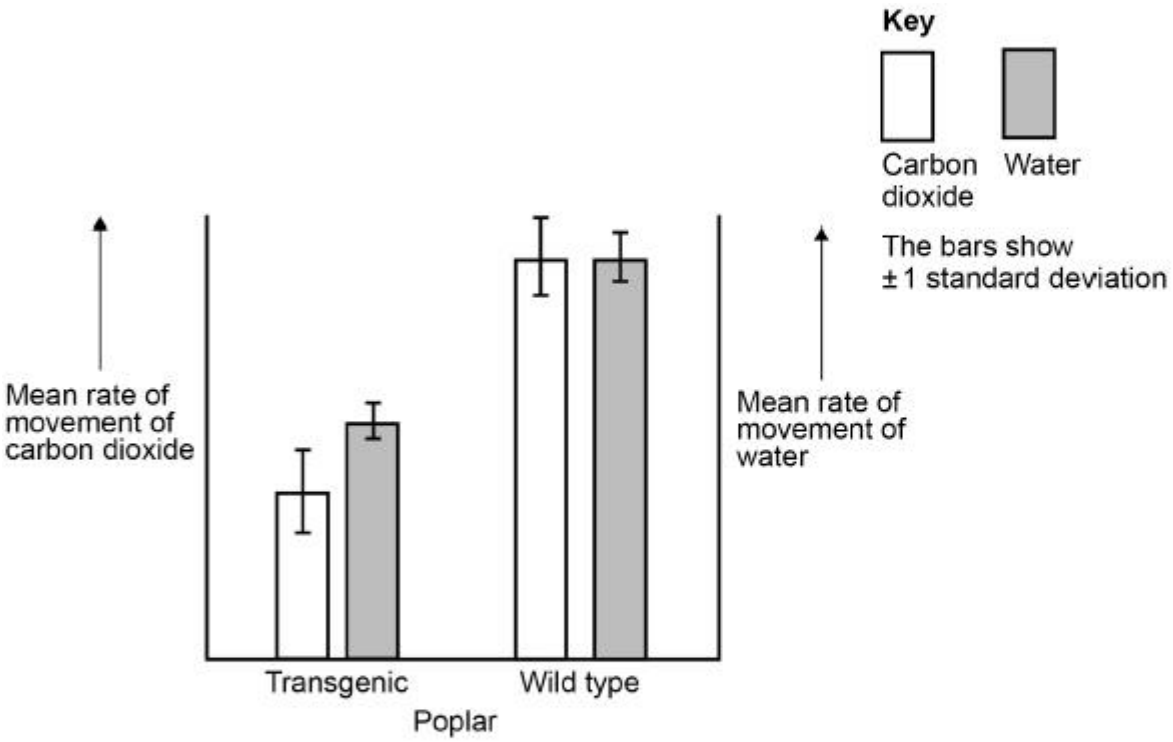
Suggest why.

(1)

(g) The scientists investigated the importance of PIP1 in the movement of water and carbon dioxide through the tissues of leaves of poplar trees.

They measured the mean rates of movement of carbon dioxide and water through the tissues of leaves of transgenic poplars and through the tissues of leaves of wild type poplars.

Their results are shown in the graph below.



Using only the graph above, evaluate the importance of PIP1 in the movement of carbon dioxide and water through leaves of poplar trees.

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____ **(3)**

(Total 15 marks)

Q30. This question should be answered in continuous prose.

Quality of Written Communication will be assessed in these answers.

(a) Describe and explain **four** ways in which the structure of a capillary adapts it for the exchange of substances between blood and the surrounding tissue.

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(4)

(b) Explain how tissue fluid is formed and how it may be returned to the circulatory system.

(6)

(Total 10 marks)