

2.3 TRANSPORT ACROSS CELL MEMBRANES 1 – QUESTIONS

Q1. In mammals, in the early stages of pregnancy, a developing embryo exchanges substances with its mother via cells in the lining of the uterus. At this stage, there is a high concentration of glycogen in cells lining the uterus.

- (a) Describe the structure of glycogen.

(2)

- (b) During early pregnancy, the glycogen in the cells lining the uterus is an important energy source for the embryo.

Suggest how glycogen acts as a source of energy.

Do **not** include transport across membranes in your answer.

(2)

- (c) Suggest and explain **two** ways the cell-surface membranes of the cells lining the uterus may be adapted to allow rapid transport of nutrients.

1. _____

2. _____

(2)

(d) In humans, after the gametes join at fertilisation, every cell of the developing embryo undergoes mitotic divisions before the embryo attaches to the uterus lining.

- The first cell division takes 24 hours.
- The subsequent divisions each take 8 hours.

After 3 days, the embryo has a total volume of $4.2 \times 10^{-3} \text{ mm}^3$.

What is the mean volume of each cell after 3 days? Express your answer in standard form.

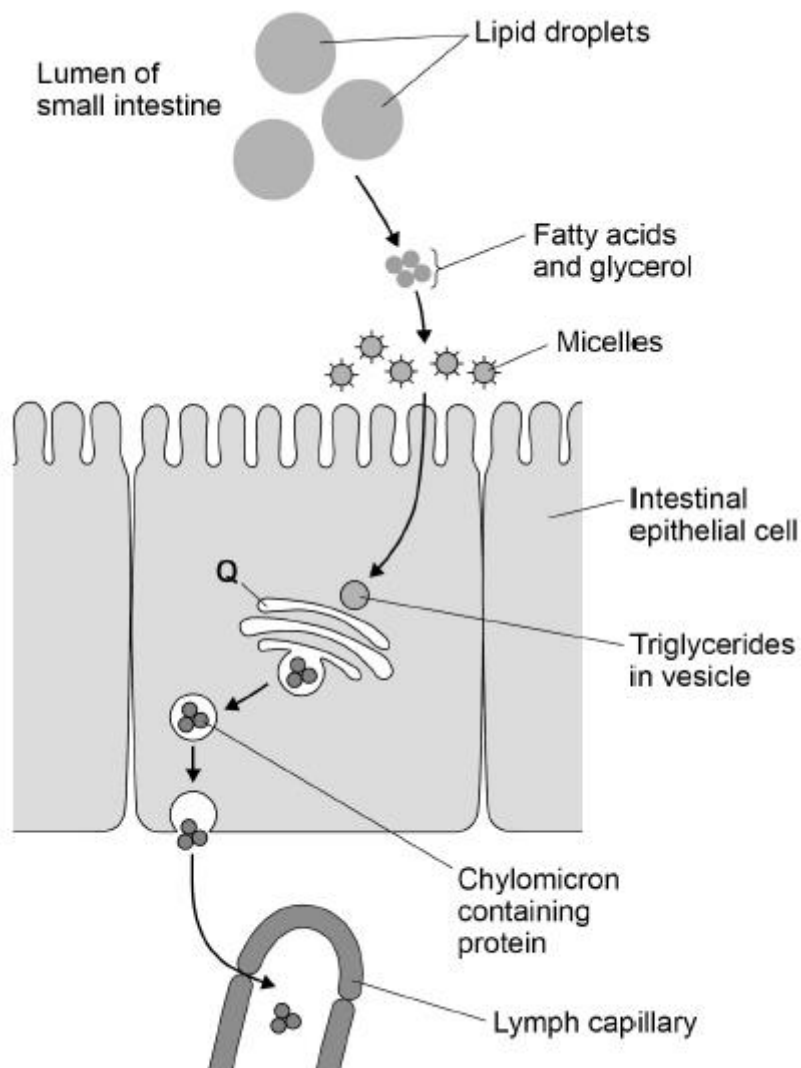
Show your working.

Answer = _____ mm^3

(2)

(Total 8 marks)

Q2. The diagram outlines the digestion and absorption of lipids.



(a) Tick (✓) the box by the name of the process by which fatty acids and glycerol enter the intestinal epithelial cell.

- Active transport
- Diffusion
- Endocytosis
- Osmosis

(1)

(b) Explain the advantages of lipid droplet and micelle formation.

(3)

(c) Name structure **Q** in the diagram above and suggest how it is involved in the absorption of lipids.

Name _____

How it is involved _____

(4)

(Total 8 marks)

Q3. Tubifex worms are small, thin animals that live in water. They have no specialised gas exchange or circulatory system.

The figure below shows a tubifex worm.



(a) Name the process by which oxygen reaches the cells inside the body of a tubifex worm.

_____ (1)

(b) Using the information provided, explain how **two** features of the body of the tubifex worm allow efficient gas exchange.

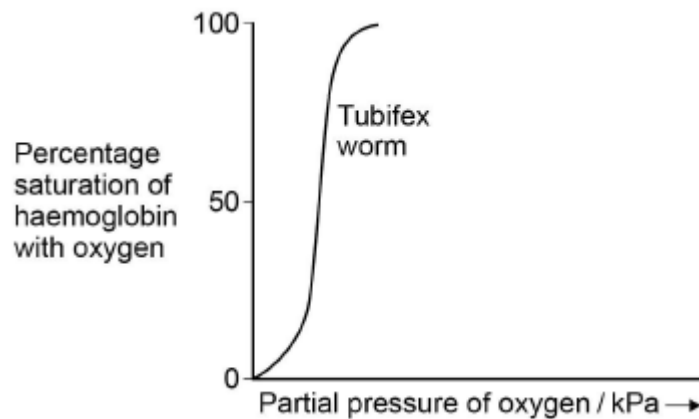
1. _____

2. _____

_____ (2)

(c) Most species of tubifex worms live at the bottom of ponds, lakes and rivers where the partial pressure of oxygen is low. Pollution of water by sewage can cause the partial pressure of oxygen to fall below 0.2 kPa.

The graph shows the oxyhaemoglobin dissociation curve for a species of tubifex worm found in a river polluted with sewage.



The species of tubifex worm in the graph has 50% saturation of their haemoglobin with oxygen at 0.08 kPa.

Explain how this enables this species to survive in water polluted with sewage.

_____ (2)

- (d) Species of tubifex worm that live in ponds, lakes and rivers **cannot** survive in seawater.

Use your knowledge of water potential to explain why they cannot survive in seawater.

(2)

(Total 7 marks)

- Q4.** (a) Endopeptidases and exopeptidases are involved in the hydrolysis of proteins.

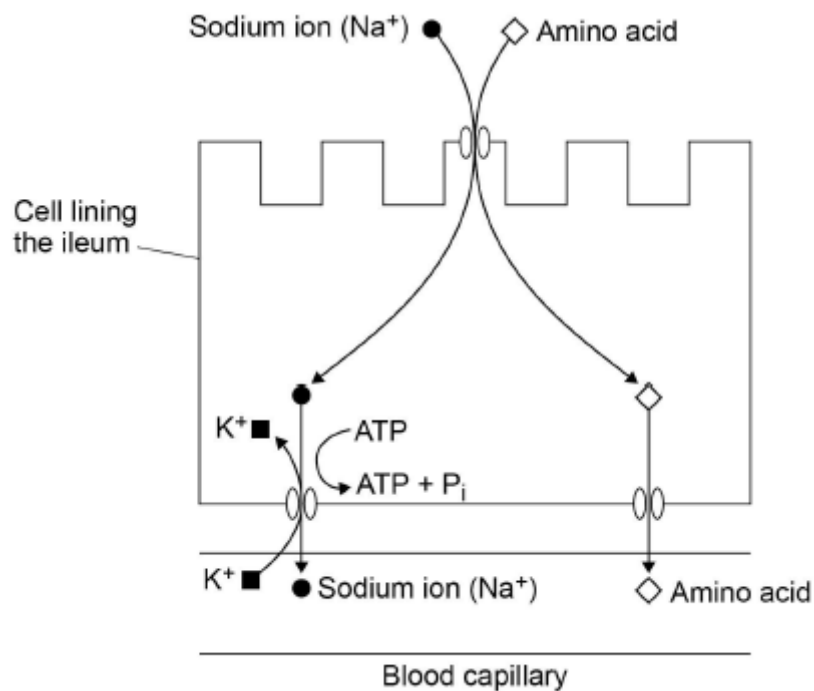
Name the other type of enzyme required for the complete hydrolysis of proteins to amino acids.

(1)

- (b) Suggest and explain why the combined actions of endopeptidases and exopeptidases are more efficient than exopeptidases on their own.

(2)

- (c) The diagram shows the co-transport mechanism for the absorption of amino acids into the blood by a cell lining the ileum.



The addition of a respiratory inhibitor stops the absorption of amino acids.

Use the diagram to explain why.

(3)
(Total 6 marks)

Q5. (a) Give **two** ways in which pathogens can cause disease.

1. _____

2. _____

(2)

(b) Putting bee honey on a cut kills bacteria. Honey contains a high concentration of sugar.

Use your knowledge of water potential to suggest how putting honey on a cut kills bacteria.

[Extra space] _____

(3)
(Total 5 marks)

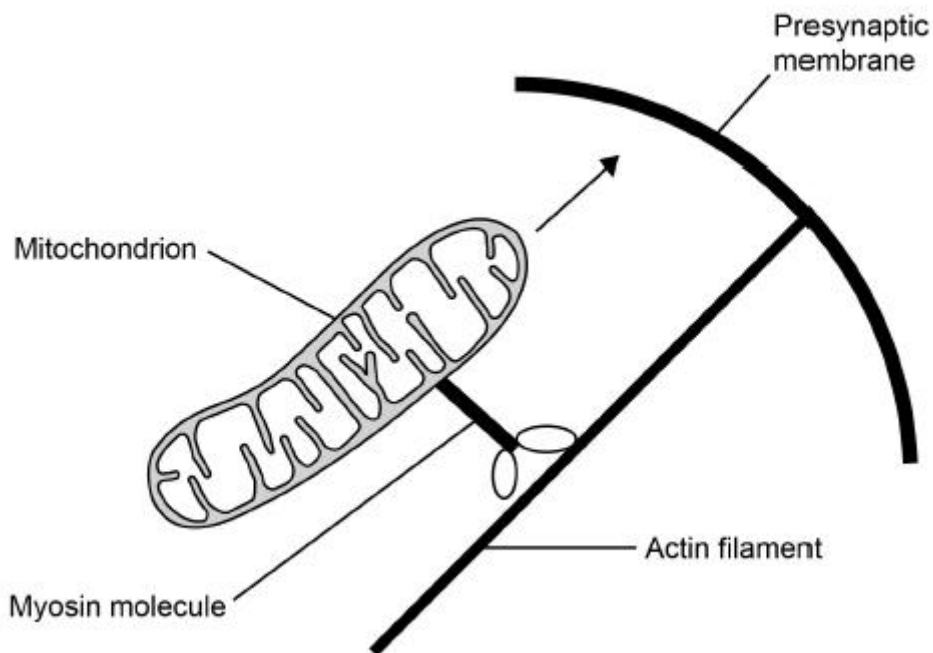
Q6. (a) When a nerve impulse arrives at a synapse, it causes the release of neurotransmitter from vesicles in the presynaptic knob.

Describe how.

(3)

(b) The presynaptic knob contains actin filaments and myosin molecules.

The myosin molecules can attach to mitochondria and move them towards the presynaptic membrane, as shown in the diagram.



Use your knowledge of how myosin and actin interact to suggest how the myosin molecule moves the mitochondrion towards the presynaptic membrane.

Do **not** include the roles of calcium ions and tropomyosin in your answer.

(2)

(c) This movement of mitochondria happens when nerve impulses arrive at the synapse.

Suggest and explain **one** advantage of the movement of mitochondria towards the presynaptic membrane when nerve impulses arrive at the synapse.

(2)

(Total 7 marks)

Q7. (a) The letters **P**, **Q**, **R**, **S** and **T** represent ways substances can move across membranes.

- **P** – diffusion through the phospholipid bilayer
- **Q** – facilitated diffusion
- **R** – active transport
- **S** – co-transport
- **T** – osmosis

For each of the following examples of transport across membranes, select the letter that represents the way in which the substance moves across the membrane.

Write the appropriate letter in each box provided.

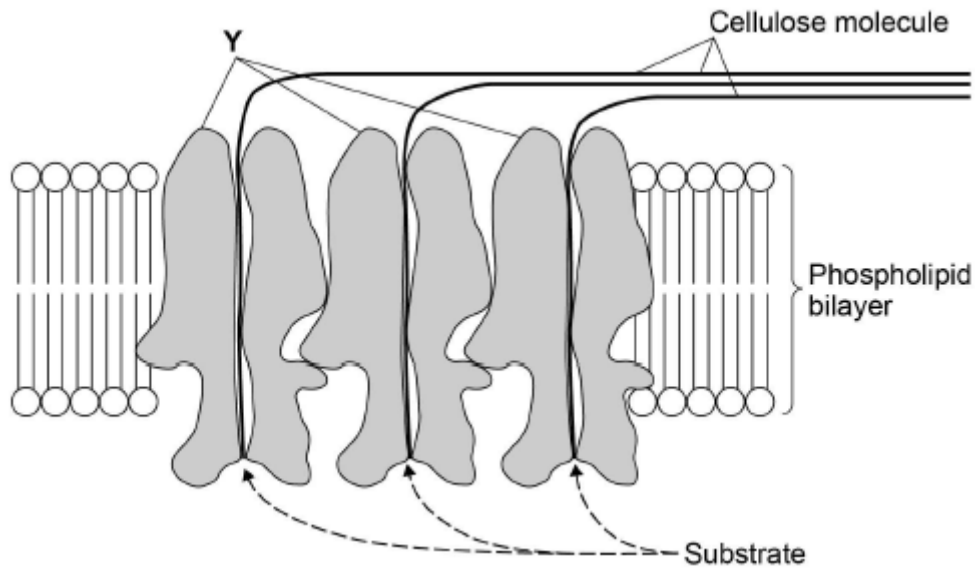
Transport through a channel protein

Transport of small, non-polar molecules

Transport of glucose with sodium ions

(3)

The diagram shows how a plant cell produces its cell wall.



- (b) Y is a protein. One function of Y is to transport cellulose molecules across the phospholipid bilayer.

Using information from the diagram, describe the other function of Y.

(2)

- (c) What is the evidence in the diagram that the phospholipid bilayer shown is part of the cell-surface membrane?

(1)

- (d) In the cell wall, bonds hold the cellulose molecules together side by side.

Tick (✓) **one** box that describes the type of bond that holds the cellulose molecules together side by side.

Ester

Hydrogen

Ionic

Peptide

(1)
(Total 7 marks)

Q8. (a) Describe the difference between the structure of a triglyceride molecule and the structure of a phospholipid molecule.

_____ (1)

(b) Describe how you would test for the presence of a lipid in a sample of food.

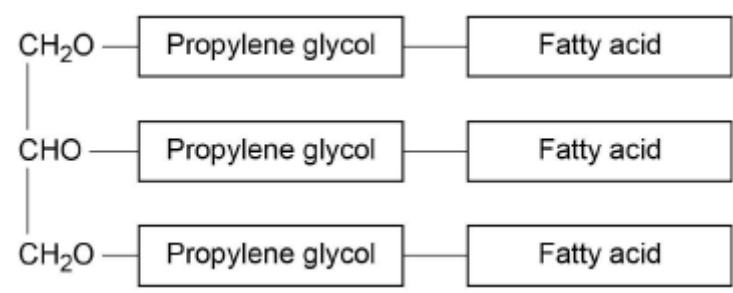
_____ (2)

(c) Animal fats contain triglycerides with a high proportion of saturated fatty acids. If people have too much fat in their diet, absorption of the products of fat digestion can increase the risk of obesity. To help people lose weight, fat substitutes can be used to replace triglycerides in food.

Describe how a saturated fatty acid is different from an unsaturated fatty acid.

_____ (1)

The diagram shows the structure of a fat substitute.



(d) This fat substitute **cannot** be digested in the gut by lipase.

Suggest why.

(2)

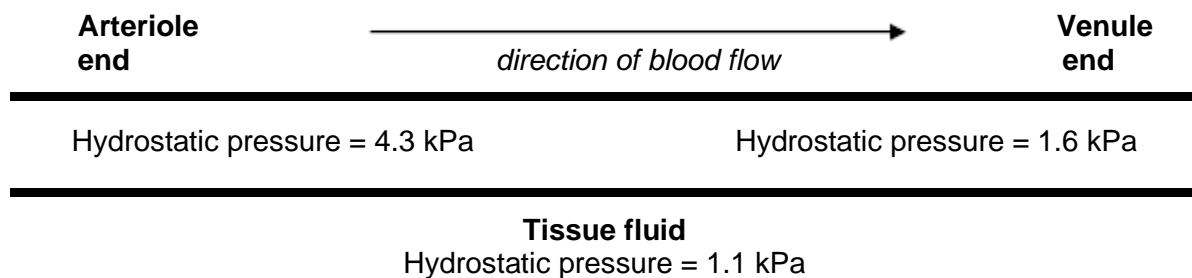
(e) This fat substitute is a lipid. Despite being a lipid, it cannot cross the cell-surface membranes of cells lining the gut.

Suggest why it **cannot** cross cell-surface membranes.

(1)

(Total 7 marks)

Q9. The figure below represents a capillary surrounded by tissue fluid. The values of the hydrostatic pressure are shown.



(a) Use the information in the figure above to explain how tissue fluid is formed.

(2)

(b) The hydrostatic pressure falls from the arteriole end of the capillary to the venule end of the capillary. Explain why.

(1)

(c) High blood pressure leads to an accumulation of tissue fluid. Explain how.

(Extra space) _____

_____ **(3)**

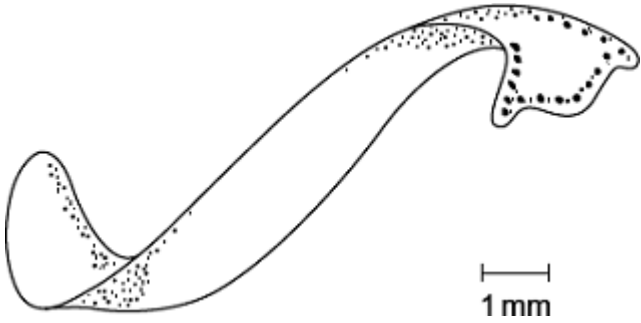
(d) The water potential of the blood plasma is more negative at the venule end of the capillary. Explain why.

(Extra space) _____

_____ **(3)**

(Total 9 marks)

Q10. (a) Flatworms are small animals that live in water. They have no specialised gas exchange or circulatory systems. The drawing shows one type of flatworm.



(i) Name the process by which oxygen reaches the cells inside the body of this flatworm.

_____ (1)

- (ii) The body of a flatworm is adapted for efficient gas exchange between the water and the cells inside the body.
Using the diagram, explain how **two** features of the flatworm's body allow efficient gas exchange.

1. _____

2. _____

_____ (2)

- (b) (i) A leaf is an organ. What is an organ?

_____ (1)

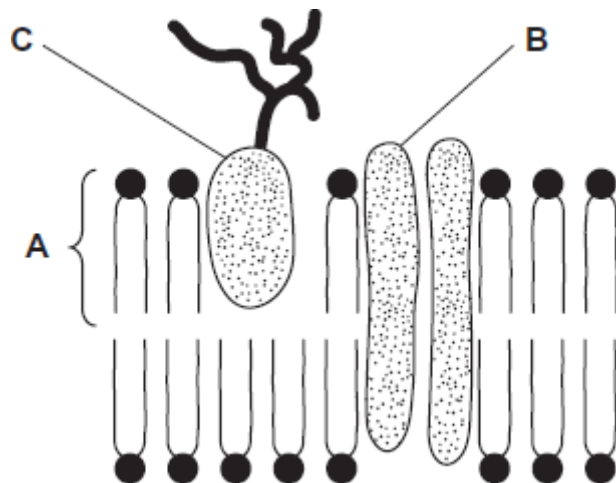
- (ii) Describe how carbon dioxide in the air outside a leaf reaches mesophyll cells inside the leaf.

(Extra space) _____

_____ (3)

(Total 7 marks)

Q11. The diagram shows the structure of the cell-surface membrane of a cell.



(a) Name **A** and **B**.

A _____

B _____ (2)

(b) (i) **C** is a protein with a carbohydrate attached to it. This carbohydrate is formed by joining monosaccharides together. Name the type of reaction that joins monosaccharides together.

Name the type of reaction that joins monosaccharides together.

_____ (1)

(ii) Some cells lining the bronchi of the lungs secrete large amounts of mucus. Mucus contains protein.

Name **one** organelle that you would expect to find in large numbers in a mucus-secreting cell and describe its role in the production of mucus.

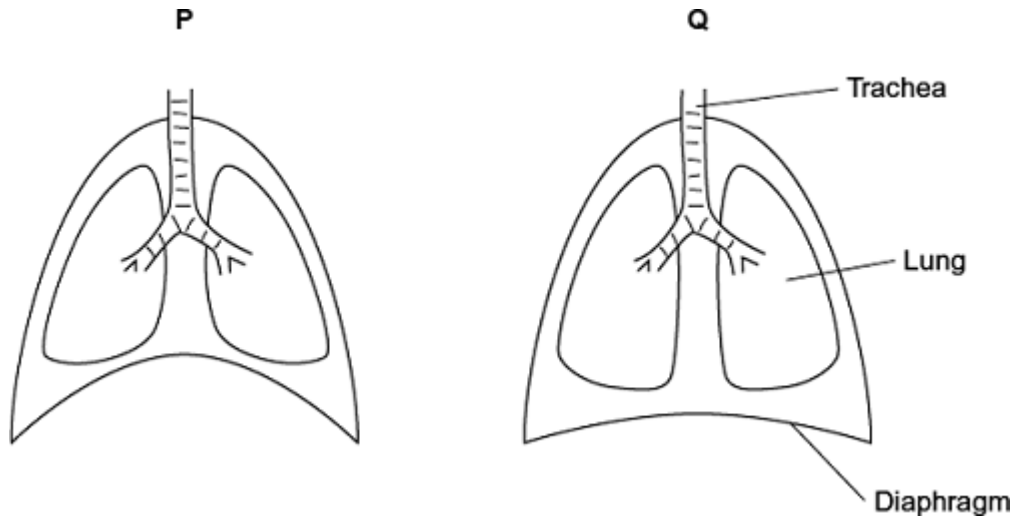
Organelle _____

Description of role _____

_____ (2)

(Total 5 marks)

Q12. The diagram shows the position of the diaphragm at times **P** and **Q**.



(a) Describe what happens to the diaphragm between times **P** and **Q** to bring about the change in its shape.

(2)

(b) Air moves into the lungs between times **P** and **Q**. Explain how the diaphragm causes this.

(Extra space)

(3)

(c) Describe how oxygen in air in the alveoli enters the blood in capillaries.

(2)

(Total 7 marks)

Q13. (a) Describe how phospholipids are arranged in a plasma membrane.

(2)

(b) Cells that secrete enzymes contain a lot of rough endoplasmic reticulum (RER) and a large Golgi apparatus.

(i) Describe how the RER is involved in the production of enzymes.

(2)

(ii) Describe how the Golgi apparatus is involved in the secretion of enzymes.

(1)

(Total 5 marks)

Q14. (a) (i) An arteriole is described as an organ. Explain why.

(1)

(ii) An arteriole contains muscle fibres. Explain how these muscle fibres reduce blood flow to capillaries.

(2)

(b) (i) A capillary has a thin wall. This leads to rapid exchange of substances between the blood and tissue fluid. Explain why.

_____ (1)

(ii) Blood flow in capillaries is slow. Give the advantage of this.

_____ (1)

(c) Kwashiorkor is a disease caused by a lack of protein in the blood. This leads to a swollen abdomen due to a build up of tissue fluid.

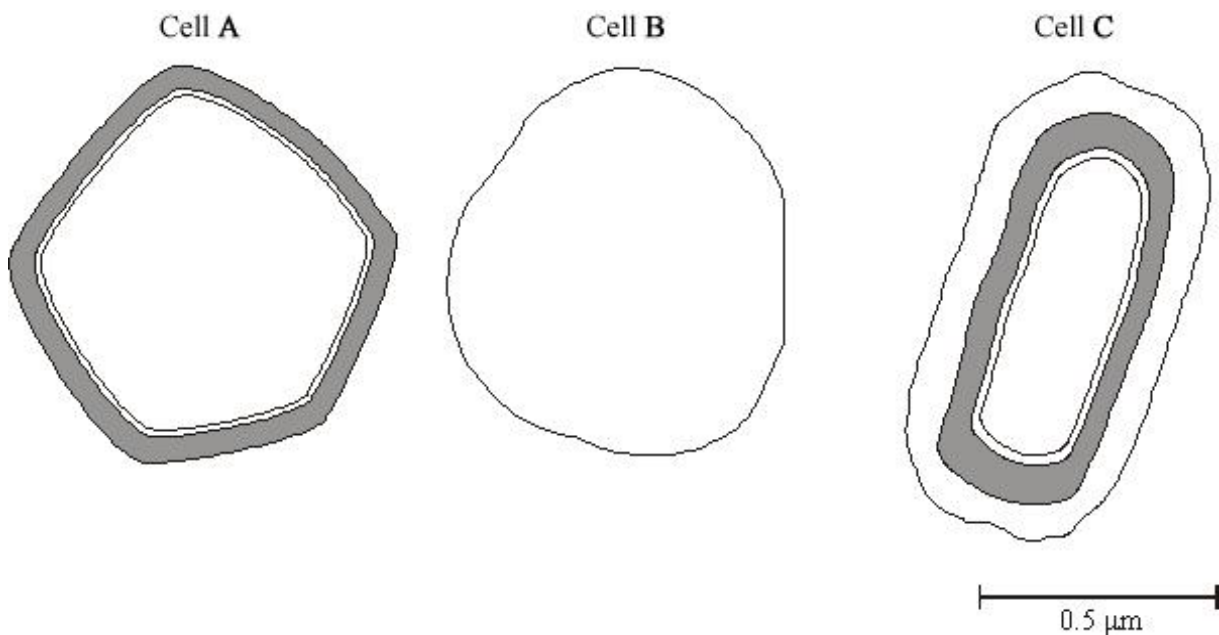
Explain why a lack of protein in the blood causes a build up of tissue fluid.

(Extra space) _____

_____ (3)

(Total 8 marks)

Q15. The diagram shows the outer layers of three different cells, **A**, **B** and **C**.



(a) What is the evidence from the diagram that

(i) cell **B** is an animal cell,

(1)

(ii) cell **C** is a prokaryotic cell?

(1)

(b) Explain how you would calculate the magnification of cell **C**.

(1)

(c) Cell **A** is a plant cell. Name a polysaccharide which may be found in cell **A** but would not be found in the animal cell.

(1)

(d) Penicillin is an antibiotic. It prevents the formation of bacterial cell walls. As a result, bacterial cells that have been treated with penicillin swell and burst as water enters.

(i) Explain how water enters a bacterial cell.

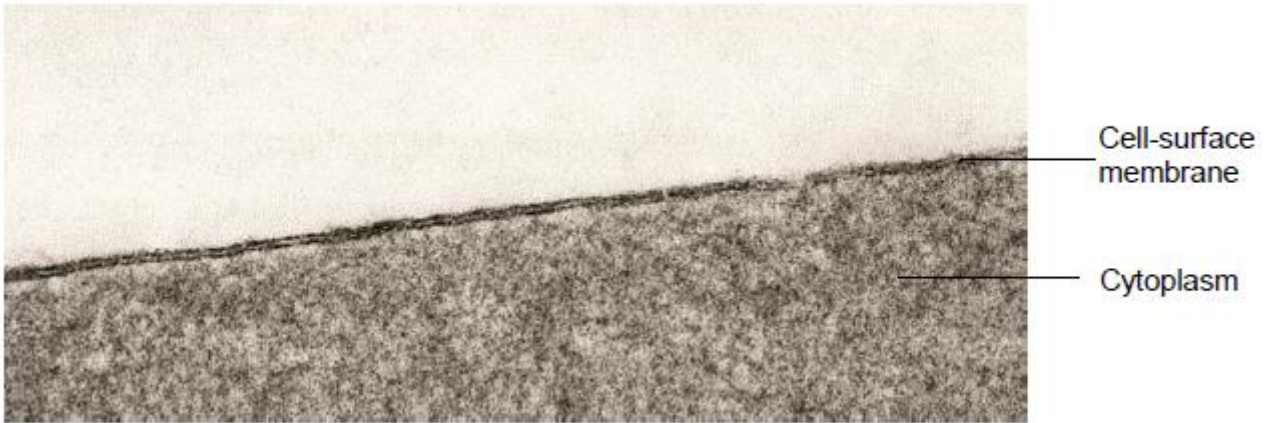
(2)

(ii) Suggest why penicillin has no effect on plant cells.

(1)

(Total 7 marks)

Q16. The image below shows the cell-surface membrane of a red blood cell seen with a transmission electron microscope.



- (a) The cell-surface membrane can be seen with a transmission electron microscope but **not** with an optical microscope.

Explain why.

(1)

- (b) No organelles are visible in the cytoplasm of this red blood cell.

Suggest why.

(1)

- (c) Before the cell was examined using the electron microscope, it was stained. This stain caused parts of the structure of the cell-surface membrane to appear as two dark lines.

Suggest an explanation for the appearance of the cell-surface membrane as two dark lines.

(3)

- (d) Describe how substances move across cell-surface membranes by facilitated diffusion.

(3)
(Total 8 marks)

Q17. Lactose is a disaccharide found in milk. In the small intestine, it is digested into glucose and galactose by the enzyme lactase. Molecules of lactase are located in the plasma membranes of cells lining the small intestine.

(a) What evidence in the paragraph suggests that galactose is a monosaccharide?

(1)

(b) (i) Name **one** other digestive enzyme that is located in the plasma membranes of cells lining the small intestine.

(1)

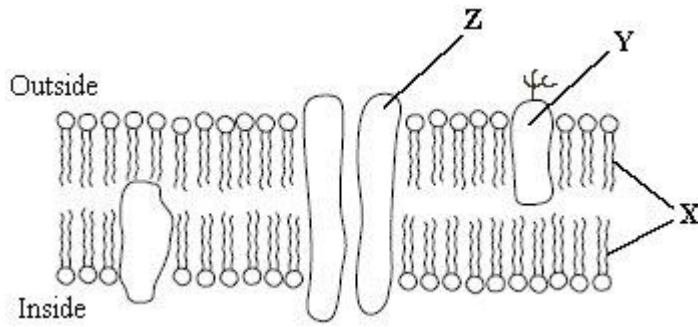
(ii) Give an advantage of lactase and other digestive enzymes being located in the plasma membranes of cells lining the small intestine, rather than being secreted into the lumen of the small intestine.

(1)

(c) The absorption of galactose from the small intestine is reduced if the absorbing cells are treated with a respiratory inhibitor, such as cyanide. Suggest an explanation for this.

(2)
(Total 5 marks)

Q18. The diagram shows part of a plasma membrane.



(a) Describe **two** functions of the structure made from the parts labelled **X**.

1. _____

2. _____

_____ (2)

(b) Give **one** function of the molecule labelled **Y**.

_____ (1)

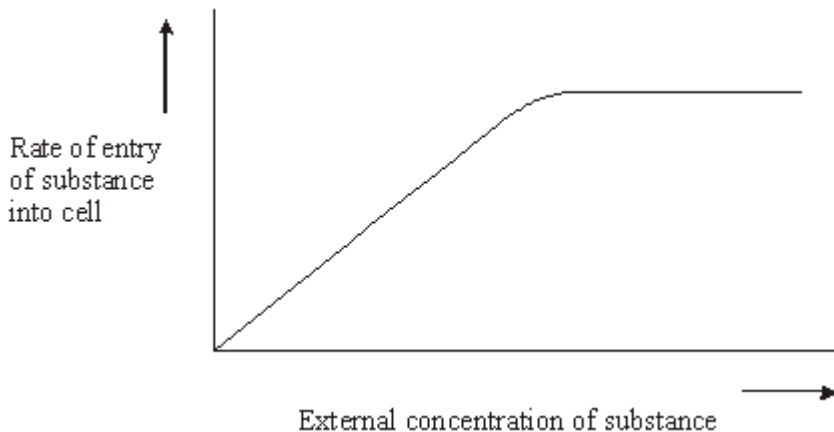
(c) The part labelled **Z** is involved in facilitated diffusion of substances across the membrane.

(i) Give **one** similarity in the way in which active transport and facilitated diffusion transport substances across the membrane.

(ii) Give **one** way in which active transport differs from facilitated diffusion.

_____ (2)

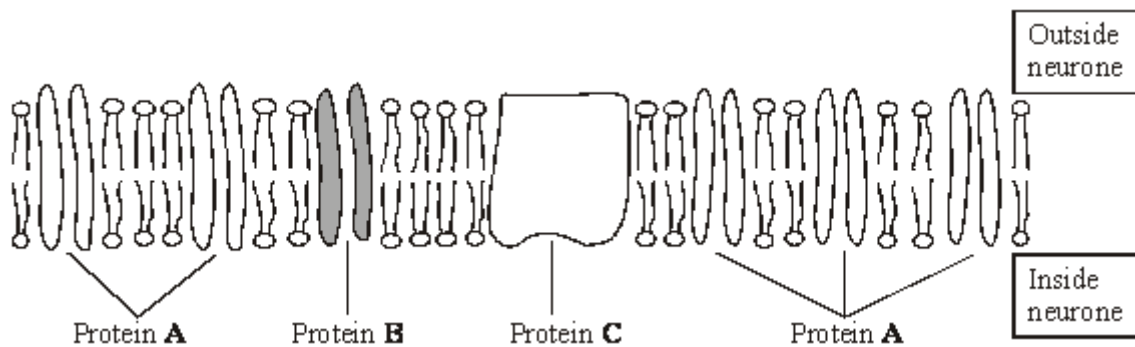
(iii) The graph shows the relationship between the concentration of a substance outside a cell and the rate of entry of this substance into the cell.



Explain the evidence from the graph that this substance is entering the cell by facilitated diffusion and not by simple diffusion.

(2)
(Total 7 marks)

Q19. The resting potential of a neurone is maintained by the unequal distribution of ions inside and outside the plasma membrane. The diagram shows the plasma membrane of a neurone and the three different proteins that are involved in maintaining the resting potential.



(a) Protein C requires ATP to function. Describe the role of protein C.

(2)

(b) (i) Proteins A and B differ from each other. Explain why different proteins are required for the diffusion of different ions through the membrane.

(2)

(ii) The plasma membrane of the neurone is more permeable to potassium ions than to sodium ions. Give the evidence from the diagram that supports this observation.

(1)

(Total 5 marks)

Q20. (a) Explain how the shape of a red blood cell allows it to take up a large amount of oxygen in a short time.

(2)

Samples of blood were mixed with equal volumes of different liquids. A drop of each mixture was put on a slide and examined with an optical microscope. The table shows the appearance of each slide.

Slide	Liquid added	Appearance of slide
A	Distilled water	No cells seen. Slide appears a uniform pale red colour
B	Sucrose solution	Cells are smaller in diameter than in an untreated sample of blood
C	Detergent (dissolves lipids)	No cells seen. Slide appears a uniform pale red colour

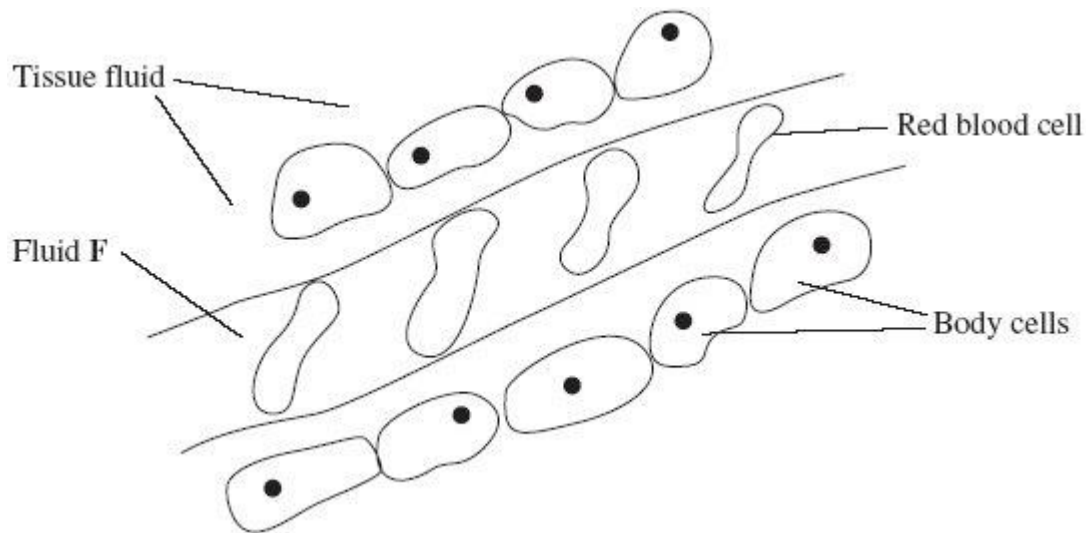
- (b) (i) What does the appearance of slide **B** tell you about the plasma membrane surrounding a red blood cell?

(1)

- (ii) Explain the appearance of slide **C**.

(2)
(Total 5 marks)

Q21. The diagram shows tissue fluid and cells surrounding a capillary.



(a) Name fluid **F**.

_____ (1)

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

_____ (1)

(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.

 _____ (1)

(ii) The blood pressure decreases along the length of the capillary. What causes this decrease in pressure?

 _____ (1)

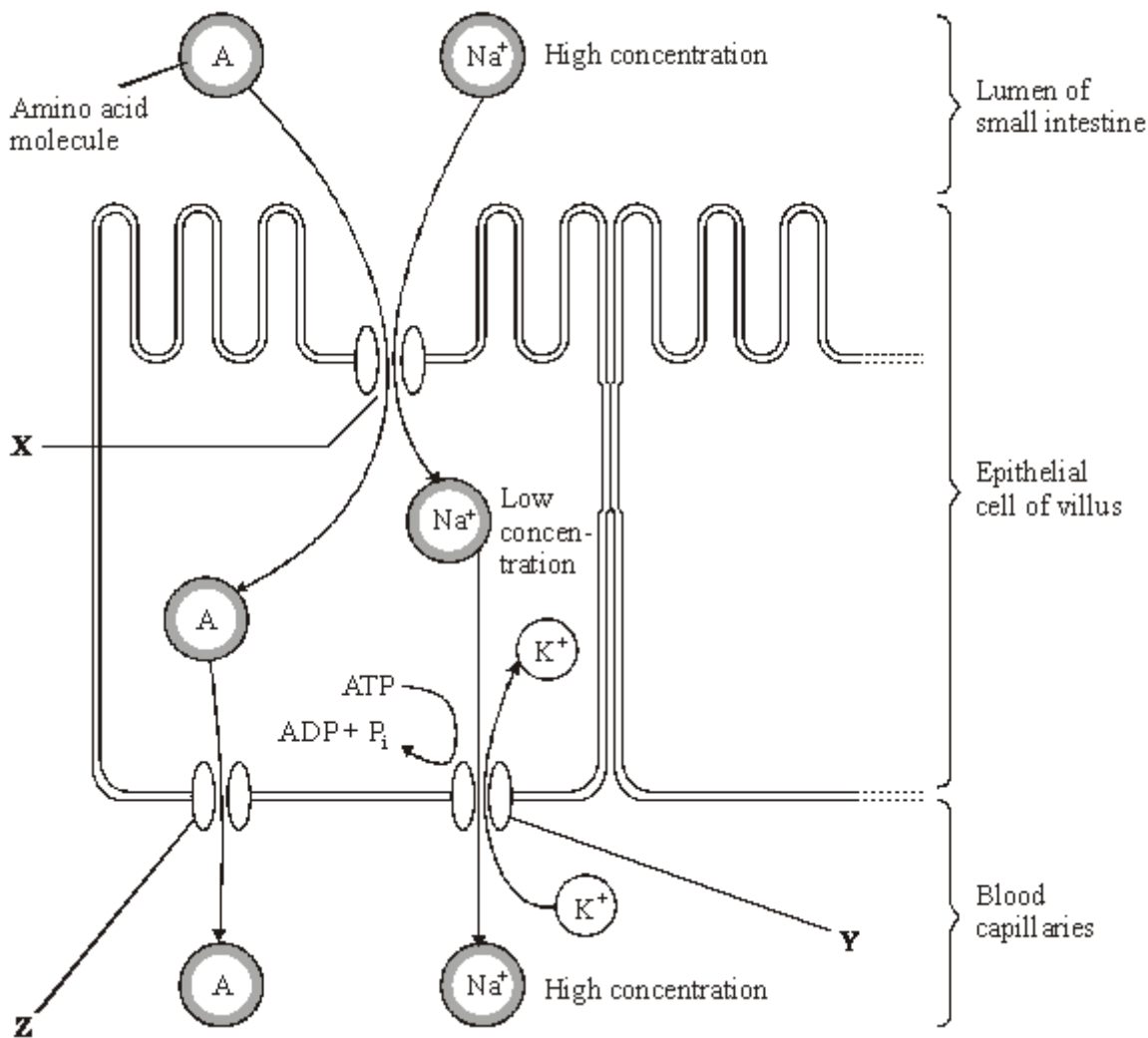
(d) In children, some diets may result in a low concentration of protein in fluid **F**. This can cause the accumulation of tissue fluid. Explain the link between a low concentration of protein in fluid **F** and the accumulation of tissue fluid.

 _____ (3)

(Total 7 marks)

Q22. The diagram shows one method by which amino acids are absorbed from the small intestine into

the blood. They are co-transported into the epithelial cell with sodium ions (Na^+) at point **X** on the diagram. Normally, the concentration of sodium ions inside the epithelial cell is low.



Source: adapted from M. ROWLAND, *Biology (University of Bath Science 16-19)* (Nelson Thornes) 1992.

Dinitrophenol (DNP) prevents oxidative phosphorylation. When treated with DNP, the sodium-potassium pump at **Y** no longer works. As a result, the concentration of sodium ions in the cell rises and amino acid absorption stops.

(i) Explain why pump **Y** will **not** work in the presence of DNP.

(2)

(ii) Explain why sodium ions and amino acids are **not** absorbed from the lumen of the small intestine in the presence of DNP.

(2)

(iii) By what mechanism would amino acids leave the epithelial cell at point Z?

(1)

(Total 5 marks)

Q23. In a hospital laboratory, a sterile Petri dish of nutrient agar was inoculated with bacteria from a patient with a throat infection. Four discs, each of which had been soaked in a different antibiotic, were placed on top of the bacteria. The dish was incubated at 37 °C. **Figure 1** shows the appearance of the dish after incubation.

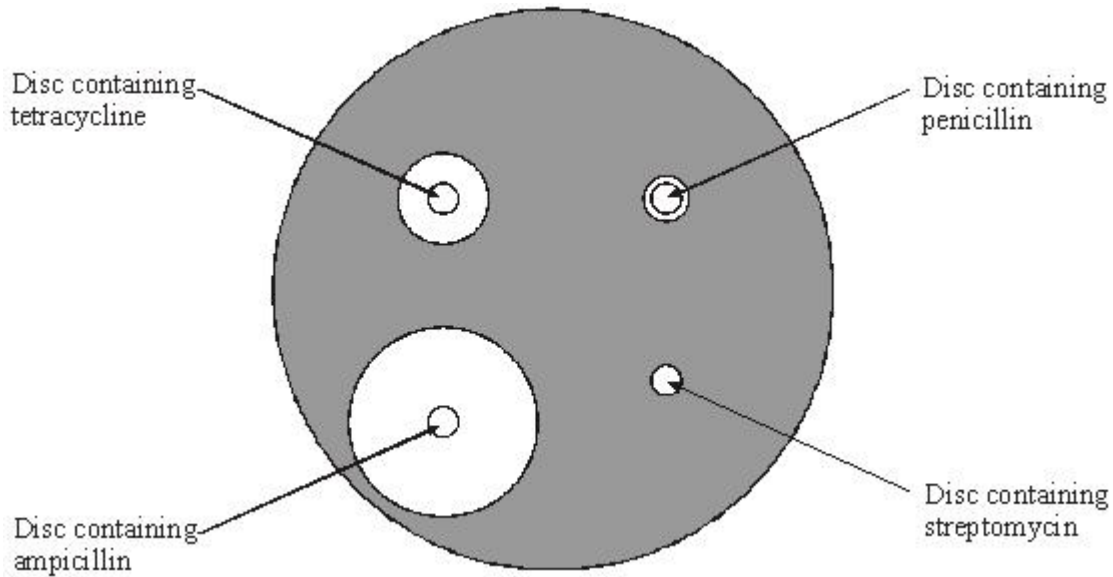


Figure 1

(a) Explain why there are clear zones around some of the discs containing antibiotic.

(2)

(b) It was suggested that ampicillin might be the best antibiotic to treat the patient's throat infection. Give the evidence from the laboratory test to support this suggestion.

(1)

(c) Tetracycline binds to bacterial ribosomes. This is shown in **Figure 2**.

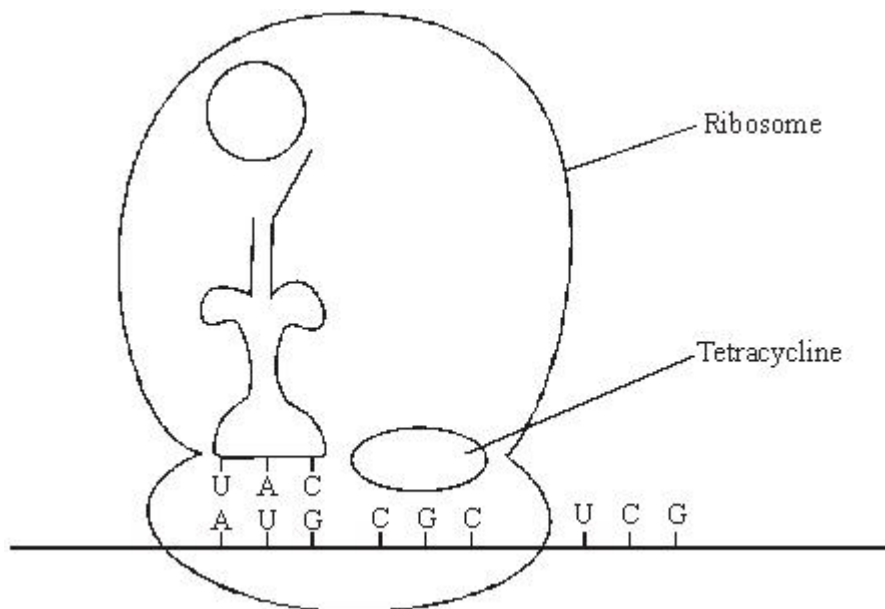


Figure 2

Tetracycline prevents bacterial growth by preventing protein synthesis. Give **two** other ways in which antibiotics can prevent bacterial growth.

1. _____

2. _____

_____ (2)

(Total 5 marks)

Q24. Water and inorganic ions have important biological functions within cells.

- (a) Give **two** properties of water that are important in the cytoplasm of cells. For each property of water, explain its importance in the cytoplasm.

Property 1 _____

Biological importance within cells _____

Property 2 _____

Biological importance within cells _____

_____ (4)

- (b) Other than sodium, name **one** inorganic ion and give **one** example of its biological importance in a cell.

Name of inorganic ion _____

Biological importance _____

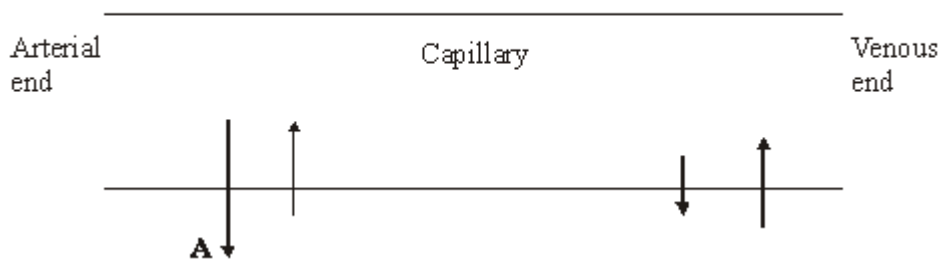
_____ (2)

(c) Compare and contrast the processes by which water and inorganic ions enter cells.

_____ (3)

(Total 9 marks)

Q25. Tissue fluid is formed when water and small molecules pass out of capillaries at their arterial end. The diagram shows some pressures involved in tissue fluid formation. The relative lengths of the arrows indicate the size of the pressures.



(a) What causes the pressure represented by the arrow labelled **A**?

_____ (1)

(b) Explain why there is a net loss of water from a capillary at the arterial end.

_____ (2)

(c) The total volume of fluid that passes from the capillaries to the surrounding tissue fluid is normally greater than the volume that is reabsorbed into them. Describe what happens to this extra fluid.

(2)

(d) Tissue fluid accumulates in the tissues of people who do not eat enough protein. Explain why.

(2)

(Total 7 marks)

Q26. (a) Describe **two** differences between active transport and facilitated diffusion.

1. _____

2. _____

(2)

(b) Explain why molecules of oxygen and carbon dioxide are able to diffuse across membranes.

(2)

(c) Explain why ventilation of the lungs increases the efficiency of gas exchange.

(2)

(Total 6 marks)

Q27. (a) The structure of a plasma membrane is described as a fluid mosaic. Explain why.

(2)

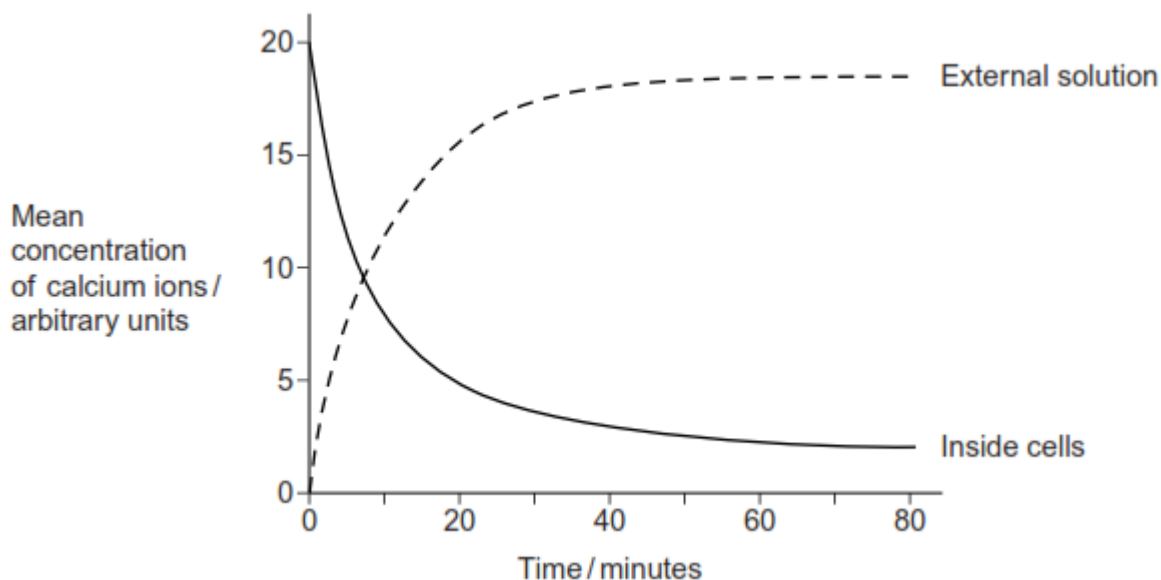
(b) Give **two** functions of proteins in plasma membranes.

1. _____

2. _____

(2)

Scientists investigated the movement of calcium ions across the plasma membrane of human cells. They placed human cells in a solution of calcium ions. At regular intervals, they measured the concentration of calcium ions in the external solution and the concentration of calcium ions inside the cells. Their results are shown in the graph.

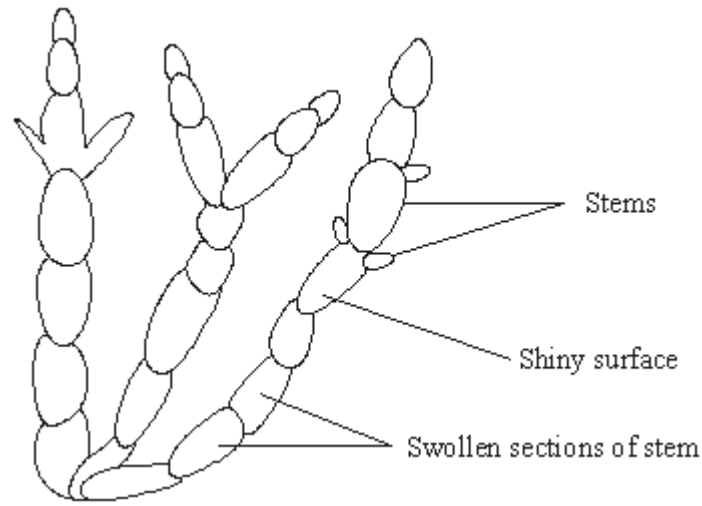


(c) By what process did the calcium ions leave the cells after 10 minutes? Use evidence from the graph to support your answer.

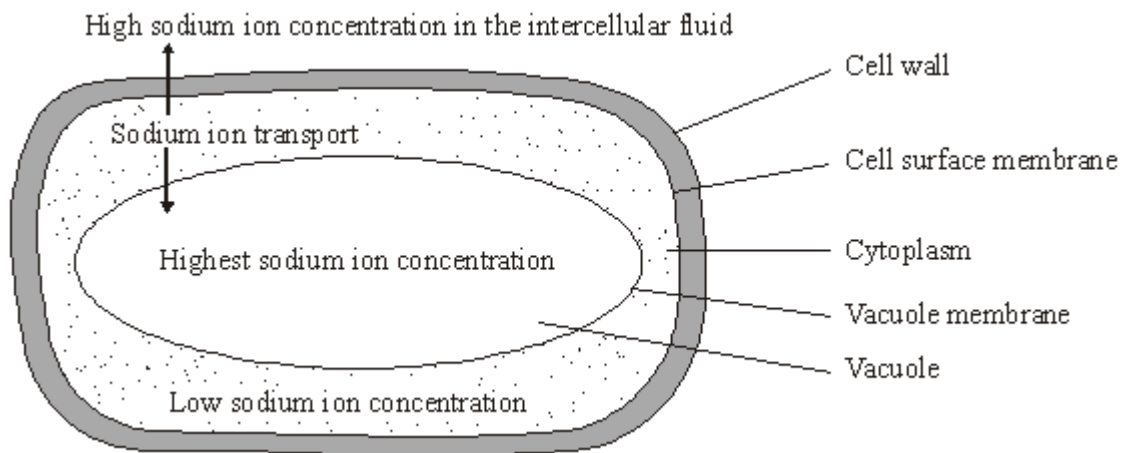
(2)

(Total 6 marks)

Q28. Glasswort is a plant that grows in salt marshes. The plants are covered by seawater at each high tide. The roots grow in mud which contains a high concentration of salt. The drawing shows a shoot of the plant.



In glasswort cells, sodium ions are transported from the cytoplasm outwards across the cell surface membrane and also into the cell vacuole. The concentration of sodium ions is greater inside the vacuole than in the intercellular fluid, which is the fluid between the cells in tissues. High sodium ion concentrations would disrupt metabolic processes in the cytoplasm. This information is summarised in the diagram below.



(a) The total concentration of all ions in the cytoplasm is higher than in the intercellular fluid. Explain how this allows the cell to take up water.

(2)

(b) (i) Explain how sodium ions are transported through the membranes.

(2)

(ii) There is a higher concentration gradient between the cytoplasm and the vacuole

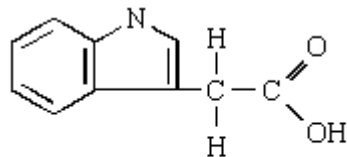
than between the cytoplasm and the intercellular fluid. Suggest how the vacuole membrane maintains this higher concentration gradient.

(2)
(Total 6 marks)

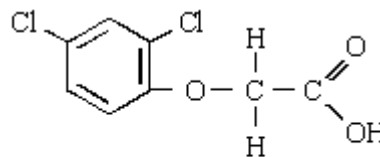
Q29. IAA is an auxin which stimulates plant growth. It binds to proteins in cell walls. This changes the arrangement of the cellulose molecules, so the walls are more easily stretched. IAA also lowers the pH around the cells.

2,4-D is a systemic herbicide which has the same effect on cell walls as IAA, but it is less easily broken down in plants.

(a) The diagram shows the molecular structures of IAA and 2,4-D.



IAA



2,4-D

Use evidence from the diagram to suggest

(i) why IAA lowers pH;

(1)

(ii) why IAA and 2,4-D have similar effects on cell walls.

(1)

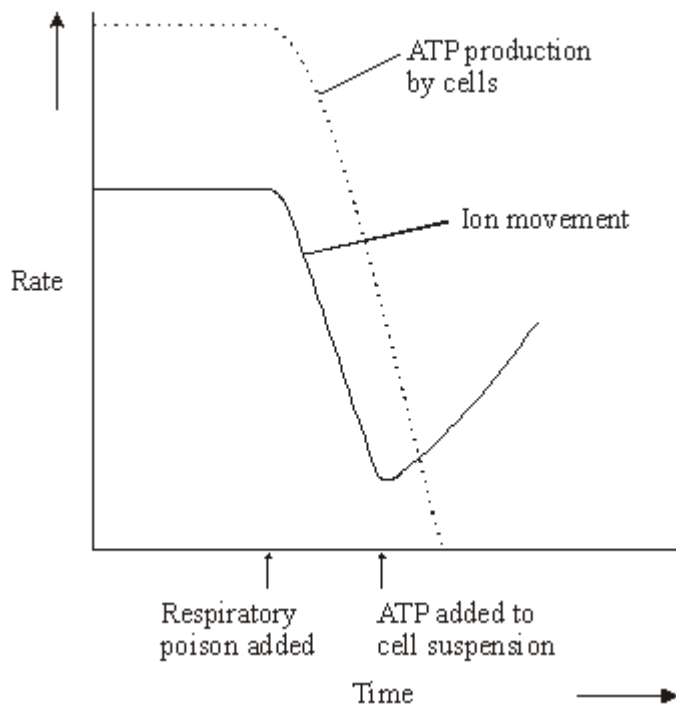
(b) When 2,4-D is applied to weeds their growth is very rapid but very distorted. After a short time they die. Suggest **one** explanation for the rapid and distorted growth of weeds when 2,4-D is applied.

(2)
(Total 4 marks)

Q30. (a) Explain how **three** features of a plasma membrane adapt it for its functions.

(6)

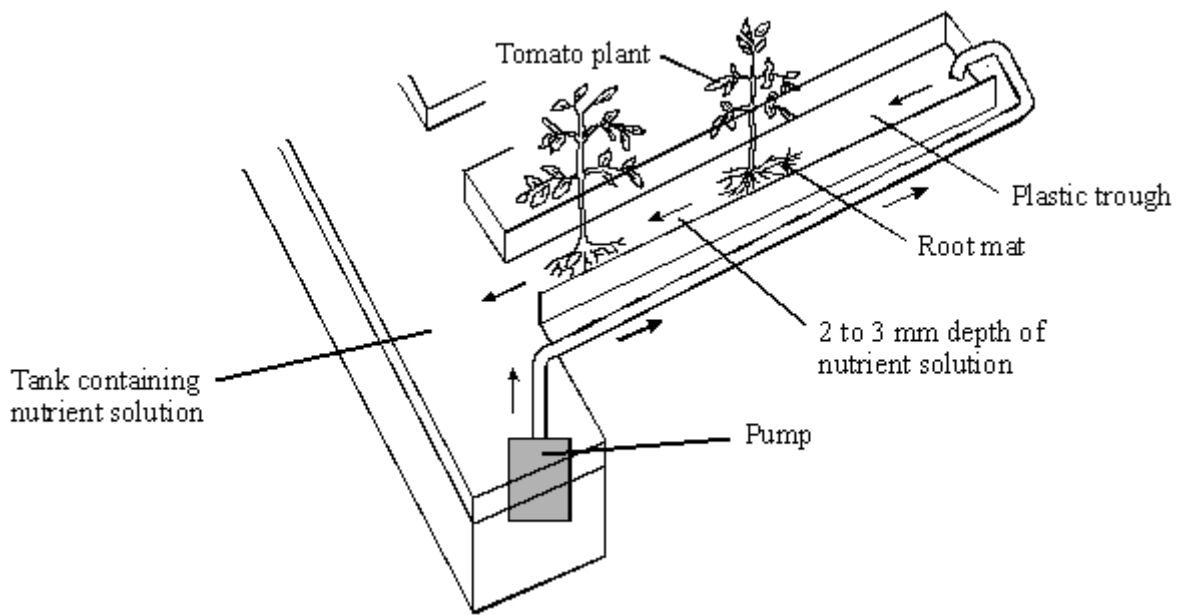
(b) ATP breaks down to ADP and phosphate releasing energy. The graph shows the rate of ion movement and the rate of ATP production in an investigation carried out on a suspension of cells. At a certain point in the investigation, a respiratory poison was added to the cell suspension. Later, ATP was added to the same cell suspension.



Describe and explain the changes in the rate of ion movement.

(4)
(Total 10 marks)

Q31. Tomato growers have increased the yield of fruit from 100 to 400 tonnes per hectare by growing the tomato plants in automatically heated glasshouses and enhancing the carbon dioxide concentration. To control the nutrient supply to the roots, the plants are grown without soil in plastic troughs, as shown in the diagram.



(a) Explain how enhancing the carbon dioxide concentration helps to increase the yield.

(2)

(b) Maintaining a high temperature in a glasshouse in winter, when the light intensity is low, may reduce the yield. Explain how.

(2)

- (c) Tomato fruits have a high percentage of water. When making tomato ketchup, it is more economical to use fruits which have a low percentage of water. Growers can reduce the water content of the fruit by adding sodium chloride to the nutrient solution in the plastic trough.

Explain how adding sodium chloride can reduce the water content of the fruit.

(2)
(Total 6 marks)

Q32. 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

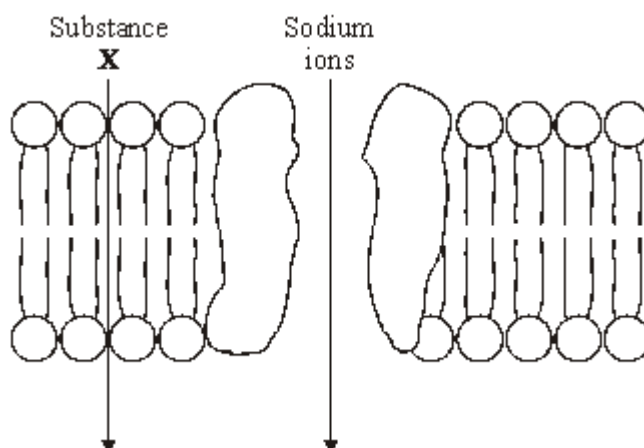
Scientific	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

Write an essay on the following topic:

The process of osmosis and its importance to living organisms.

(Total 25 marks)

- Q33.** The diagram shows part of a plasma membrane. The arrows show the path taken by sodium ions and by substance **X** when they diffuse through the membrane into a cell.



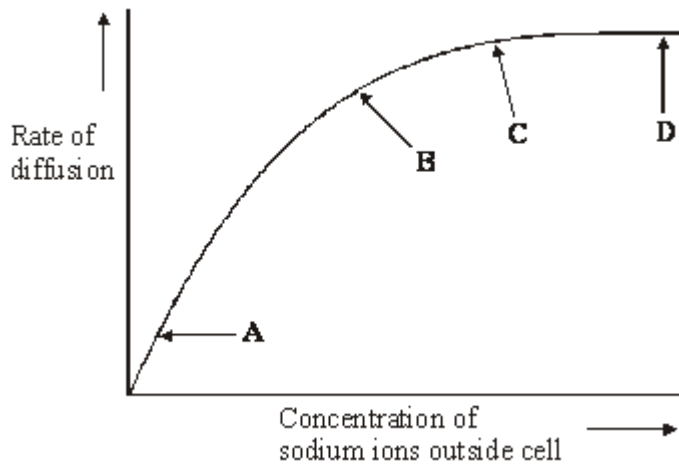
(a) An optical microscope cannot be used to see a plasma membrane. Explain why.

(2)

(b) Give **one** property of the molecules of substance **X** which allows them to diffuse through the membrane at the position shown.

(1)

(c) The effect of the concentration of sodium ions in the surrounding solution on their rate of diffusion across the membrane was investigated. The graph shows the results.



(i) What limits the diffusion of sodium ions across the membrane between **A** and **B** on the graph? Give the evidence for your answer.

Limiting factor _____

Evidence _____

_____ (2)

(ii) Explain the shape of the curve between **C** and **D**.

(2)

(Total 7 marks)