Cell Membrane and Transport

(Past Year Topical Questions 2010-2015)

Oct/Nov 2010 (21)

3 Red blood cells are suspended in plasma which has a concentration equivalent to that of 0.9% sodium chloride (NaC*l*) solution.

A student investigated what happens to red blood cells when placed into sodium chloride solutions of different concentration.

A small drop of blood was added to 10 cm^3 of each sodium chloride solution. Samples were taken from each mixture and observed under the microscope. The number of red blood cells remaining in each sample was calculated as a percentage of the number in the 0.9% solution. The results are shown in Fig. 3.1.

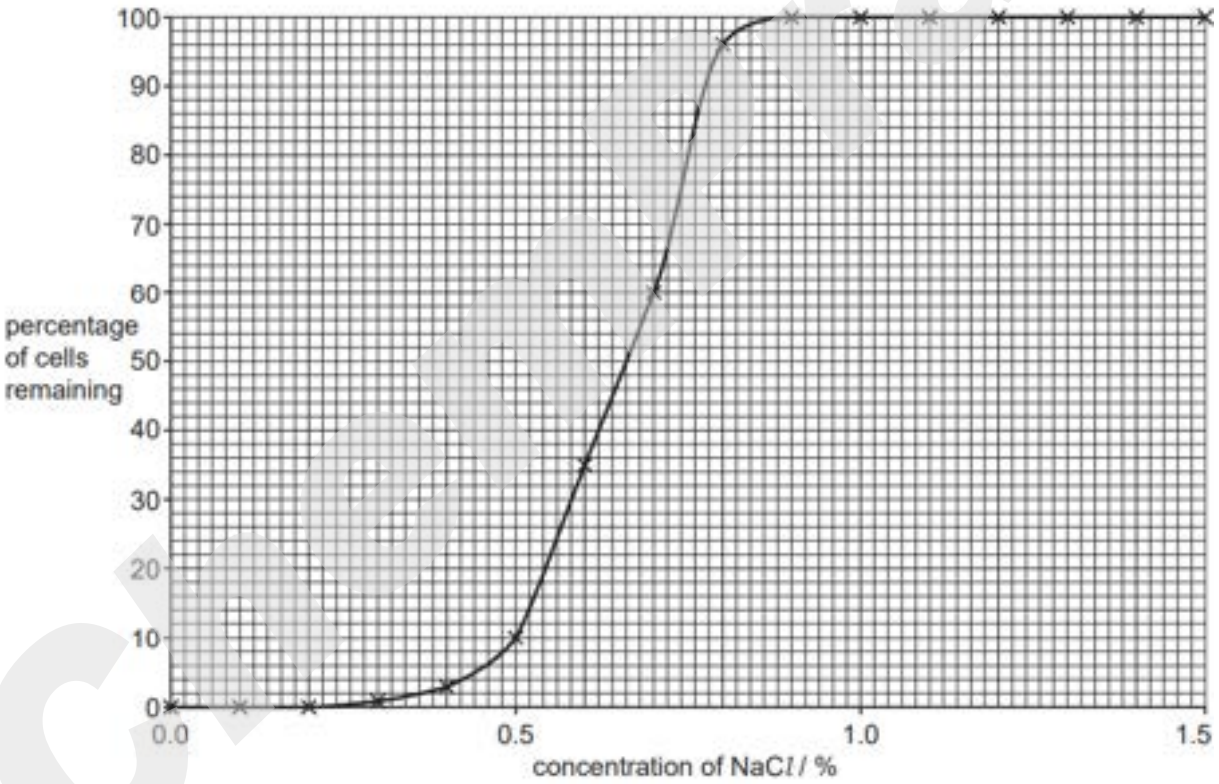

Fig. 3.1

(a) With reference to Fig. 3.1, describe the student's results.

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The student also measured the cell volumes of the red blood cells in three of the sodium chloride solutions. The results are shown in Table 3.1.

Table 3.1

concentration of sodium chloride /%	mean red cell volume / μm^3
0.7	120
0.9	90
1.5	65

Fig. 3.2 shows the appearance of some red blood cells removed from the 1.5% sodium chloride solution.

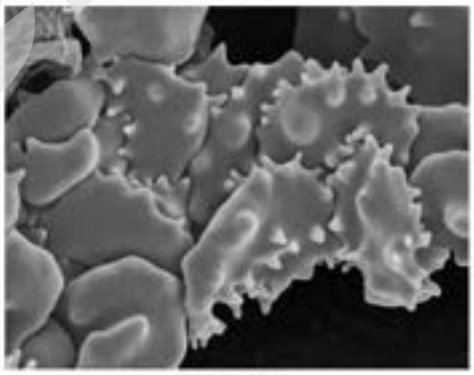

Fig. 3.2

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(b) Explain the results shown in Fig. 3.1, Table 3.1 and Fig. 3.2, in terms of **water potential**.

0% NaCl solution .....

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0.7% NaCl solution .....

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1.5% NaCl solution .....

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Oct/Nov 2010 (22)/Q1

(b) Describe the process of ***exocytosis***.

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Oct/Nov 2010 (22)/Q3

(c) A student carried out an investigation into osmosis using red blood cells.

Red blood cells were placed in sodium chloride (salt) solutions at five different concentrations. For each concentration, a sample was added immediately to a microscope slide and the cells were viewed using a light microscope for a period of time. The observations recorded are shown in Table 3.1.

Table 3.1

concentration of salt solution / %	observation of red blood cells
0.0	swell and burst, numbers decrease
0.4	increase in size
0.9	remain the same size
1.5	decrease in size
3.0	smaller and shrivelled

Explain, in terms of **water potential** and osmosis, the results that the student obtained.

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(d) The student also carried out a similar investigation using plant cells with cell walls removed. These cells were suspended in a 12% mannitol solution so that the water potential inside and outside of the cells was equal.

Fig. 3.1 is a photomicrograph of these cells.

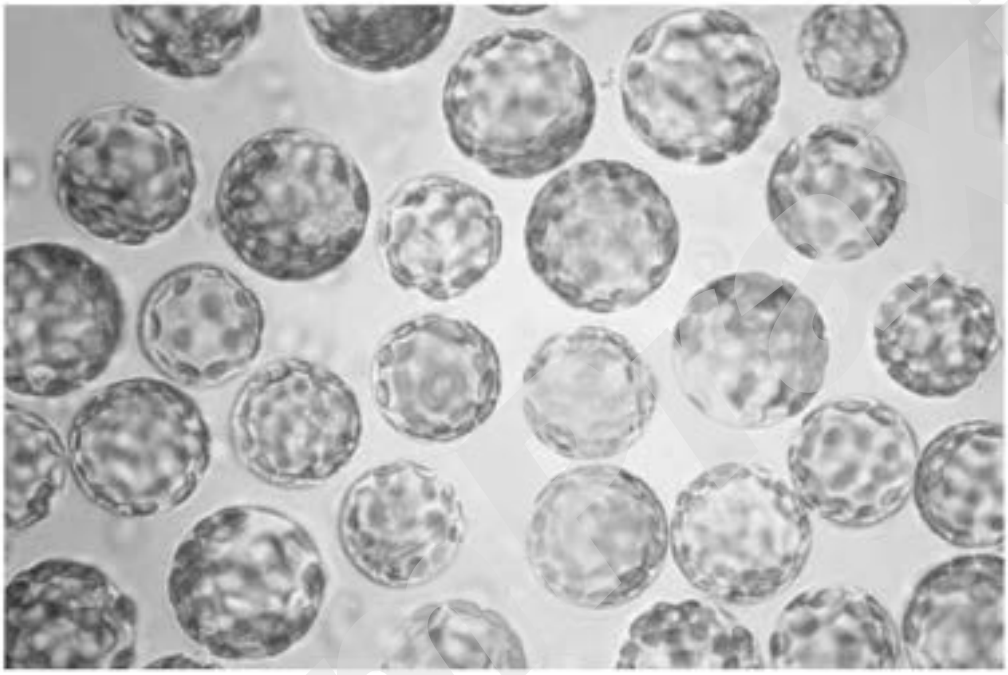

Fig. 3.1

The student removed a sample of these cells. The sample was placed into distilled water and was viewed using a light microscope.

Describe what you would expect the student to observe and explain why this would not occur with normal plant cells.

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May/June 2011 (22)/Q5

(ii) Explain how a phospholipid is suited to its role in cell membranes.

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May/June 2011 (23)

3 **(a)** Plants take in mineral ions through their root hair cells. This may happen by a process which moves the ions from a low concentration in the soil to a higher concentration in the root hair cell.

(i) Name and describe this process by which mineral ions are taken in.

name .....

description .....

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(ii) Phosphate is an example of an ion transported in this way. State **one** use for this ion in plant cells.

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Oct/Nov 2011 (21)

1 Fig. 1.1 is a diagram of a cell surface membrane.

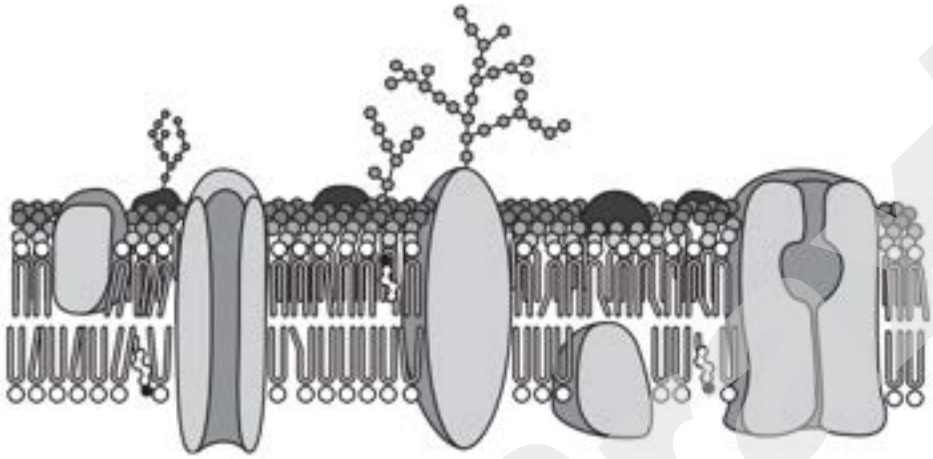

Fig. 1.1

(a) Use a label line and the appropriate letter to label each of the following on Fig. 1.1.

P protein for active uptake of potassium ions

Q protein for facilitated diffusion of polar molecules

R receptor site for a hormone

S hydrophilic heads of phospholipids on the internal surface of the membrane

T molecule that modifies the fluidity of the membrane [5]

(b) Some cells take in bacteria by endocytosis.

Explain how endocytosis occurs at a cell surface membrane.

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Oct/Nov 2011 (22)

3 *Azotobacter vinelandii* is a bacterium found in the soil that is able to fix atmospheric nitrogen. One feature of nitrogen-fixing bacteria is the ability to synthesise the enzyme nitrogenase, a molybdenum- and iron-containing, protein complex.

(a) (i) Molybdenum is a mineral ion found in the soil solution. It enters the cell as molybdate ions, through membrane transport proteins. The proteins have the ability to bind to, and hydrolyse, ATP.

Name **and** describe the mechanism of transport of molybdate ions into the cell.

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May/June 2012 (21)

2 Fig. 2.1 shows a drawing made from an electron micrograph of two adjacent cells in a leaf.

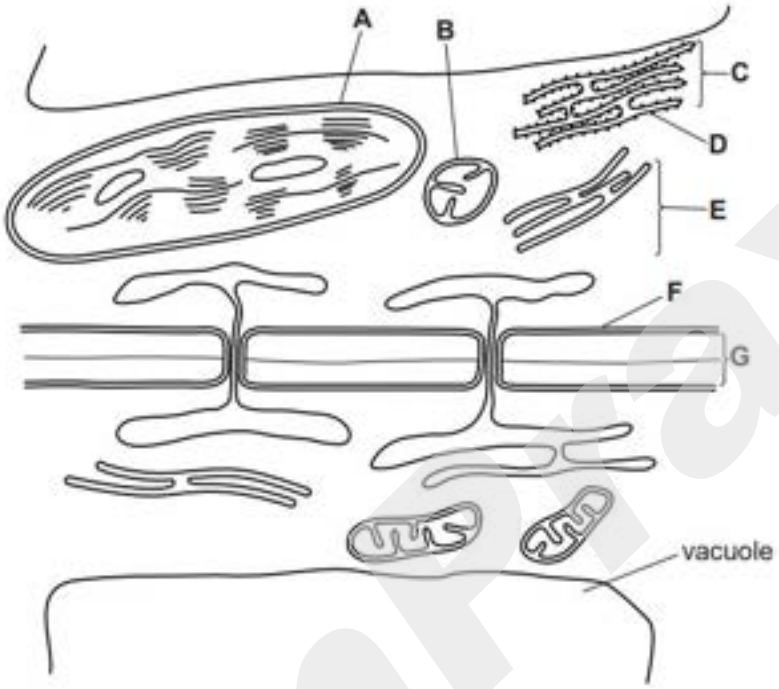

Fig. 2.1

(d) Structures **F** and **G** have very different permeability properties.

Explain how the composition of structures **F** and **G** determines the permeability properties of these structures.

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May/June 2012 (21)/Q5

(d) Suggest why a transporter protein is required for the removal of ammonium ions from *D. discoideum*.

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May/June 2012 (22)

1 One role of the cell surface membrane is to control the entry and exit of substances.

(a) Complete Table 1.1 to show the transport mechanisms across cell surface membranes and examples of materials transported.

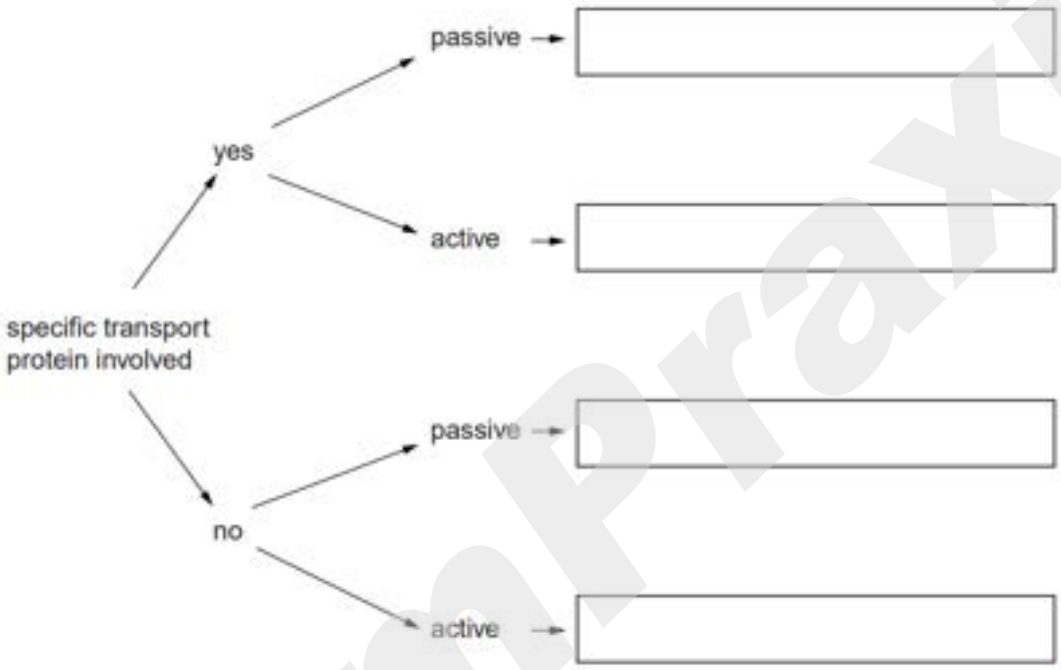
Table 1.1

transport mechanism across cell surface membrane	example of material transported across membrane
active transport	sodium ions
	oxygen molecules
	bacteria
exocytosis	mucin (for mucus)
facilitated diffusion	
osmosis	

[2]

(b) Each transport mechanism across cell surface membranes has a characteristic set of features.

In **each** of the boxes below, state **one** example of a transport mechanism that matches the pathway shown.



[4]

May/June 2012 (23)/Q3

The cholera toxin interacts with ion channels in the epithelial membranes, resulting in watery diarrhoea.

These channels open, allowing ions to move from the epithelial cells into the lumen of the intestine.

(b) (i) Name the process by which the ions move in this case.

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(ii) Due to the movement of ions into the lumen, water moves from the epithelial cells into the lumen.

Name the process by which water moves and explain why it moves into the lumen.

name .....

explanation .....

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.....[3]

Oct/Nov 2012 (21)

2 Thale cress, *Arabidopsis thaliana*, is used to study the roles of genes and proteins in plants.

The cell membranes of the root hairs of *A. thaliana* contain proteins called aquaporins that allow the movement of water between the soil and the cytoplasm as shown in Fig. 2.1.

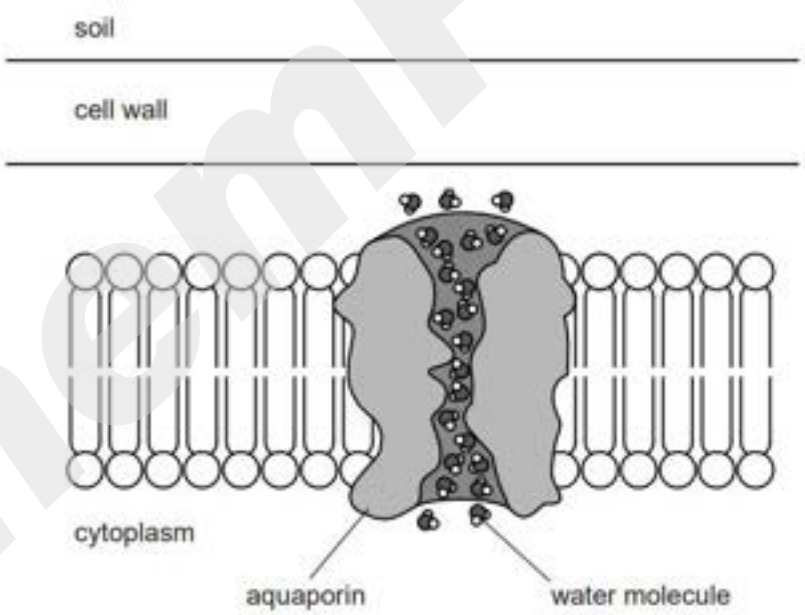

Fig. 2.1

(a) With reference to Fig. 2.1:

(i) explain how water is absorbed by root hairs of *A. thaliana*

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(ii) state why aquaporins are necessary in cell surface membranes.

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Oct/Nov 2012 (22)

2 The fluid mosaic model of membrane structure was first proposed in 1972 by Singer and Nicolson. The model describes in detail how the components of a membrane are organised.

(a) Some of the components of the cell surface membrane are:

- phospholipid molecules
- protein molecules
- cholesterol molecules.

(i) In the box below, draw a labelled diagram of a section through a cell surface membrane to show how the above components are organised within the membrane.

The diagram should include other named components of the membrane.

Label the inner and outer surfaces of the membrane.

[5]

(ii) Suggest why 'fluid mosaic' is an appropriate term to use to describe membrane structure.

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May/June 2013 (21)

5 Fig. 5.1 shows a section of a cell surface membrane.

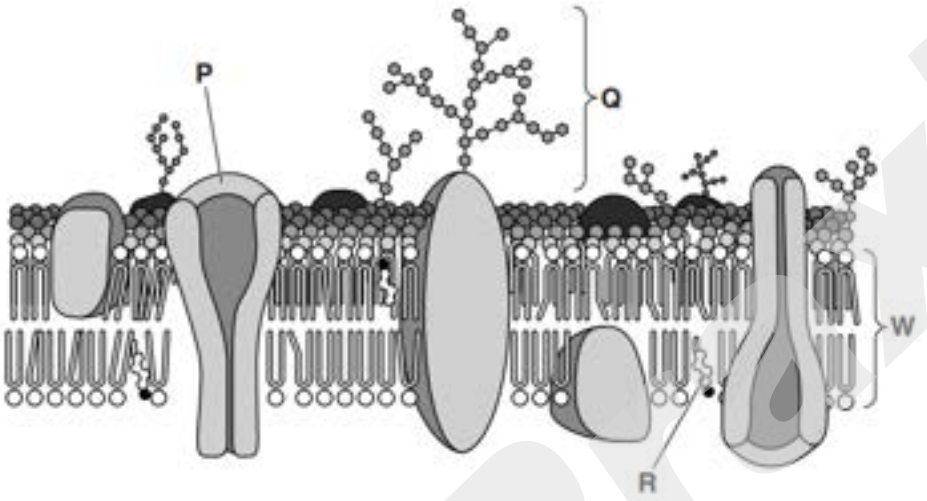

Fig. 5.1

(a) State the functions of structures **P**, **Q** and R.

P .....

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Q .....

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R .....

..... [3]

(b) Circle the width of the membrane shown as **W** in Fig. 5.1.

17.0 μm 1.7 μm 0.7 μm 70.0 nm 17.0 nm 7.0 nm 0.7 nm [1]

(c) Membranes, such as the cell surface membrane, are described as having a fluid mosaic structure.

Explain what is meant by the term *fluid mosaic*.

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(d) Aquaporins are membrane channel proteins in plant and animal cells. They permit the movement of water across membranes. Explain why they are necessary.

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May/June 2013 (22)/Q4

Freezing temperatures can damage the cell surface membrane and membranes within the cell.

(c) Explain the importance of the cell surface membrane to cells.

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May/June 2013 (23)/Q1

(c) The membrane surrounding the vacuole, called the tonoplast, has a fluid mosaic structure.

Describe the structure of this membrane.

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Oct/Nov 2013 (21)/Q2

(c) Some pea plants were grown with their roots in a solution of mineral ions. The solution was kept aerated for three days.
The concentrations of five ions in the solution and in the root tissue were determined after the three days. The results are shown in Table 2.2.

Table 2.2

ion	concentration / mmol dm^{-3}	
	surrounding solution	root tissue
potassium (K^+)	1.0	75.0
magnesium (Mg^{2+})	0.3	3.5
calcium (Ca^{2+})	1.0	2.0
phosphate (PO_4^{3-})	1.0	21.1
sulfate (SO_4^{2-})	0.3	19.7

With reference to Table 2.2, suggest how cell surface membranes of root cells are responsible for the concentrations of ions in the roots compared to the surrounding solution.

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.....[5]

Oct/Nov 2013 (22)/Q4

(b) Bacterial cells behave in a similar way to plant cells when immersed in solutions of different water potential.

Suggest **and** explain what would happen to bacteria placed in a solution with a water potential more negative than their cell contents.

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.....[3]

Oct/Nov 2013 (23)/Q5

(c) Digested material in animals is absorbed using both facilitated diffusion and active transport.

State two similarities **and** two differences between facilitated diffusion and active transport.

similarities:

1. .....

2. .....

differences:

1. .....

2. .....

[4]

May/June 2014 (23)/Q3

(b) The bacteria take in glutamic acid by active transport.

Describe the process of active transport.

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Oct/Nov 2014 (21)

6 Fig. 6.1 shows the pathway taken by water as it enters the root of a flowering plant.

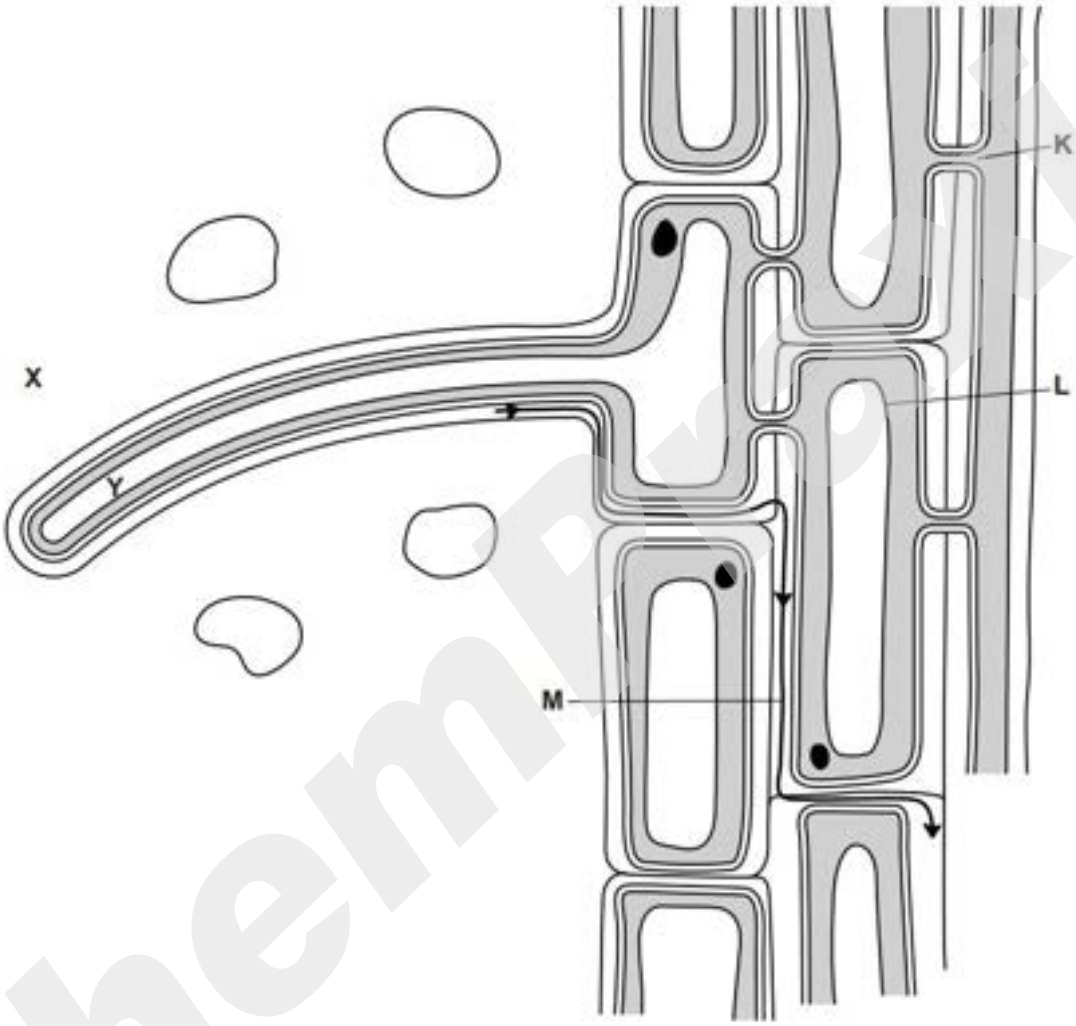

Fig. 6.1

(a) Explain how water passes from **X** to **Y**.

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Oct/Nov 2014 (22)/Q2

(e) Nitrate ions are taken up by root hair cells.

Outline the role of the cell surface membrane of root hair cells in the uptake of nitrate ions.

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.....[2]

Oct/Nov 2013 (23)/Q4

Glucose can enter cells by active transport or facilitated diffusion.

Glucose-6-phosphate is a charged, polar molecule and cannot move out of cells.

(d) (i) State two **differences** between active transport and facilitated diffusion.

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2. .....

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(ii) Suggest why glucose-6-phosphate cannot move out of cells.

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..... [2]

May/June 2015 (22)

3 Outside the body, red blood cells can be maintained in an intact state by keeping the cells in a 0.9% solution of sodium chloride. This is known as a normal saline solution.

Fig. 3.1 shows intact red blood cells.

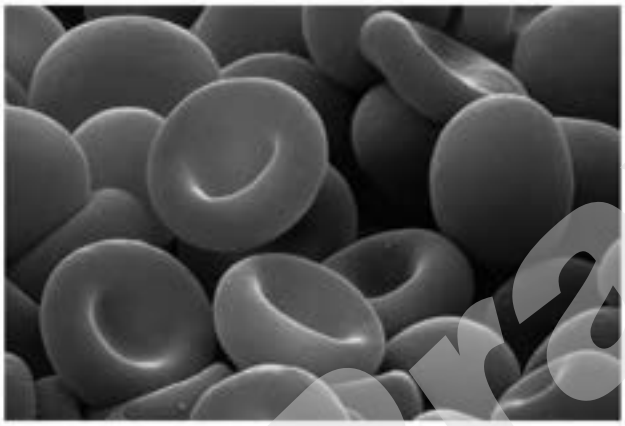

Fig. 3.1

(a) Explain why red blood cells can be maintained in an intact state by keeping them in a normal saline solution.

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.....[2]

May/June 2015 (23)

1 The cell surface membrane has a fluid mosaic structure.

(a) Describe what is meant by the term *fluid mosaic*.

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.....[2]

(b) In 1934, the biologists Davson and Danielli published their suggestion for the structure of the cell surface membrane, as shown in Fig. 1.1.

They suggested that the membrane was a phospholipid bilayer with a layer of hydrophilic protein on both surfaces.

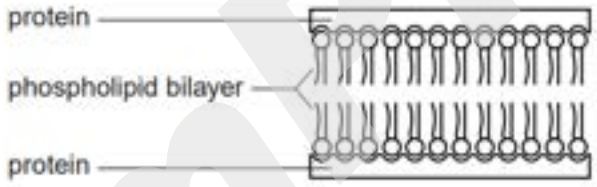

Fig 1.1

State **one** way in which the Davson-Danielli structure is similar to the fluid mosaic structure **and one** way in which it differs from the fluid mosaic model.

similarity

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.....[1]

difference

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.....[1]

(c) One way in which substances can cross cell membranes is by active transport.

Describe the mechanism of active transport.

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(d) High temperature can damage cell membranes. One factor contributing to this damage is the denaturation of membrane proteins.

Describe how proteins become denatured at high temperature **and** explain how this could lead to damaging cell membranes.

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.....[3]

Oct/Nov 2015 (21)

2 Fig. 2.1 is a diagram of the structure of a protein channel for ions in a cell surface membrane.

Fig. 2.1a shows the channel when open and Fig. 2.1b shows the same channel when closed.

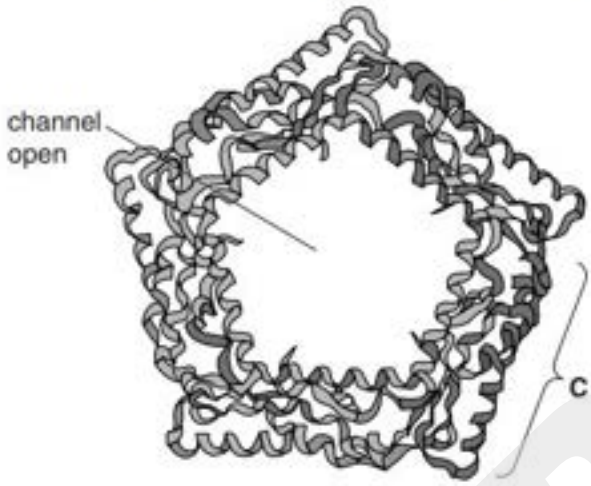

Fig. 2.1a

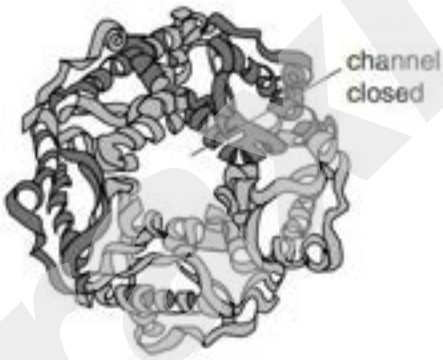

Fig. 2.1 b

(a) (i) Name the process by which ions pass across the membrane using channel proteins.

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(ii) Explain why a channel protein is needed for ions to pass across a cell membrane.

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..... [2]

(c) Channel proteins are examples of transmembrane proteins. The polypeptides are held together and also interact with phospholipids in the membrane.

Suggest how the polypeptides are held together **and** suggest how they interact with phospholipids.

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..... [3]

Oct/Nov 2015 (23)/Q3

(e) Enzyme inhibitors can also inhibit carrier proteins in cell surface membranes.

Explain why carrier proteins are required in cell surface membranes.

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..... [2]

(f) Describe three roles of cell surface membranes, **other** than the transport of substances into and out of cells.

1. .....

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2. .....

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3. .....

..... [3]