IB · SL · Biology

2 hours 15 questions

Structured Questions

Membranes & Membrane Transport

Lipid Bilayers / Membrane Proteins / Membrane Transport / Glycolipids & Glycoproteins / The Fluid Mosaic Model: Skills

Easy (6 questions)	/38
Medium (5 questions)	/36
Hard (4 questions)	/20
Total Marks	**/94**

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Easy Questions

1 (a) Define the following terms:

(i) hydrophilic

[1]

(ii) hydrophobic

[1]

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.....

(2 marks)

(b) Draw a labelled diagram of a phospholipid molecule.

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(2 marks)

(c) State the name of the property of phospholipids that causes them to form bilayers when placed in water.

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(1 mark)

2 (a) Define the term active transport.

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(3 marks)

(b) List **three** factors that affect the rate of diffusion of substances across a membrane.

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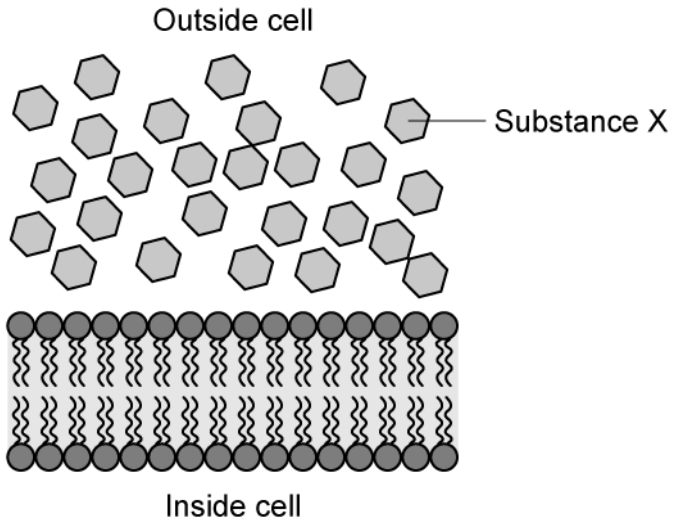
(3 marks)

3 (a) The below diagram shows the plasma membrane of an *Amoeba* cell and some molecules of a small, nonpolar substance labelled substance **X**.



State:

(i) The direction in which substance X would move

[1]

(ii) The process by which substance X would move

[1]

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.....

(2 marks)

(b) List two possible names of substance **X**.

.....

.....

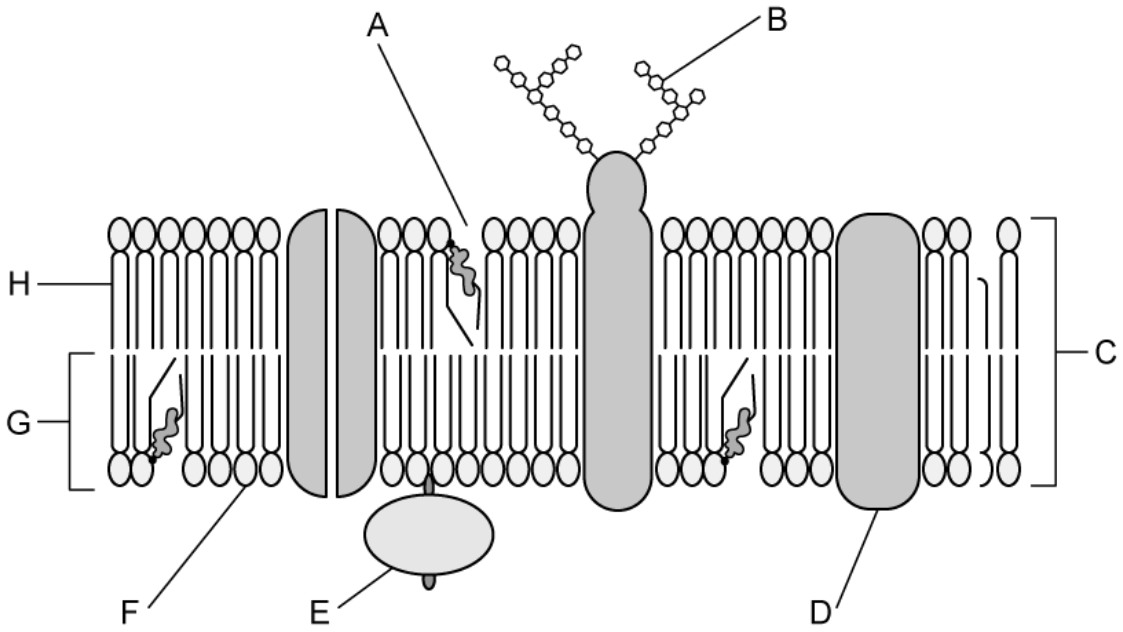
(2 marks)

(c) *Amoeba* require potassium ions to assist with detecting prey.

Outline how these ions would be transported across the membrane shown in part (a).

(2 marks)

4 (a) Label structures **A**-**E** in the diagram below.



(5 marks)

(b) A group of students investigated the impact of different salt concentrations on the mass of celery. They entered the results into the table below.

Concentration of salt / mol dm^{-3}	Initial mass / g	Final mass / g	Mass change / g	Mass change / %
0.0	12.2	14.5	+ 2.3	+ 18.9
0.2	10.0	11.7	+ 1.7	+ 17.0
0.4	9.6	9.3	- 0.3	- 3.1
0.6	11.3	10.5	- 0.8	
0.8	12.5	11.2	- 1.3	- 10.4
1.0	10.7	8.5	- 2.2	- 20.6

(i) Calculate the percentage change in mass of the celery in a salt solution of 0.6 mol dm^{-3}

[1]

(ii) Estimate, with a reason, the solute concentration of the celery tissue

[2]

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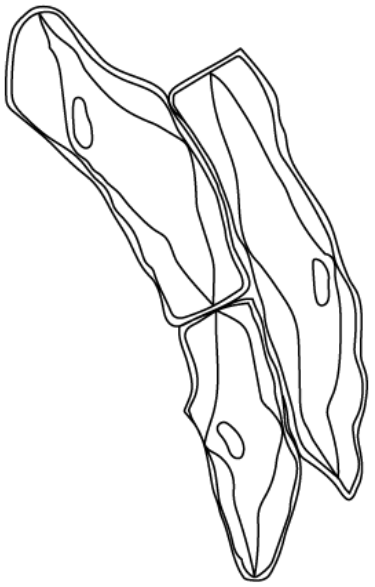
(3 marks)

(c) The diagram below is a student's drawing of three celery cells seen under a light microscope at the end of the investigation in part (b).



Deduce, with a reason, the salt concentration in which these cells have been immersed.

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(2 marks)

5 Outline the functions of membrane proteins.

(4 marks)

6 (a) Compare the passive transport of substances across membranes, using **named** examples.

(5 marks)

(b) The majority of metabolites are not able to pass directly through the phospholipid bilayer and require assistance to do so.

Explain the property of membranes that causes this to be the case.

(2 marks)

Medium Questions

1 (a) Phospholipids are described as amphipathic molecules.

Explain what this means.

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(1 mark)

(b) Liposomes are spherical vesicles surrounded by a phospholipid bilayer. They can be used in a range of applications, such as the delivery of mRNA vaccines to specific areas of the body.

Sketch a small section of the structure of a liposome, indicating its exterior, interior and the hydrophobic and hydrophilic regions.

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(2 marks)

(c) Describe the properties that allow some molecules to diffuse rapidly across cell membranes.

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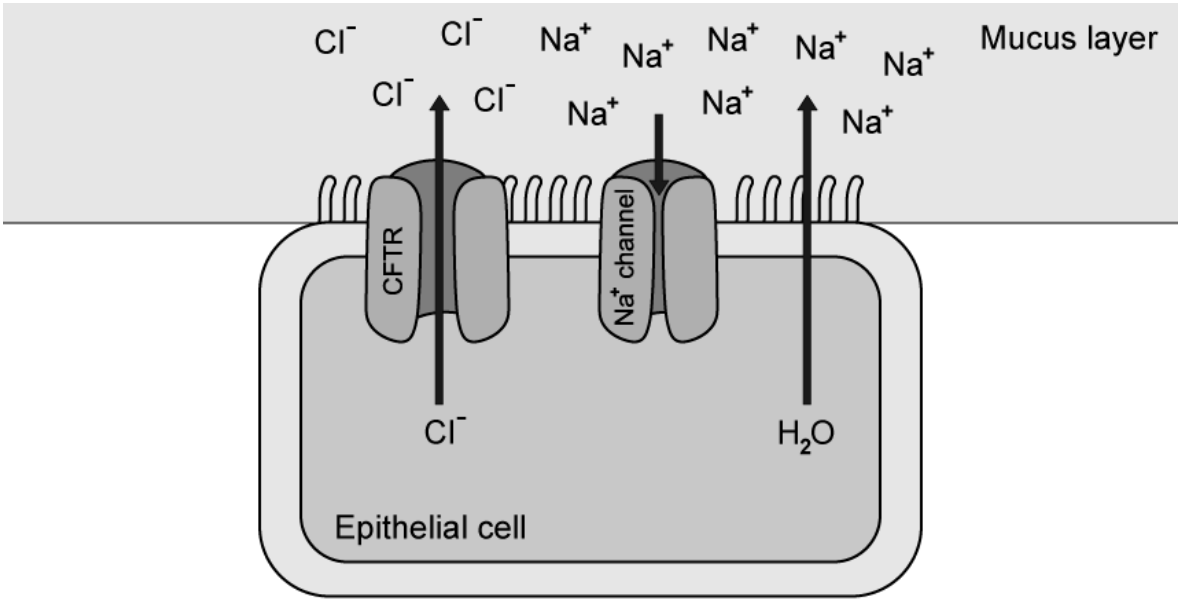
(2 marks)

(d) The diagram below shows a typical epithelial cell from the lining of the airways. The stickiness of mucus in the airways is controlled by CFTR chloride ion channels.

When there is too little water in the mucus the CFTR channel opens, allowing Cl^- ions to move into the mucus. When active, the CFTR channel also inhibits the activity of sodium channels and limits movement of Na^+ ions into the cells. The resulting high concentration of salt in the mucus draws water out of the cells, making the mucus less sticky.



Cystic fibrosis is a genetic disorder characterised by a build-up of thick, sticky mucus that damages the function of the airways and digestive system. People with class I cystic fibrosis have inherited two faulty versions of the gene that codes for CFTR, resulting in non-functioning CFTR channels.

(i) Suggest how a lack of functioning CFTR channel impacts the movement of Na^+ and Cl^- ions across epithelial cells.

[3]

(ii) Explain why the mucus of cystic fibrosis sufferers is thick and sticky.

[1]

(4 marks)

2 (a) As part of an investigation cubes of potato were placed in a solution containing sodium ions. The concentration of oxygen in air bubbled through the solution was changed and the rates of respiration and uptake of sodium ions were measured. The results are shown in the table below.

Concentration of oxygen / %	Rate of respiration / arbitrary units	Rate of uptake of sodium ions / arbitrary units
3.8	43	54
15.6	56	76
24.7	62	87
32.9	89	90

Describe the relationship between oxygen concentration, rate of respiration and rate of uptake of sodium ions.

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(1 mark)

(b) Suggest reasons for the relationship between oxygen concentration, rate of respiration and rate of uptake of sodium ions described in part (a).

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(2 marks)

(c) Give **two** similarities between the processes by which inorganic ions and water molecules enter cells.

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(2 marks)

(d) Distinguish between the passive and active movement of molecules across cell membranes.

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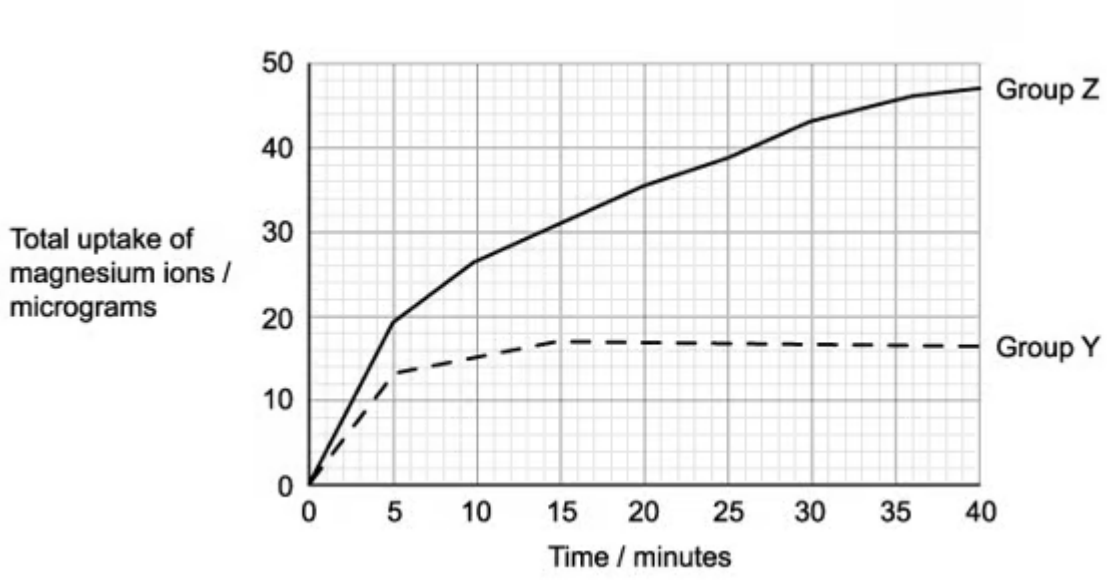
(3 marks)

3 (a) Some scientists investigated the uptake of magnesium ions in rice plants. They divided the plants into two groups and placed their roots in solutions containing radioactive magnesium ions.

Group Y: plants had a substance that inhibited respiration added to the solution

Group Z: plants did **not** have the respiratory inhibitor added to the solution

The scientists calculated the total mass of magnesium ions absorbed by the plants every 5 minutes. Their results are shown in the graph below:



Calculate the ratio of the mean rate of uptake of magnesium ions in the first 20 minutes to the mean rate of uptake of magnesium ions in the second 20 minutes for group **Z**.

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(2 marks)

(b) Using the graph in part (a), calculate the rate of uptake of magnesium ions for group **Y** plants after 40 minutes. Give suitable units.

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(2 marks)

(c) Consider the graph in part (a). Explain the results of the investigation.

(3 marks)

(d) State **two** differences between the processes of facilitated diffusion and active transport.

(2 marks)

4 Draw an annotated diagram of the cell membrane based on the fluid mosaic model, including all the relevant structures.

(6 marks)

5 (a) A contractile vacuole can expand to take on water, and is able to fuse with the cell-surface membrane.

Suggest how a contractile vacuole aids osmoregulation in amoebas.

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(2 marks)

(b) Describe what would happen to an amoeba cell placed into saltwater.

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(2 marks)

Hard Questions

1 The concentration of sodium ions in red blood cells is lower than the concentration in blood plasma.

Suggest how this sodium ion concentration gradient is maintained.

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(2 marks)

2 Researchers have discovered that an individual phospholipid molecule can exchange places with its neighbouring phospholipid molecule in a monolayer as frequently as 10^7 times per second. By contrast, phospholipid molecules almost never exchange places with each other from one monolayer to the other within a bilayer, referred to as a 'flip-flop' exchange. The 'flip-flop' takes place around once a month for a typical phospholipid molecule.

Suggest a reason for this difference in molecular behaviour.

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(2 marks)

3 (a) Detergents are amphipathic molecules.

Suggest why scientists use detergents to study the structure of membranes.

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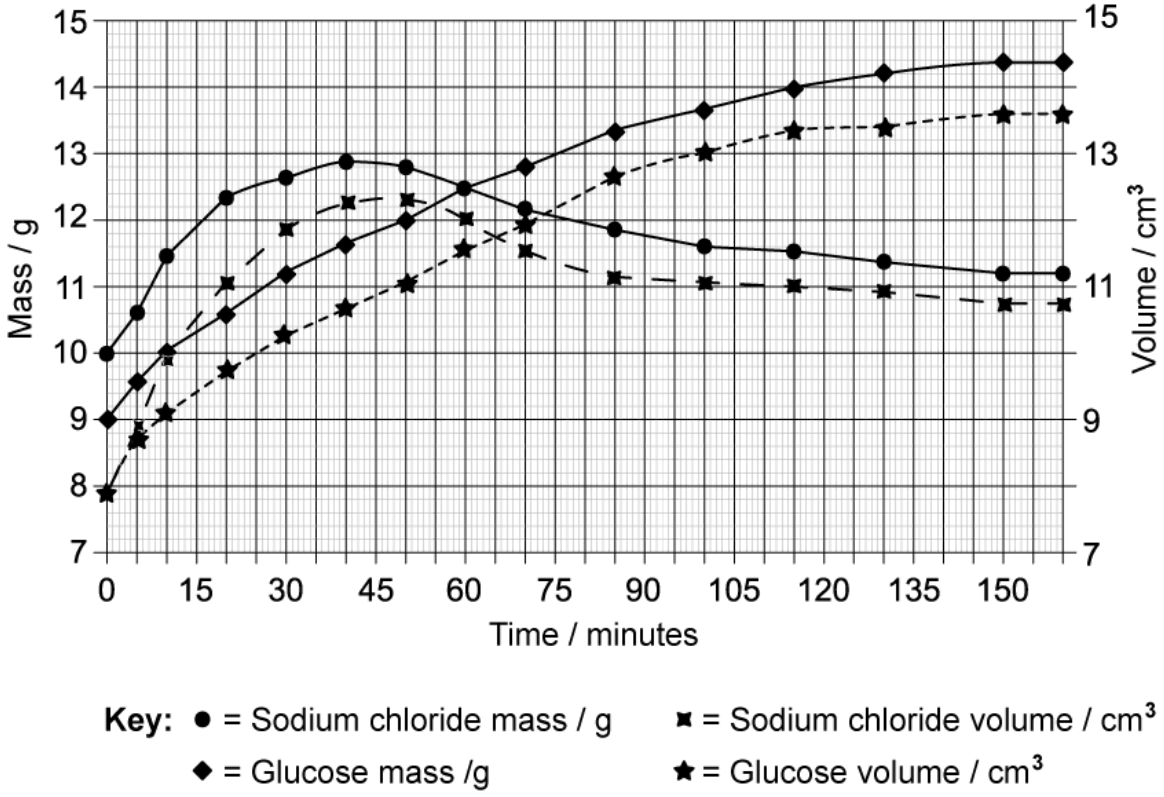
(2 marks)

(b) Diffusion can be studied using Visking tubing. Students set up an investigation in which equal volumes of the following solutions were placed into separate pieces of Visking tubing:

- 0.7 mol dm^{-3} sodium chloride
- 0.7 mol dm^{-3} glucose

The Visking tubing, containing the solutions, were placed in distilled water and maintained at a constant temperature of 23 °C. The volume and mass of the bags were measured at 5 minute intervals for 160 minutes.

The data recorded is shown below.



Calculate the rate of increase in mass and in volume for the visking tubing containing glucose solution during the first 30 minutes.

(2 marks)

(c) Compare and contrast the change in mass for the Visking tubing in each solution.

(3 marks)

(d) Explain why the volume of both sets of Visking tubing increases over time.

(2 marks)

4 Draw a labelled diagram to show the structure of the fluid mosaic model. Your drawing should label proteins with **four** named membrane protein functions.

(7 marks)