

1.3 Cells: Membrane Structure & Transport

Question Paper

Course	DP IB Biology
Section	1. Cell Biology
Topic	1.3 Cells: Membrane Structure & Transport
Difficulty	Medium

Time allowed: 60
Score: /49
Percentage: /100

Question 1a

- a) Phospholipids are described as amphipathic molecules. Explain what this means.

[1 mark]

Question 1b

- b) Liposomes 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.

[2 marks]

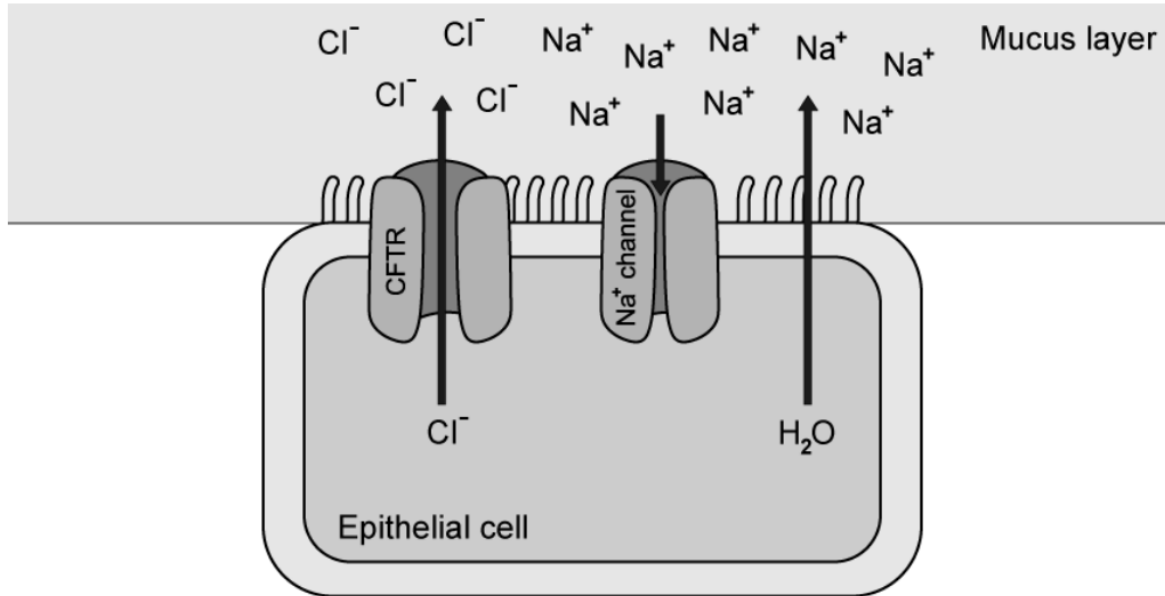
Question 1c

- c) Describe the properties that allow some molecules to diffuse rapidly across the cell membrane.

[2 marks]

Question 1d

- d) The diagram below shows a typical epithelial cell that lines the airways of the lungs. The viscosity of mucus is controlled by the CFTR chloride ion channel. 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 sodium channel and limits movement of Na^+ ions into the cell. The resulting high concentration of salt in the mucus draws water out of the cell via osmosis which makes the mucus less viscous.



Cystic fibrosis is a genetic disorder characterised by the build-up of thick sticky mucus that causes severe damage to the respiratory and digestive systems. People with class I cystic fibrosis have inherited two faulty versions of the gene for CFTR which results in an absence of the CFTR channel.

- i) Suggest how having no CFTR channel impacts the movement of Na^+ and Cl^- ions across epithelial cells.
- ii) Describe why the mucus of cystic fibrosis sufferers is thick and sticky.

[4 marks]

Question 2a

- a) 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.

[1 mark]

Question 2b

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

[2 marks]

Question 2c

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

[2 marks]

Question 2d

- d) Distinguish between passive and active movement of molecules across the cell membrane.

Passive	Active

[3 marks]

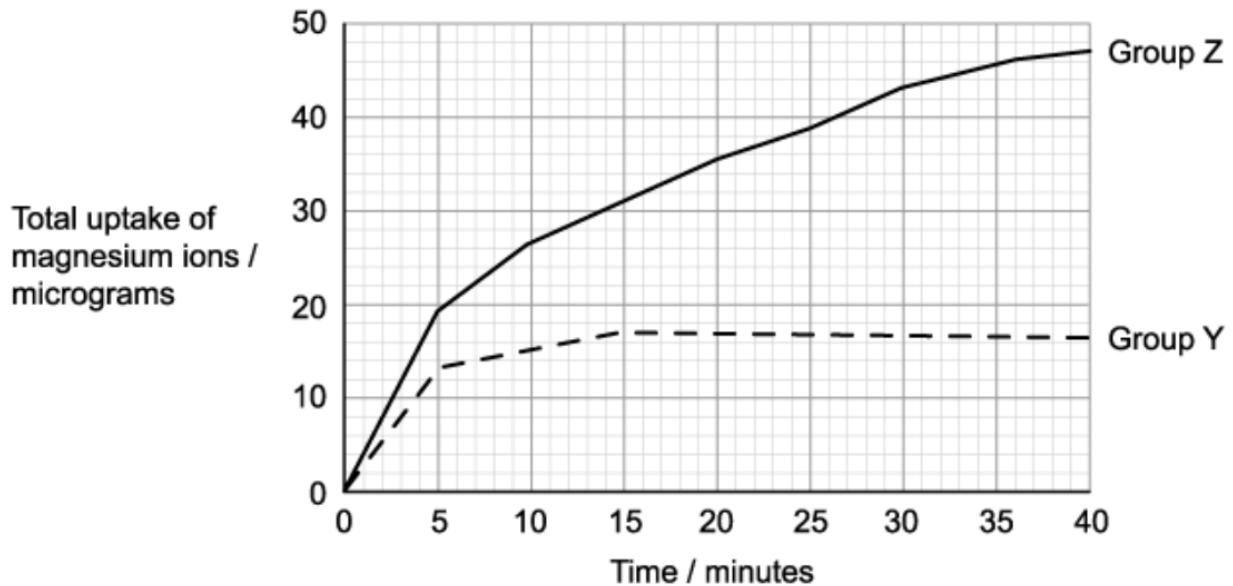
Question 3a

- 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** plants.

[2 marks]

Question 3b

- 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.

[2 marks]

Question 3c

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

[3 marks]

Question 3d

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

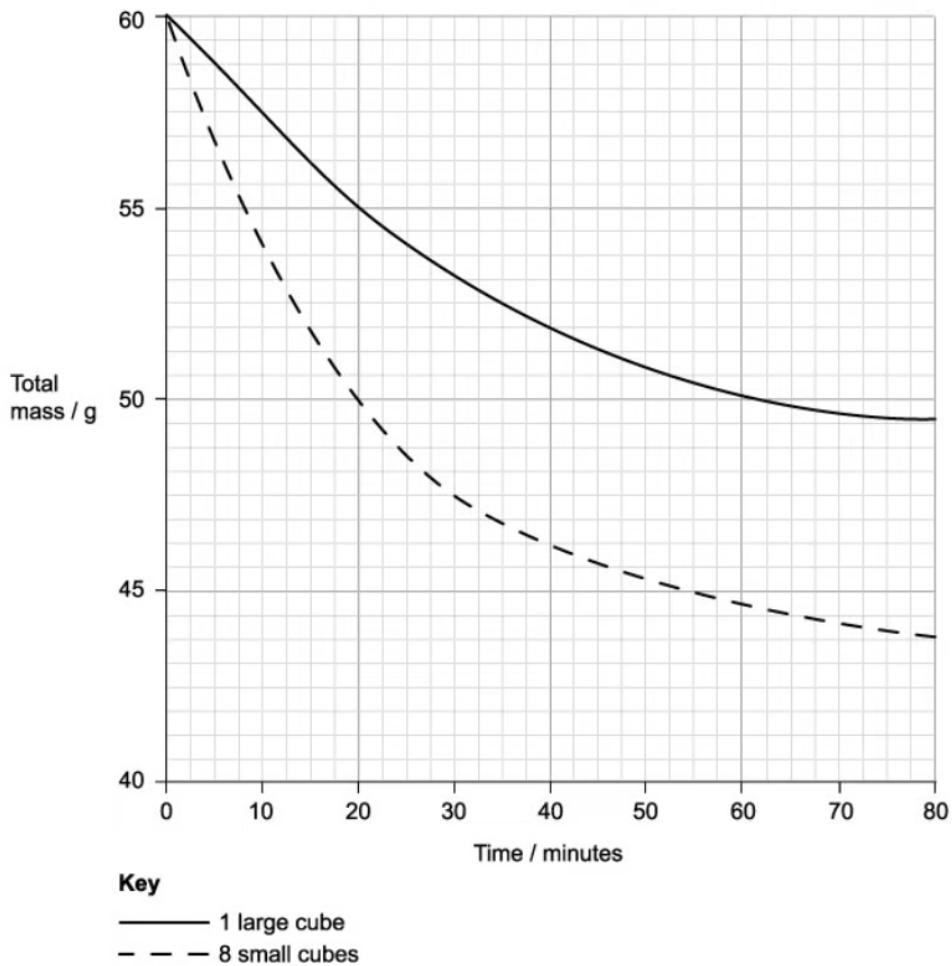
[2 marks]

Question 4a

a) A biologist investigated how surface area affects osmosis in potato cubes.

- Step 1:** Cut two cubes of potato, each with sides of 4 cm in length.
- Step 2:** Place one cube into concentrated (40%) sucrose solution.
- Step 3:** Cut the remaining cube into eight equal-sized smaller cubes and place into concentrated (40%) sucrose solution.
- Step 4:** Record the masses of the cubes at time intervals.

The results are shown in the graph



Explain why the potato tissue changed in mass.

[2 marks]

Question 4b

- b) The biologist recorded the masses of the cubes at intervals. Before weighing the cubes at each interval, the biologist blotted dry the outside of each cube. Explain why.

[2 marks]

Question 4c

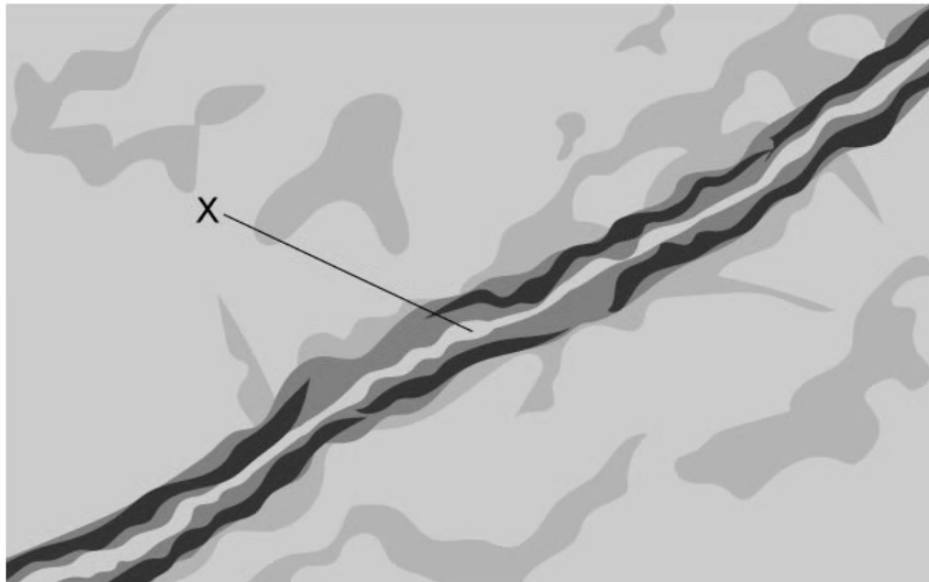
- c) During the first 20 minutes, the combined loss in mass of the eight small cubes is greater than in the single large cube (as shown in the graph in part a). Calculate the rate of loss in mass per cm^2 per minute for the single large cube and the eight small cubes during the first 20 minutes. Give your answers in grams per cm^2 per minute and show your working.

[4 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

- a) The drawing below shows an electron micrograph of a neuron. Similar images helped support the Davson and Danielli model of membrane structure.



- i) Describe the Davson and Danielli model of membrane structure.
- ii) Explain how the structure labeled X was misinterpreted.

[4 marks]

Question 5b

- b) Outline the evidence that led to the Davson and Danielli model being rejected.

[4 marks]

Question 5c

- c) Draw an annotated diagram of the cell membrane based on the fluid mosaic model including all the relevant structures.

[7 marks]

