1.3 Cells: Membrane Structure & Transport

Question Paper

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

Time allowed: 60

Score: /49

Percentage: /100

Question 1a

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

Explain how this difference in sodium concentration is maintained.

[2 marks]

[2 marks]

Question 1b

b)
During pregnancy, the fetus is dependent on essential proteins being absorbed from the mother's blood in the placenta.

Explain how these proteins would be transported into the fetus.

[2 marks]

[2 marks]

Question 1c

c)
Describe how the structure of the membrane allows for the transport of proteins from the mother to the fetus.

[3 marks]

[3 marks]

Question 1d

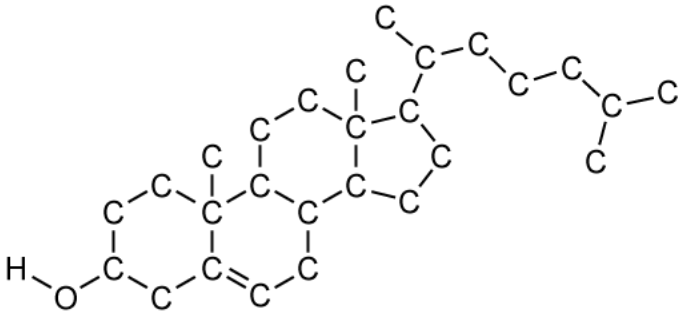
d)
Discuss the evidence used to falsify the Davson-Danielli model of membrane structure.

[3 marks]

[3 marks]

Question 2a

a)
Identify the part of the fluid mosaic structure of the plasma membrane represented by the molecular diagram below.



[1 mark]

[1 mark]

Question 2b

b)
Scientists have found that wheat crops adapted to grow in winter have increased unsaturated phospholipid content.

Suggest why the presence of unsaturated phospholipids would be advantageous.

[3 marks]

[3 marks]

Question 2c

c)
Pieces of phospholipid bilayer were analysed from two different mammalian cell surface membranes. Sample **X** contained phospholipid molecules at a density of 4.2×10^6 molecules μm^{-2}, whereas sample **Y** contained phospholipid molecules at a density of 5.5×10^6 molecules μm^{-2}. One sample was from an exocrine pancreatic cell and the other was from a skin cell.

Identify, with reasons, which cell type corresponds to samples **X** and **Y**.

[2 marks]

[2 marks]

Question 2d

d)
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 why there is this difference in molecular behaviour.

[2 marks]

[2 marks]

Question 3a

a)
Outline why scientists use detergents to study the structure of membranes.

[2 marks]

[2 marks]

Question 3b

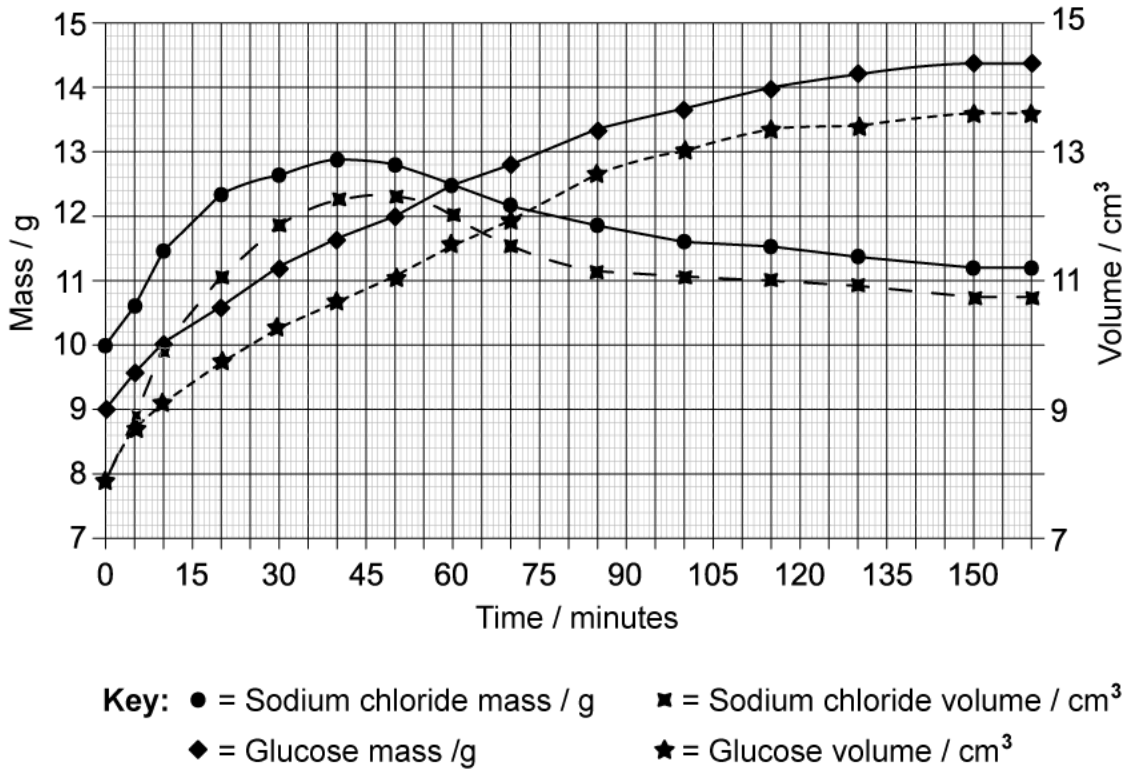
b)
Diffusion can be studied using visking tubing. Students set up an investigation in which equal volumes of each of the following solutions were placed into separate visking tubings:

0.7 mol dm^{-3} sodium chloride

0.7 mol dm^{-3} glucose

The visking tubings, each of the same size, 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 rates of increase in mass and in volume for the visking tubing containing glucose solution during the first 30 minutes.

[2 marks]

[2 marks]

Question 3c

c)
Compare and contrast the rates of change in mass for the two visking tubings.

[3 marks]

[3 marks]

Question 3d

d)
Explain why the volume of both visking tubings increases over time.

[2 marks]

[2 marks]

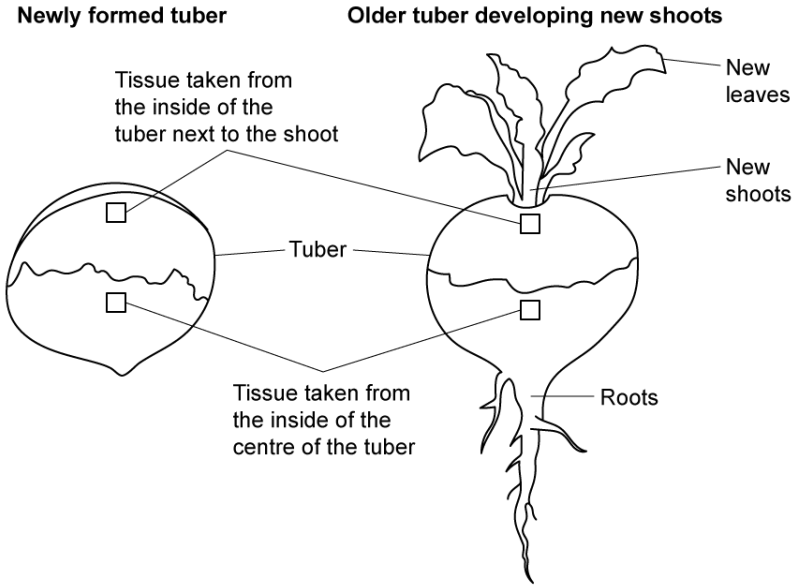
Question 4a

a)

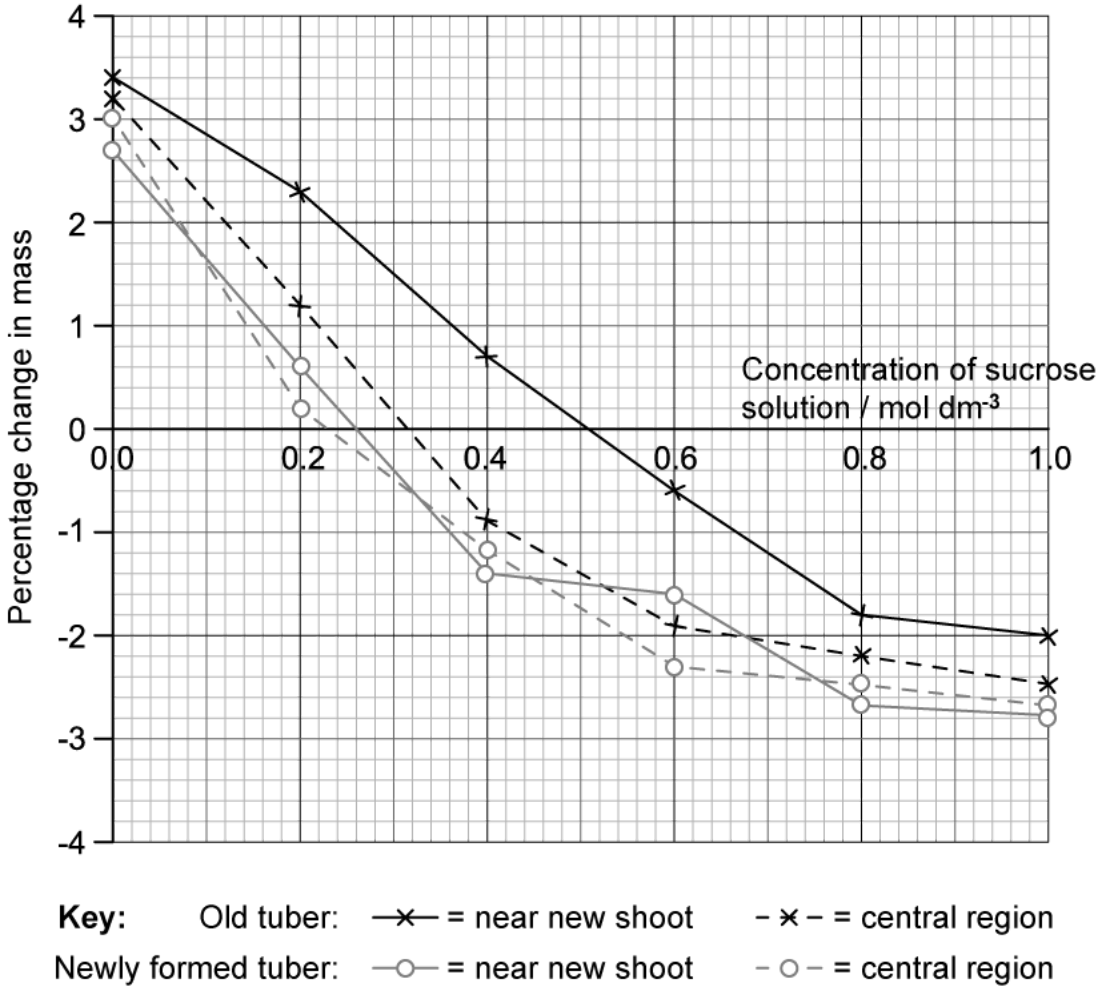
A biologist investigated the osmolarity of different parts of turnip tubers of different ages (as shown in the diagram below).
The osmolarity was estimated using discs of turnip tissue and sucrose solutions of different concentrations.
The diagram below shows:

The appearance of the tubers

The places where the tissues were removed



The results are shown in the graph below



Estimate the osmolarity of the near new shoot sample of the old tuber.

[1 mark]

[1 mark]

Question 4b

b)
Explain why the biologist used percentage change in mass rather than the change in actual mass.

[2 marks]

[2 marks]

Question 4c

c)
After analysing the data the biologist came to the following conclusions:

1. The tissue in the old tuber close to the new shoots has the highest osmolarity
2. In the old tuber close to new shoots, starch reserves were being converted to sugar
3. In the old tuber central region, starch was being converted to sugar
4. In the newly formed tuber, all the sugar had been converted to starch.

Evaluate the conclusions made by the biologist based on the evidence collected.

[3 marks]

[3 marks]

Question 4d

d)
Suggest **two** possible sources of error that the biologist may have encountered when collecting the data in this investigation.

[2 marks]

[2 marks]

Question 5a

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

a)
Explain the consequences to impulse transmission if mammalian neurons were to stop performing facilitated diffusion of potassium ions.

[3 marks]

[3 marks]

Question 5b

b)
Outline the effects of putting human heart tissue into a hypotonic solution.

[4 marks]

[4 marks]

Question 5c

c)
Draw a labelled diagram to show the structure of the fluid mosaic structure containing **four different named** proteins.

[7 marks]

[7 marks]