# **Biological Membranes**

## Model Answers 1

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Foundations in Biology
Торіс	Biological Membranes
Booklet	Model Answers 1

Time allowed:	50 minutes
Score:	/37
Percentage:	/100 AISTRY ONLINE
Grade Boundaries:	

A*	А	В	С	D	E
>69%	56%	50%	42%	34%	26%

### **Question 1**

The graph shows the rate of movement of four different substances across a membrane.



The substances shown in the graph are: carbon dioxide, testosterone (a lipid-based hormone), ethanol and sodium ions.

Which of the lines, **A** to **D**, represents the pattern of movement of sodium ions across a membrane?

Sodium ions cross membranes through channel proteins so as the concentration of ions

outside increases, then the rate of movement increases as the gradient is steeper.

However, eventually the rate is limited by the number of channel proteins so it levels off.



An investigation into how a change in sodium chloride concentration effects osmosis in potato cells concluded that the isotonic point of the potato was 0.25 M.

Which of the statements, **A** to **D**, describes what is happening at the isotonic point?

[1]

- A. there is a net movement of water from the sodium chloride solution into the potato cells
- B. there is a net movement of water from the cytoplasm of the potato cells into the sodium chloride solution
- C. there is no movement of water into or out of the potato cell cytoplasm

D. the movement of water into the potato cells is equal to the movement of water out of the potato cells

At equilibrium the rate at which water flows in is the same as that flowing out. It does

not stop moving

## CHEMISTRY ONLINE — TUITION —

### **Question 3**

(a) A student carried out an investigation into the effect of ethanol on the permeability of cell membranes in beetroot.

The student's method comprised the following five steps:

- 1. Cut equal sized pieces of beetroot using a cork borer.
- 2. Wash the pieces in running water.
- 3. Place the pieces in 100 cm<sup>3</sup> of different concentrations of ethanol.
- 4. After 5 minutes, remove samples from each of the ethanol solutions.
- 5. Place each of the samples into a colorimeter to collect quantitative data.
  - (i) Each step in the student's method relies on certain assumptions. [3]

For each assumption listed below, select the **numbered step** from the student's method that relies upon that assumption.

Assumption A

Pigment will only leak into the solution if membranes are disrupted.

Assumption **A** relates to step .....

Assumption **B** 

Absorbance is proportional to concentration of pigment.

Assumption **B** relates to step .....<sup>5</sup>......

Assumption C	
Pigment will be released when the beetroot is sliced.	

Assumption **C** relates to step .....<sup>2</sup>

[2]

- (ii) The student kept the ethanol solutions at a constant temperature. State **two other** variables which need to be controlled in this investigation to ensure the data collected are valid.
  - The variety / age / type of beetroot
  - Surface area / volume of beetroot
  - Pieces taken from the same part of the beetroot These are all control variables and
  - Washing time / pre-treatment should be the same must be kept the same in each
  - Volumes of solution removed investigation as they make it VALID
  - Same pH or use same colorimeter

(b) Fig. 20.1 shows the graph plotted by the student.





(i) Make three criticisms of the way the student has displayed these results.

[3]

[2]

- It should be a line graph
  Line graphs are used for continuous
- The x axis has no units
- It has no title
  data. Missing units and intervals are
- 0.6 is missing on the ethanol concentration

(ii) Explain how carrying out replicates would improve this investigation.

- It allows you to calculate a mean
- Anomalies can be identified
- It improves repeatability
- It allows you to calculate a statistical test

Repeatability means that if you repeat the experiment then you are more likely to get similar results. Having more repeats means this is more likely to happen making the results more

5

#### **Question 4**

The fluid mosaic model describes plasma membranes of all living organisms.

- (a) How does the fluid mosaic model describe the structure of plasma membranes? [2]
  - Membranes consist of a phospholipid bilayer
  - Phosphate heads project out and fatty acid tails face inwards
  - Proteins are free to move (hence fluid)
  - Proteins are scattered randomly about the membrane (mosaic)
- (b) Plasma membranes are partially permeable, allowing some molecules to cross the membrane with relative ease.

One molecule that crosses membranes easily is the steroid hormone progesterone which is produced in the ovaries from cholesterol.

[2]

- Explain why progesterone can move across membranes. (i)
  - Progesterone is fat soluble
  - It can diffuse through the phospholipid bi layer
- (ii) Name one other molecule that can cross plasma membranes. [1]

Water/oxygen/carbon dioxide/ethanol

- (c) Potassium ions are unable to move across membranes as they are charged.
  - State how the structure of the cell surface membrane allows potassium ions to enter or (i) leave a cell. [1]

Channel / carrier proteins

The process of active transport uses ATP to pump potassium ions through the cell (ii) surface membrane against the concentration gradient.

ATP is made up of phosphate groups and two other molecules.



(d) A group of students investigated the effect of temperature on the membranes of beetroot cells.

A colorimeter was used to measure the concentration of purple betalain pigment that leaked out of the cells when they were exposed to different temperatures.

Tempera (°C)	ture	Number of readings	Mean absorbance (arbitrary units)	Standard deviation
0		10	0.04	0.01
10		10	0.04	0.02
20		10	0.04	0.02
30		10	0.06	0.02
40		10	0.09	0.03
50		10	0.21	0.06
60		10	0.44	0.18

Table 23 shows a summary of the data collected.

#### Table 23

(i) Using the Student's *t*-test formula below, calculate the value of *t* between the data for **50**°C and **60**°C.



where: **x** is the mean **S** is the standard deviation **n** is the number of readings . [3]

3.83

The mean at 60°C is 0.44 minus the mean at 50°C which is 0.21 = 0.23

The standard deviation at 60°C is 0.18 and at 50°C is 0.06

Both of these are squared and divided by the number of readings, 10

(ii) The critical value for t at the significance level of 5%, with 18 degrees of freedom, is 2.10.

Use the value of *t* that you calculated in part (i) to explain whether the null hypothesis should be accepted or rejected. [2]

• The value of t is greater than the critical value which is 2.10 so the null hypothesis is

rejected

• The difference between the means is too great and are significant

The null hypothesis states that there is no relationship between two variables. If the results

are significant then they are not due to chance and the original hypothesis is supported.

(e) The students plotted the data onto a graph, shown in Fig. 23.



Fig. 23

Describe and explain the pattern of data shown on the graph as temperature increases.

[3]

- At low temperatures there is little change in absorbance (0°C to 20°C)
- There is little change as the membrane is still intact
- At higher temperatures the absorbance increases (30°C to 60°C)
- More pigment is leaking out as the membrane is damaged creating gaps
- From 30°C to 60°C the absorbance rises from 0.06 to 0.45

The pigment, betalain, it trapped inside the cell membrane and can only leave when the membrane becomes permeable enough. In the actual practical there is a spike in the absorbance above 40°C when the channel proteins in the membrane denature, creating large gaps allowing a dramatic rise in absorbance.

Note this a 'Describe and Explain' so you must give reasons

[Total: 16]

Transmembrane proteins are involved in the transport of sugars across the plasma membrane.

- (a) Glucose can be moved into cells by facilitated diffusion using proteins called GLUT proteins. These proteins expose a single binding site on one side of the membrane. Glucose binds to this site and causes a change in the shape of the protein. This change moves the glucose across the membrane and releases it on the other side.
  - (i) Explain why facilitated diffusion via GLUT proteins requires no metabolic energy.
    - The glucose molecules move down their own concentration gradient
    - The glucose molecules have their own kinetic energy

Channel proteins allow facilitated diffusion whilst carrier proteins carry out active transport

[2]

[1]

(ii) Glucose can also be absorbed by an active process which requires metabolic energy. What is the immediate source of this energy in cells?

ATP

To release its energy ATP is hydrolysed to ADP and Pi

- (iii) Explain why glucose cannot pass through a cell membrane by simple diffusion. [2]
  - Glucose molecules are too large
  - The phospholipid bilayer acts as a barrier

Phospholipid bilayer acts as a barrier to all water-soluble substances. ATP is also polar and soluble in water, not lipids (b) A student investigated the effect of alcohol on the permeability of membranes in plant cells. The student wanted to find the minimum concentration of alcohol at which all the cells became permeable to the stain Evans Blue. Evans Blue stains the nucleus of the cell.

The student followed this method:

- The student placed samples of onion epidermis into different concentrations of ethanol.
- After five minutes a few drops of Evans Blue stain was added to each sample.
- After a further five minutes, the samples were viewed using a light microscope.
- The student observed 20 cells and recorded how many contained a blue nucleus.

**Table 21.1** shows the student's results.

Concentration of ethanol	Number of cells with	% cells with blue	
(%)	a blue nucleus	nucleus	
0	1	5	
10	4	20	
20	16	80	
30	20	100	
40	20	100	
Table 71.1			

#### Table 21.1

(i) Identify one limitation of the method the student followed.

• The volume of ethanol was not given

- The size / source of onion epidermis was not stated
- (ii) On evaluating the results the student decided to use a narrower range of ethanol concentrations.

Suggest what range of ethanol concentrations the student should use and give a reason for your choice.

- Between 20% and 30%
- The lowest concentration must be above 20%

(iii) How would using a narrower range of alcohol concentrations improve the investigation?

[1]

[2]

[1]

They would be more accurate

Remember!!

Accuracy = narrower intervals

Precision = smaller scale of equipment

Repeats = reliability

Validity = control variables