Membrane Transport PPQs

1. Which of the following, **A** to **D**, is **not** an example of cell signalling?

A The hormone insulin being removed from the blood by the glomerulus.
B The neurotransmitter acetylcholine causing depolarisation.
C The hormone prolactin binding to a cell receptor in breast tissue.
D Epithelial cells releasing cytokines in response to histamine.

Your answer ☐ **[1]**

2. Which of the following statements demonstrate that plant cells carry out cell signalling?

1 Plants have cell surface receptors that cause the cells to respond to specific molecules.
2 Binding to receptors at the plasma membrane can change chemical pathways within the cell.
3 Plant cells respond to soluble molecules which can be carried in both the xylem and the phloem.

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐

[1]

3. The hormone ecdysone is synthesised in the prothoracic glands found in the upper thorax of some invertebrates and is released into haemolymph. It is then transported to cells near the surface of the body and causes the loss of the exoskeleton so that a new exoskeleton can form.

Which of the following statements explains how ecdysone is able to act on cells near the surface of the body?

1 Ecdysone is synthesised by specialised neurosecretory cells.

2 Ecdysone is soluble in haemolymph because it is a polar molecule.

3 Ecdysone is complementary to cell surface receptors on cells throughout the body of some invertebrates.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐ **[1]**

4. 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?

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

Your answer ☐ **[1]**

5. Cells require vitamins and minerals in order to function correctly. These vitamins and minerals need to cross the plasma membrane.

Vitamins are either fat soluble or water soluble. Vitamins A, D, E and K are fat soluble.

Which of the following combinations enter a cell by facilitated diffusion?

A vitamin A and calcium ions
B vitamin C and calcium atoms
C vitamin C and calcium ions
D vitamin A and calcium atoms

Your answer ☐

[1]

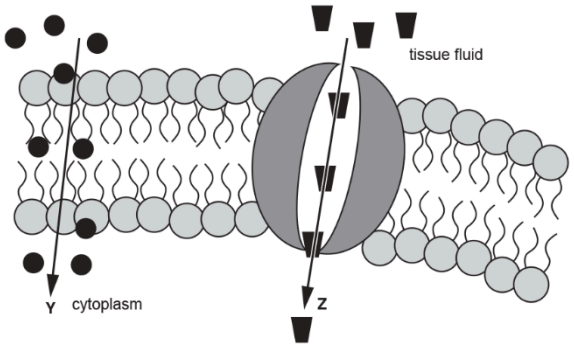
6. Cut pieces of agar jelly can be used to investigate the factors affecting diffusion rates in cells.
Four pieces of agar jelly containing universal indicator were soaked in the same concentration of hydrochloric acid for one minute.
The cubes were then removed and blotted dry.

Which of the following pieces of agar jelly would be the first to turn entirely red?

A a cube with edges 4 cm each
B a cuboid with edges 2 cm, 4 cm and 6 cm
C a cuboid with edges 3 cm, 3 cm and 5 cm
D a sphere with diameter 4

Your answer ☐ **[1]**

7. This diagram shows the transport of two molecules across a plasma membrane.



Which row, **A** to **D**, correctly identifies the molecule being transported **and** the mechanism of transport across the plasma membrane?

	Y	**Z**
A	glucose by active transport	oxygen by diffusion
B	glucose by diffusion	oxygen by active transport
C	oxygen by active transport	glucose by active transport
D	oxygen by diffusion	glucose by diffusion

Your answer ☐ **[1]**

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

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.

[2]

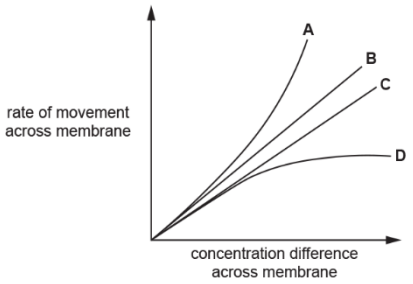
ii. Glucose can also be absorbed by an active process which requires metabolic energy.
What is the immediate source of this energy in cells?

[1]

iii. Explain why glucose cannot pass through a cell membrane by simple diffusion.

[2]

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



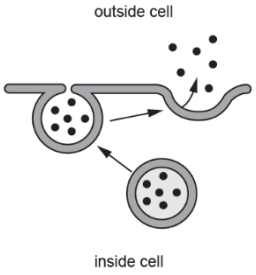
The substances shown in the graph are: carbon dioxide, testosterone (a lipid-based hormone), ethanol and sodium ions.

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

Your answer ☐

[1]

10. The diagram below shows one method of transport across a cell membrane.



Which of the following options, **A** to **D**, is the name of this method of transport?

A cytokinesis
B endocytosis
C exocytosis
D phagocytosis

Your answer ☐ **[1]**

11. Fig. 16.1 shows the results of an osmosis experiment on sections of potato and beetroot. The original mass of each potato section was 4.6 g.

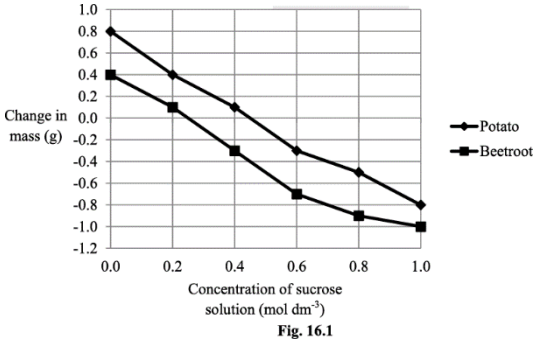


Fig. 16.1

Which option shows the correct percentage change in mass when a potato section was placed in the solution with the highest water potential?

A –17.4%
B 10.8%
C –27.0%
D 17.4%

Your answer ☐

[1]

12(a). *Amoeba proteus* is a single-celled organism that lives in freshwater habitats. Fig. 1.1 is a drawing of *A. proteus*.

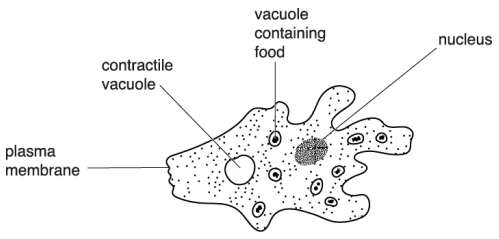


Fig. 1.1

One role of the plasma membrane is to act as a barrier between the cell and its surroundings.

i. Which component of the plasma membrane acts as a barrier to mineral ions entering the cell?

[1]

ii. Describe **two other** roles of membranes in an *Amoeba*.

[2]

(b). Water continually enters an *Amoeba* from its surroundings. The contractile vacuole is an organelle that collects water from inside the cell and expels it from the cell. The contractile vacuole expands as it collects water and then fuses with the plasma membrane to release the water from the cell.

i. Name the process by which water is expelled from the *Amoeba*.

[1]

ii. What would happen to an *Amoeba* if it had no contractile vacuole?

[1]

(c). A student investigated the activity of the contractile vacuole when an *Amoeba* was placed in solutions of different water potential.

The student placed the *Amoeba* in each solution and counted the number of times the

contractile vacuole filled and emptied in the first minute. The results are shown in Table 1.1.

Water potential surrounding *Amoeba* (kPa)	**Number of times the contractile vacuole filled and emptied in the first minute**
0	19
–100	14
–200	9
–300	5
–400	2
–500	0

Table 1.1

Explain why the contractile vacuole emptied more frequently when the water potential surrounding the *Amoeba* was –100 kPa compared to when the water potential was –400 kPa.

[2]

13(a).

A student carried out an investigation into the effect of different concentrations of sucrose on tissue from different vegetables.

Four different vegetables were cut into slices. The slices were placed into solutions containing different concentrations of sucrose. The change in mass of the slices was measured after a set period of time.

The results are shown in Table 20.

Vegetable	Concentration of sucrose (mol dm^{-3})	Mass at start (g)	Mass at end (g)	Change in mass (%)
Potato	0.0	3.56	4.38	23.03
	0.5	4.76	4.81	1.05
	1.0	2.93	2.81	–4.10
	1.5	4.56	3.99	–12.50
	2.0	3.44	2.78	–28.77
Butternut squash	0.0	6.34	6.36	0.32
	0.5	4.32	4.21	–2.55
	1.0	3.54	3.10	–12.43
	1.5	2.98	2.02	–32.21
	2.0	3.77	2.36	–37.40
Swede	0.0	4.01	5.23	30.42
	0.5	5.76	6.34	10.07
	1.0	4.33	4.56	5.31
	1.5	3.98	3.94	–1.01
	2.0	5.09	4.74	–6.88
Parsnip	0.0	6.66	6.69	0.45
	0.5	4.56	4.57	0.22
	1.0	5.67	5.66	–0.18
	1.5	3.99	3.77	–5.51
	2.0	4.81	4.00	–16.84

Table 20

i. The student has made an error with one calculation from the potato samples. Calculate the correct value. Show your working.

Answer = ... **[3]**

ii. Estimate the concentration of sucrose in the cytosol of swede cells.

[1]

iii. What other factor will change as the concentration of the sucrose solutions changes?

[1]

(b). Describe how the student should represent the data from Table 20 as a graph **and** explain why this is the correct way to represent these data.

[3]

(c). Considering the data in Table 20, suggest **three** improvements to the design of this experiment. For each improvement explain how it will increase the validity of the data collected.

improvement 1:

explanation:

improvement 2:

explanation:

improvement 3:

explanation:

[6]

(a). A student investigated the effect of concentration on the rate of diffusion. The student placed identical cubes of agar jelly containing phenolphthalein indicator into hydrochloric acid. Phenolphthalein is pink when alkaline but turns colourless in acidic conditions. The student used a range of concentrations of hydrochloric acid (0.0, 0.1, 0.2, 0.4 and 0.8M) and measured the time taken for the pink colour in the agar to completely disappear using a stop watch. The student carried out three measurements at each acid concentration.

The student's results are recorded in Fig. 19.

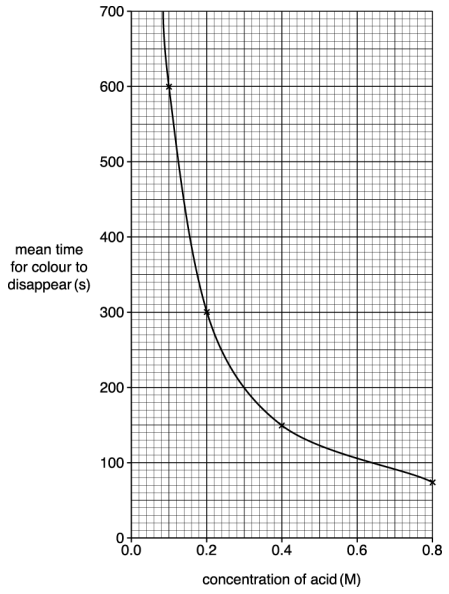


Fig. 19

i. The student was supplied with a solution of 1M hydrochloric acid.

The student decided to make 50 cm^3 of each solution required.

Describe how the student created the concentrations shown using a serial dilution technique.

[3]

ii. Use the graph in Fig. 19 to estimate the expected time taken to completely discolour a block in 0.3M hydrochloric acid.

[1]

iii. The student found it very hard to determine exactly when the colour completely disappeared. The results were not easily repeatable.

Describe and explain how this problem could be displayed quantitatively on the graph.

[2]

iv. The student was using 10 mm agar blocks. The teacher suggested that using larger agar blocks could make the results more easily repeatable.

Explain why using larger agar blocks would make the results more repeatable.

[2]

(b). Another student repeated the experiment using 30 mm agar blocks. However, as the end of the lesson approached the blocks still had large areas of pink colour left. The student modified the method and removed all the blocks from the acid at the same time.

Suggest how the student could use the partly-discoloured blocks to measure the rate of diffusion.

[3]

15. i. Soluble mineral ions are present in soil.

Explain why water molecules can form hydrogen bonds with nitrate (NO_3^-) ions.

[2]

ii. Fig. 18 shows a process that occurs in the cell surface membrane of the endodermis in the root.

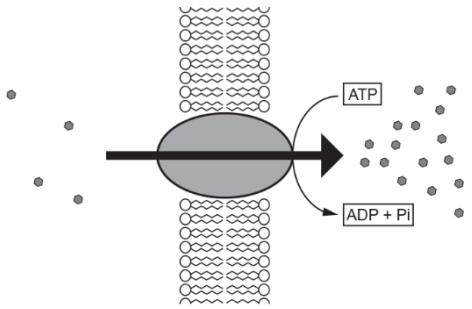


Fig. 18

Explain how the events shown in Fig. 18 cause water to enter the endodermis.

[2]

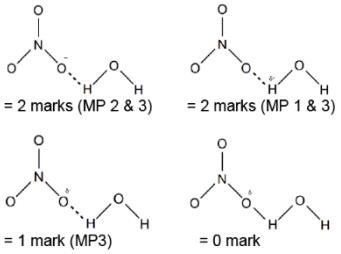
END OF QUESTION PAPER

Mark scheme Membrane Transport PPQs

Question			Answer/Indicative content	Marks	Guidance
1			A ✓	1 (AO2.5)	
			Total	**1**	
2			A ✓	1	
			Total	**1**	
3			C ✓	**1**	**Examiner's Comments** Option **A** provided a distractor and common incorrect response to the correct option **C** in this question, as statement 1 relating to the cells synthesising ecdysone, would not form part of an explanation for the site of action of the hormone.
			Total	**1**	
4			**D** ✓	1	**Examiner's Comments** This questions tests understanding of osmosis. Most candidates gave either C or D as their response. More able candidates realised that there may be some movement of water molecules and that the movement would be equal in both directions – response D.
			Total	**1**	
5			C	1	
			Total	**1**	
6			B	1	
			Total	**1**	
7			**D** ✓	1	**Examiner's Comments** Many candidates selected the correct response, D. A frequent incorrect response was B where candidates possibly felt that the large molecule in the membrane could have been an active transport protein.
			Total	**1**	
8		i	particles have (their own) kinetic energy (1) (movement) down concentration gradient (1)	2	**ALLOW** glucose for particles **ALLOW** from high(er) concentration to low(er) concentration
		ii	ATP	1	**ALLOW** adenosine triphosphate
		iii	phospholipids act as a barrier (1) (glucose) molecules too large (1)	2	**ALLOW** (glucose) not soluble in phospholipid bilayer because of polar –OH groups for 2 marks
			Total	**5**	
9			**D** ✓	1	**Examiner's Comments** This question tests understanding of how substances pass through cell membranes. The more able candidates appreciated that sodium ions would pass through channel proteins. If the number of channel proteins in the membrane is limited then this will eventually limit the rate of movement of the ions.
			Total	**1**	
10			**C** ✓	1	

			Total	**1**	
11			D	1	
			Total	**1**	
12	a	i	phospholipids / phospholipid bilayer;	1	**Mark the first answer.** **IGNORE** cholesterol **DO NOT CREDIT** phosphate / heads **ACCEPT** phospholipid tails / lipid tails / fatty acids
		ii	control what, enters / leaves, the organelles; (contains receptors to) detect changes in environment; compartmentalisation; site for, enzymes / electron carriers / components of metabolic pathways; create concentration gradients; form pseudopodia;	max 2	**Mark the first two answers.** If two correct responses are given followed by one or two incorrect responses or which contradict the correct answers then = **1 or 0 marks** **IGNORE** ref to control of materials entering / leaving cell / ref. to barrier with outside **ACCEPT** cell, communication / signalling / recognition **ACCEPT** separate, organelles/ DNA / food / enzymes, (from cytoplasm) separate organelles from each other formation of, vesicles / vacuoles hold water separate metabolic pathways **IGNORE** ref to increases surface area
	b	i	exocytosis;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **DO NOT CREDIT pinocytosis / pino(exocytosis)**
		ii	burst / lysis / plasma membrane would rupture;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** haemolysis **DO NOT CREDIT** plasmolysis
	c		WP of -100 solution higher than -400 / ORA; (at -100kPa) water potential gradient steeper / described / ORA; (at -100kPa) water enters Amoeba more quickly / ORA;	max 2	**IGNORE** refs to hyper / hypo tonic solutions **ACCEPT –**100 less negative than –400 Note: response must contain clear ref to both –100 solution and –400 solution **ACCEPT** more water enters Note: ref to osmosis being more rapid **only** valid if direction of water movement is clear
			Total	**7**	
13	a	i	*-28.77 is incorrect* -19.19 ✓✓✓	3	**IGNORE** units (would not be written into table) 2 marks **maximum** if answer is not to 2 d.p. (so it is in the same format as the table) If incorrect, **ALLOW** 1 mark for evidence of: $\frac{2.78 - 3.44}{2.78} \times 100$
		ii	(any value from) 1.1 - 1.5 (inclusive) mol dm^{-3} ✓	1	**DO NOT ALLOW** if units not included **ALLOW** any range within this range (inclusive)

		iii	water potential ✓	1	
	b		line graph ✓ (because) both variables are continuous ✓ concentration on *x* / horizontal axis, because it is independent variable **AND** (%) change in mass on *y* / vertical axis, because it is dependent variable ✓ separate line plotted for each vegetable (with key) ✓	3 max	**ALLOW** scatter graph / scattergram
	c		*improvement:* at least, two repeats / three replicates ✓ *explanation:* allows for (named) statistical test / identify anomalies / improves repeatability ✓ *improvement:* more intermediate values (of sucrose solution) ✓ *explanation:* allows trend to be identified more clearly / allows solute concentration of cells to be identified more accurately ✓ *improvement:* keep pieces (of vegetable) the same size ✓ *explanation:* reduces effect of surface area (on osmosis) ✓	6	**ALLOW** reproducibility **ALLOW** stated examples of intermediate values
			Total	**14**	
14	a	i	(use a) 100cm^3 measuring cylinder ✓ mix 80cm^3 acid and 20cm^3 water ✓ take 50cm^3 of the resulting solution and add 50cm^3 water ✓ repeat 50 / 50 dilution for each subsequent solution required / AW ✓	Max 3	**ACCEPT** annotated diagram
		ii	195 – 200 s ✓	1	the unit must be included
		iii	range bars ✓ longer range bar indicates more variability / less repeatable ✓	2	
		iv	longer time taken to discolour ✓ error becomes smaller proportion of total / % error reduced ✓	2	
	b		cut block in half ✓ measure, thickness of colourless region / distance from edge of block to coloured region ✓ divide distance (acid diffused) by time ✓	3	
			Total	**11**	
15		i		**2 max**	*Read answer first; if two marks from written response,* ***IGNORE*** *diagram. If two marks not awarded refer to diagram to find additional mark(s).* **DO NOT ALLOW** water is charged **ALLOW** water has slightly positive / δ^+, H

			water is (a) polar (molecule) ✔ nitrate (ion) / NO_3^-, is, charged / negative ✔ (hydrogen bonds form) between H on water and O on nitrate ✔		**IGNORE** 'δ^- O' if describing water **IGNORE** 'δ^- O' if describing nitrate or on diagram **DO NOT ALLOW** nitrate is polar **IGNORE** solid line for H bond on diagram **NOTE** 'delta plus of water is attracted to negative charge of nitrate' = 2 marks (MP1 and 2) **NOTE** the following examples  = 2 marks (MP 2 & 3) = 2 marks (MP 1 & 3) = 1 mark (MP3) = 0 mark
		ii	solutes / ions / named ion, enter, against concentration gradient / by active transport ✔ reduces water potential of (endodermal) cell(s) ✔ water, moves / diffuses, by osmosis / down water potential gradient ✔	**2 max**	**ALLOW** Ψ for water potential throughout **DO NOT ALLOW** ref to concentration of water in mps 2 or 3 **ALLOW** 'pumped' as AW for active transport **ALLOW** water potential of cell(s) becomes more negative **ALLOW** from high to low water potential **Examiner's Comments** **Q18(c)(ii)** was surprisingly challenging despite the desired responses being fairly straightforward. Good responses clearly indicated that active transport of mineral ions or solutes into the endodermis would lead to water entering by osmosis. A large number of incorrect responses were seen which referred to water being actively transported or water moving down a concentration gradient.
			Total	**4**	