OCR A-LEVEL BIOLOGY A · H420

BIOLOGY



EXAM QUESTION PACK

2.1.5 BIOLOGICAL MEMBRANES

SCORE	PERCENTAGE
/134	%

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Answer **all** the questions.

1. A group of microorganisms called slime moulds includes the species *Dictyostelium discoideum.*

The life cycle of *D. discoideum* is shown in Fig. 5.1.

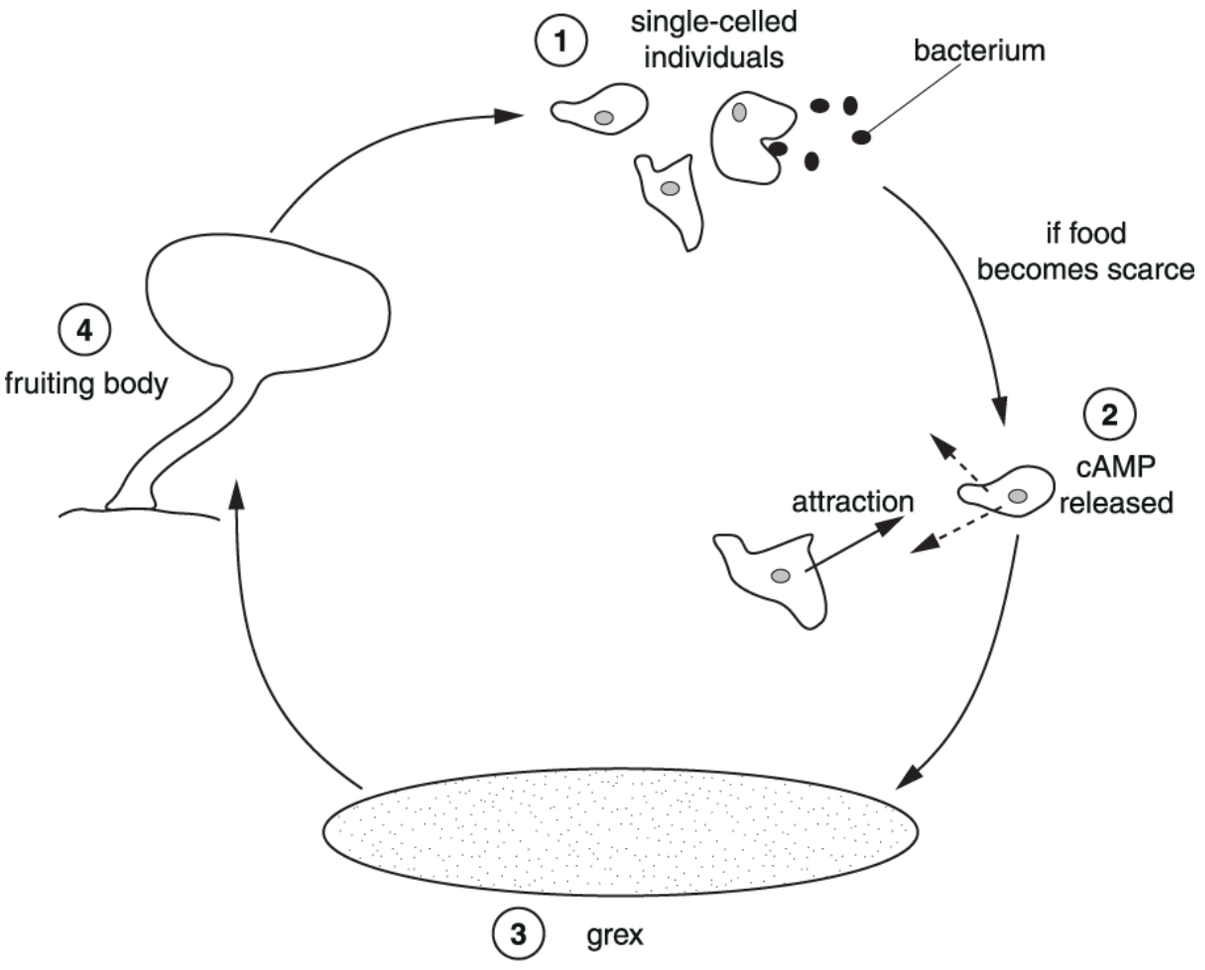


Fig. 5.1

① When plenty of food is available this slime mould exists as single-celled individuals which feed and reproduce asexually.
The slime mould cells feed on bacteria.
The slime mould cells are attracted to folic acid which has been released by the bacteria.
② When food becomes scarce the slime mould cells release a chemical (cAMP) which attracts other slime mould cells.

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③ The slime mould cells then group and stick together to form a multicellular mass called a grex.
The grex moves in a coordinated way in search of a more suitable environment.
As the grex moves, the cells release the chemical DIF. DIF causes some cells to become stalk cells and others to become spore cells.
④ When the grex reaches suitable conditions, it forms a fruiting body consisting of a stalk and spores.
These spores are released and develop into new, individual, slime mould cells.

Communication and cooperation between cells is essential for the survival of *D. discoideum.*

(i) State the correct term for communication between cells.

---

[1]

(ii) Describe **two** examples of communication between cells that occur during the life cycle of *D. discoideum.*

---

[2]

(iii) The plasma membranes of the slime mould cells are specially adapted for communication.

Using the information in Fig. 5.1 and the text below it, as well as your biological knowledge, suggest how the plasma membrane of *D. discoideum* is adapted for cell communication.

---

[2]

2. Translocation occurs through the sieve elements by _____**1**_____ . Sucrose is loaded into the phloem at regions of the plant known as _____**2**_____ . This mechanism is _____**3**_____ . The addition of sucrose _____**4**_____ the water potential of the sieve element sap. This causes water to enter from surrounding tissues by _____**5**_____ which in turn increases the _____**6**_____ of the sap.

Which words correctly complete the numbered gaps **1**–**6**?

	1	**2**	**3**	**4**	**5**	**6**
A	active transport	sources	active	raises	osmosis	concentration
B	mass flow	sources	active	lowers	active transport	pressure
C	mass flow	sinks	passive	raises	diffusion	concentration
D	mass flow	sources	active	lowers	osmosis	pressure

Your answer ☐

[1]

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3. Which of the following is **not** a role of an intracellular membrane?

A cell to cell signalling
B partially permeable barrier
C site of chemical reactions
D transport of substances across the membrane

Your answer ☐

[1]

4. 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.

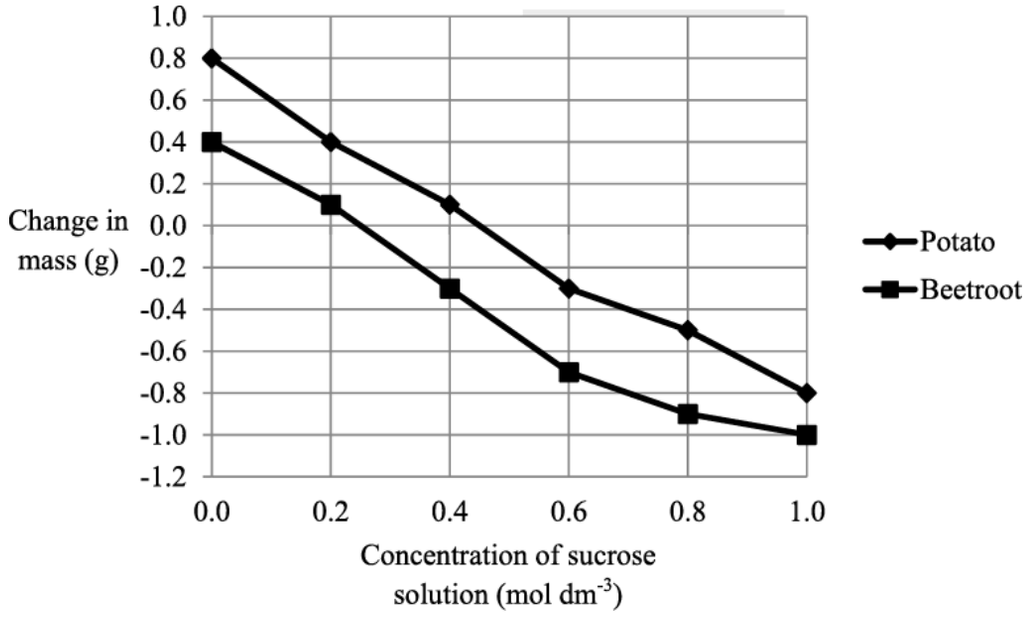


Fig. 16.1

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]

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5(a). Biological processes can be investigated using models.

The effect of cell size on diffusion can be investigated using cubes of agar jelly to represent cells of different sizes.

A student used cubes of agar jelly containing universal indicator, which changes colour at different pH.

- Five different sizes of cubes were cut from a larger block using a scalpel.
- Cubes were placed in a beaker containing hydrochloric acid (enough to cover the cubes) and a stopwatch was started.
- After 2 minutes the cubes were removed, rinsed with distilled water and blotted dry.
- Acid absorbed at the outside continued diffusing towards the centre of the blocks.
- The time taken for the blocks to turn entirely red was recorded.

The results are shown in **Table 22.1 on the insert**.

Cube	Length of one side of agar cube (mm)	Surface area to volume ratio	Time taken to turn red (min)			
			Test 1	Test 2	Test 3	Mean
A	5	1.20	6.4	2.9	5.4	4.9
B	10	0.60	14.8	15.5	14.6	15.0
C	20	0.30	30.6	28.3	27.4	28.8
D	30	0.20	44.1	42.2	43.0	43.1
E	40	0.15	58.7	60.1	57.4	58.7

Table 22.1

What was the role of the universal indicator in this experiment?

---

[1]

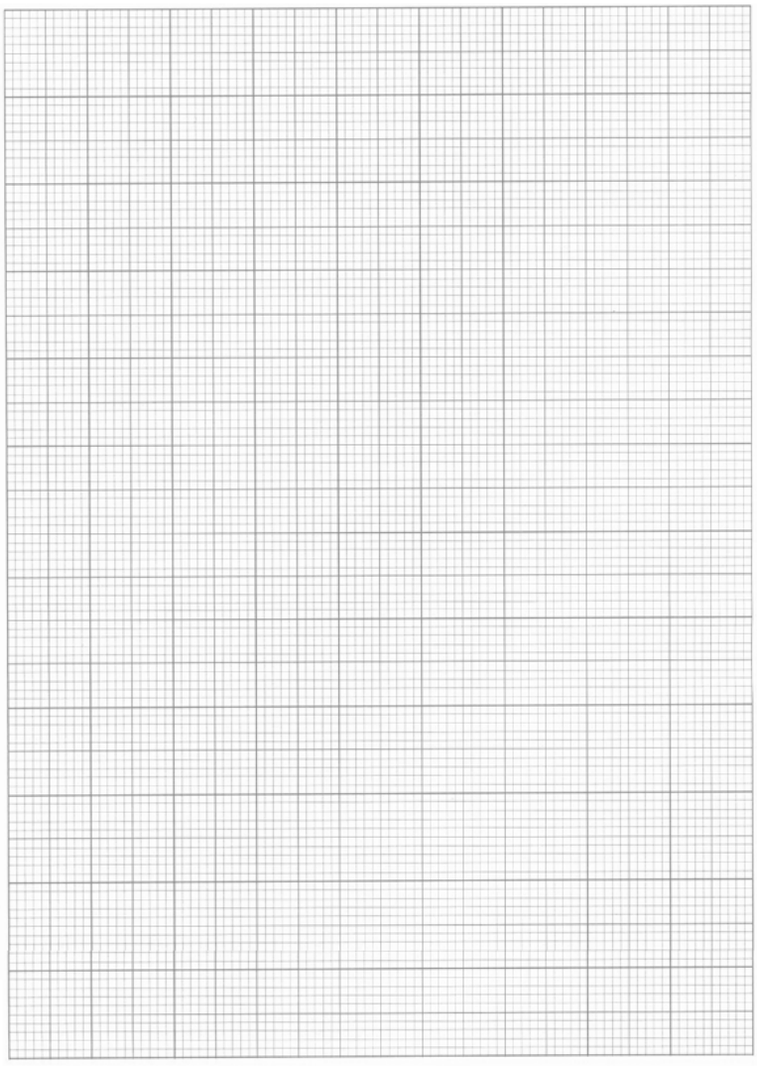
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(b).

(i) In the space provided, plot a graph of mean time taken to turn red against surface area to volume ratio. **[4]**



(ii) Describe the pattern shown by your graph.

---

[1]

(iii) An identical procedure was carried out on a cube of unknown size. This cube turned red after 21.5 min.

Use your graph to estimate the surface area to volume ratio of this unknown cube.

Answer_____ **[1]**

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(iv) Suggest how the original procedure could be modified in order to improve the accuracy of your answer to part **(iii)**.

---

[1]

(c). Use the data in **Table 22.1, on the insert**, to calculate the **rate** of diffusion of acid in **Cube C** from the outer surface to the centre of the cube.

Answer _____ **[3]**

(d).

(i) Explain which of the mean values, **A**–**E**, is likely to be the least accurate. You should process data from the table to support your answer.

---

[2]

(ii) Identify one limitation in the practical procedure that may have caused the results to be inaccurate **and** explain which cube's results are most likely to have been affected by this limitation.

Limitation _____

Is more likely to affect cube ….. because _____

---

[3]

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(e). The procedure described above involved the use of model cells. Hydrogen ions from the acid were able to travel freely to the centre of the agar jelly cubes.

The rate of movement of molecules from the plasma membrane towards the centre of **living** cells is often **greater** than that seen in the procedure the student carried out even if the cells are kept at the same temperature.

Suggest a reason for this observation.

---

[1]

6(a). 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]

(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.

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Table 21.1 shows the student's results.

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

Table 21.1

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

---

[1]

(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.

---

[2]

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

---

[1]

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7. The concept of molecules with complementary shapes can be used to explain many processes in living things.

Lupus is an autoimmune disease. Lupus occurs when nuclear proteins are exposed and the immune system makes antibodies against these proteins. As a result the proteins clump together. These clumps stick to surfaces such as the blood vessel walls and cause fatigue, joint pain and skin rashes.

(i) What is meant by the term *autoimmune disease*?

---

[2]

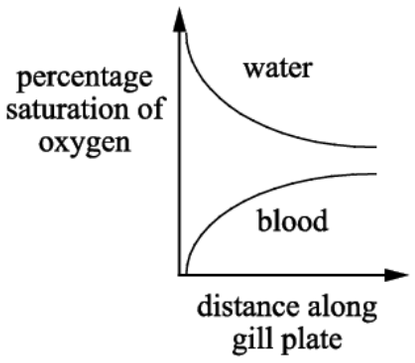
(ii) Suggest why antibodies specific to nuclear proteins are not normally made.

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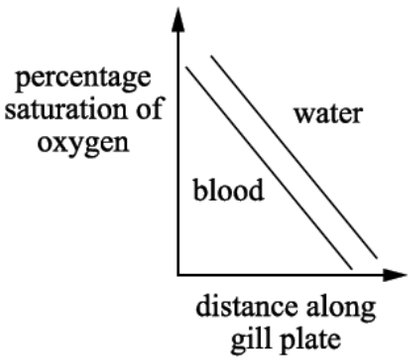
[1]

8. Which graph represents the counter-current exchange system in fish gills?

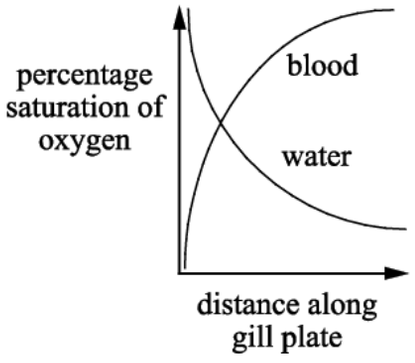
A



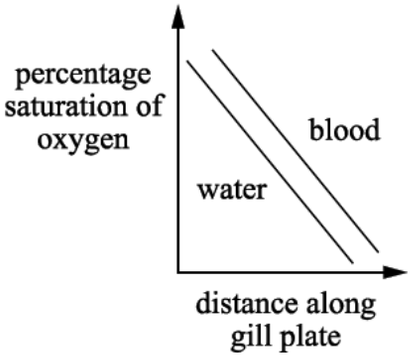
B



C



D



Your answer

[1]

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9. 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]

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10. Phospholipid bilayers play crucial roles within plant cells.

Which of the following statements linked to the importance of membranes in plant cells is / are true?

Statement 1: ATP synthase embedded in thylakoid membranes maintains chemiosmotic gradients.

Statement 2: Phospholipid bilayers within the chloroplast are impermeable to protons.

Statement 3: Thylakoid membranes contain electron transport chain proteins.

A 1, 2 and 3

B Only 1 and 2

C Only 2 and 3

D Only 1

Your answer ☐

[1]

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11. One of the main functions of the liver cells is the formation of urea by the ornithine cycle, an outline of which is shown in **Fig. 17.2**.

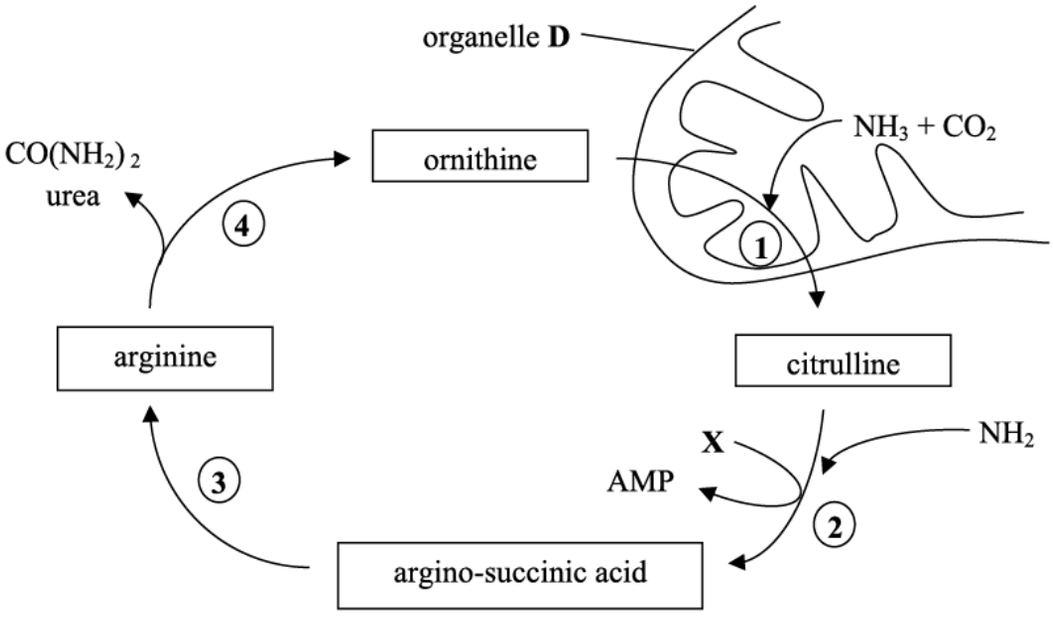


Fig. 17.2

(i) Step **1** of the cycle takes place in the organelle represented by **D**.

Identify organelle **D**.

---

[1]

(ii) During the cycle ornithine moves into organelle **D** and citrulline moves out of the organelle.

Suggest the method by which these molecules move into and out of the organelle during the cycle. Give reasons for your choice.

---

[2]

(iii) How has the ammonia that is used in step **1** been formed?

---

[1]

(iv) Identify the compound labelled **X** in **Fig. 17.2**.

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[1]

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12. Temperature is very important in determining a plant's ability to photosynthesise effectively.
Temperature stress is becoming of great concern to plant physiologists because of climate change.

- High temperature (HT) stress is defined as the rise in temperature that is sufficient to cause irreversible damage to plant growth and development.

Some of the stress effects of temperature have been recorded in various plants and are outlined in **Table 18.1**.

Temperature	Effect
Moderate HT stress	Heat-induced deactivation of RuBisCO No change in chlorophyll fluorescence in PSII Reduction in stomatal aperture
Severe HT stress	Decrease in chlorophyll content as a result of photodeterioration Changes in the ultrastructure of the chloroplast

Table 18.1

(i) Assess the impact of moderate HT stress on the process of photosynthesis.

---**[3]**

(ii) Suggest **two** ways in which the ultrastructure of the chloroplast can be altered by high temperatures.

For each suggestion, explain the effect that it will have on photosynthesis.

Suggestion ---

Explanation ---

Suggestion ---

Explanation ---

---

[4]

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13. During pregnancy, the hormone human chorionic gonadotrophin (hCG) is produced by the placenta. Fig. 16.1 shows how levels of hCG change throughout pregnancy.

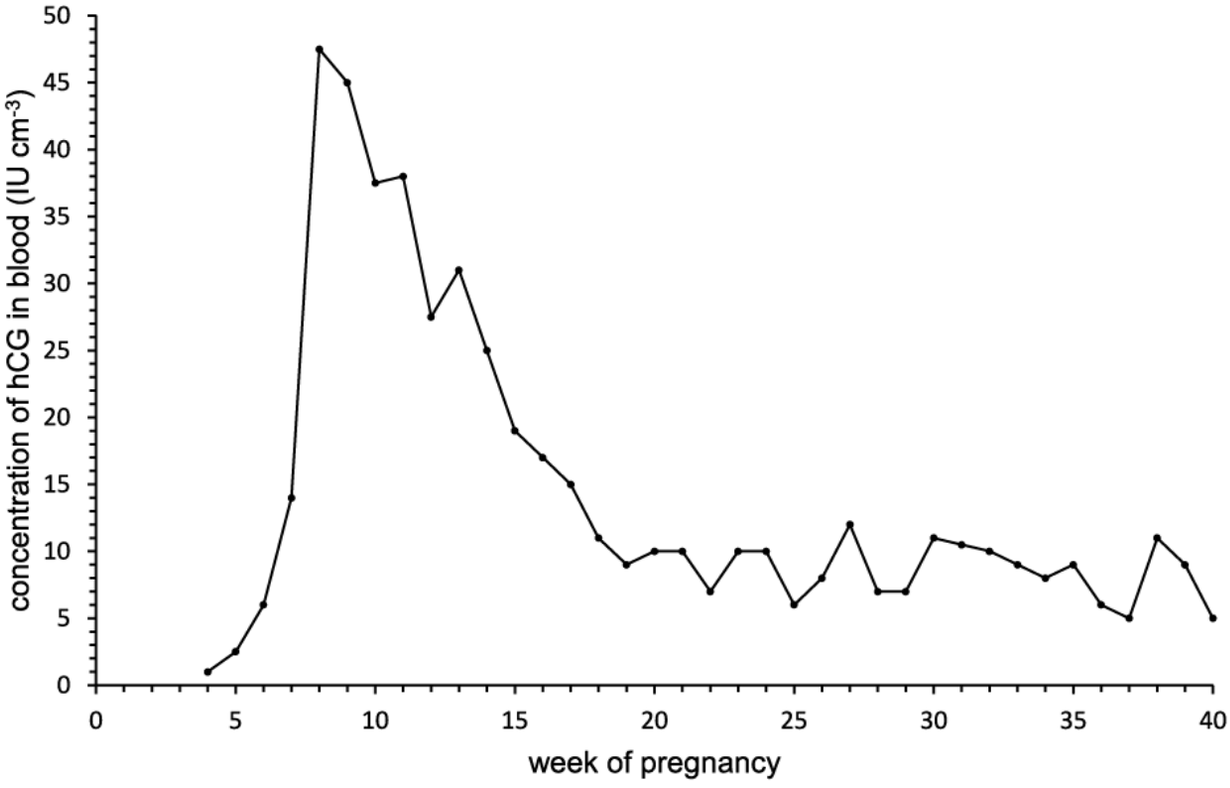


Fig. 16.1

Studies on the effects of hCG in humans have revealed the following information:

- Many different tissues are affected by hCG.
- Susceptible cells have glycoprotein receptors on their cell surface.
- These receptors are complementary to the shape of hCG molecules.

(i) What can be concluded from this information?

---

[3]

(ii) Another hormone produced during pregnancy is oestrogen. Oestrogen is lipid soluble.

Which molecule does oestrogen interact with when it changes cell activity?

---

[1]

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14. Sodium ions and glucose are both reabsorbed into the blood from proximal convoluted tubules (PCTs) in the kidney.

(i) A student designed an experiment to investigate the effect of temperature on the rate of glucose diffusion through dialysis tubing.

State **two** factors that would need to be controlled in this experiment.

1

2

---

[2]

(ii) Describe the structural difference between alpha and beta glucose molecules.

---

[1]

(iii) Sulthiame is a drug that inhibits the enzyme carbonic anhydrase.

Fig. 2.2 shows the role of carbonic anhydrase in the PCT of the kidney.

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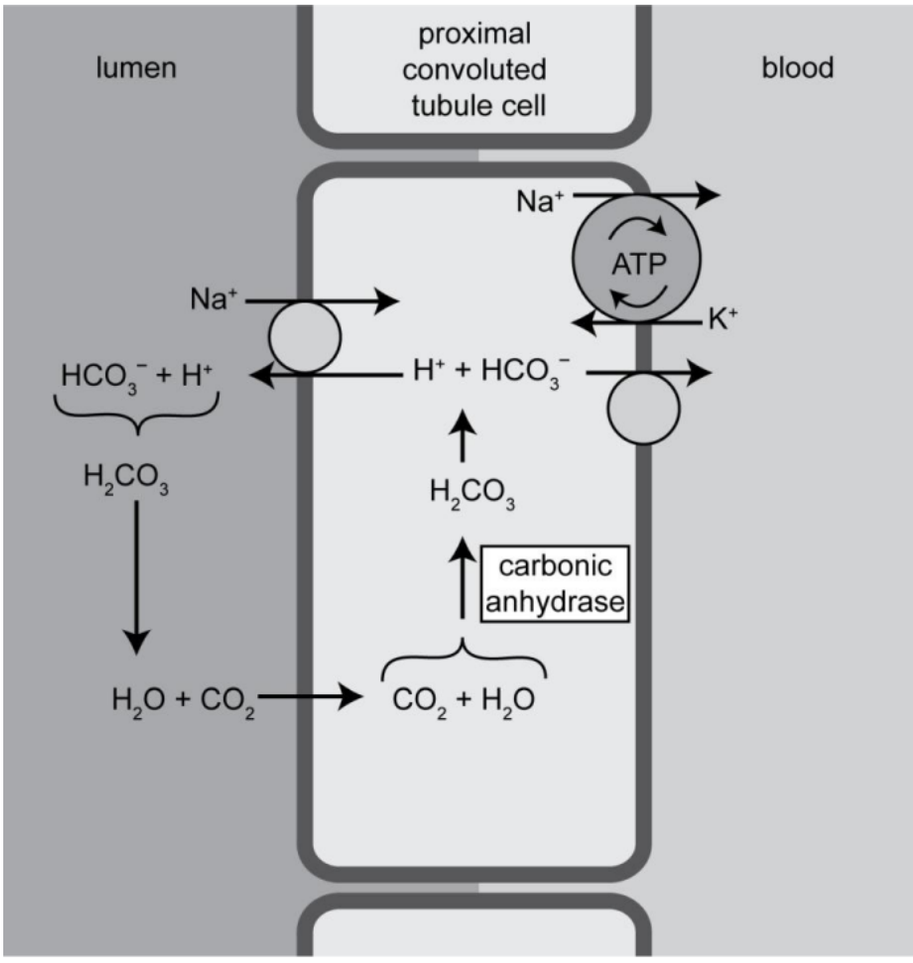


Fig. 2.2

Using the information in Fig. 2.2, what can you conclude about the likely effect of sulthiame on the reabsorption of sodium ions in the PCT?

---

[3]

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15. Heart rate can be increased by the hormone adrenaline, which binds to cardiac cells.

Describe how adrenaline binds to cardiac cells.

---

[2]

16. Milk contains lactose. Lactose cannot be absorbed in the small intestine. The intestinal cells of mammalian infants produce lactase, an enzyme that splits lactose into glucose and galactose. These monosaccharides can pass into the blood.

Fig. 18.1 shows a molecule of the disaccharide lactose and the products of its breakdown in digestion.

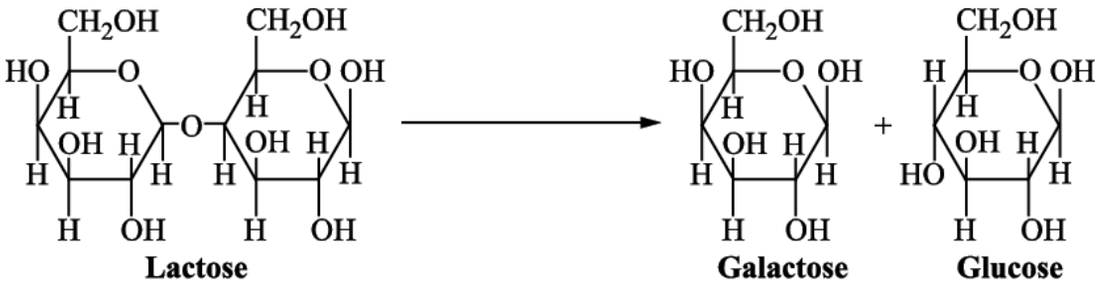


Fig. 18.1

(i) Suggest why galactose and glucose cannot pass through the plasma membrane into intestinal cells by simple diffusion through the phospholipid bi-layer.

---

[1]

(ii) What two substances are required to break the glycosidic bond in lactose?

1

2

---

[1]

17. The MMR injection is actually a combination of three different vaccines.

It protects children against measles, mumps and rubella pathogens.

Explain why it is not possible to protect against the different pathogens using only one vaccine.

---

[3]

18. A student tried to extract some DNA from a crushed banana at home. DNA dissolves in water but the student realised that they needed to add something to break open the nuclear envelope to release the DNA.

Suggest a suitable substance the student could use to release the DNA, **and** explain why it should work.

---

[2]

19. This question is about the impact of potentially harmful chemicals and microorganisms.

(i) Salts that a plant needs, such as nitrates and phosphates, are taken into root hair cells by active transport.

For which macromolecule does a plant need both nitrogen **and** phosphorus?

[1]

(ii) Flooding of fields by seawater can damage crops. Seawater contains dissolved salts, including sodium chloride.

How would flooding affect soil water potential?

[1]

(iii) Sodium chloride in solution dissociates into Na^+ and Cl^-.

Explain how the Casparian strip prevents these ions from reaching the xylem of the plant by the apoplast pathway.

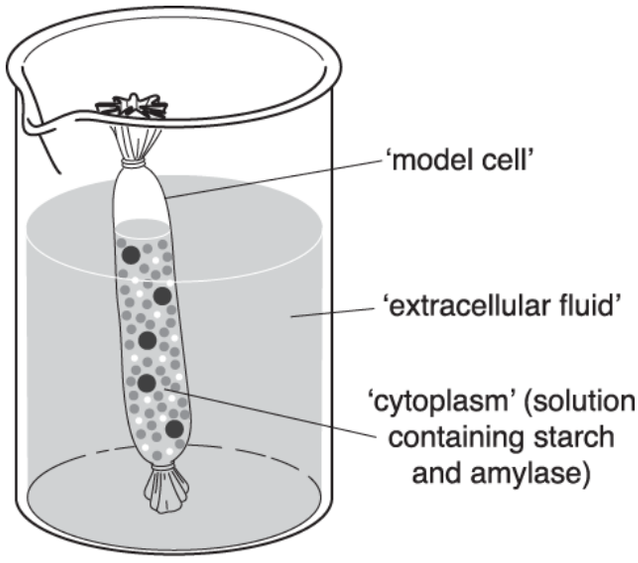
[2]

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20. A group of students were investigating the diffusion of molecules across membranes using a 'model cell', as shown below.



Biochemical tests were used to identify the types of molecules present. The results are shown in the table below.

A tick (☐) represents a positive result.

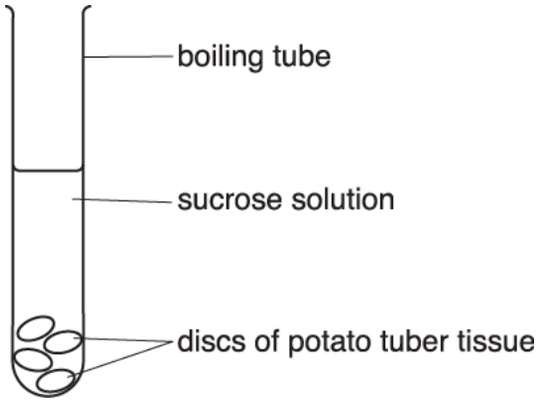
Which of the rows, **A** to **D**, shows the correct results for the 'cytoplasm' at the beginning of the experiment **and** the 'extracellular fluid' at the end of the experiment?

	Benedict's test		**Biuret test**		**Iodine test**	
	'cytoplasm'	'extracellular fluid'	'cytoplasm'	'extracellular fluid'	'cytoplasm'	'extracellular fluid'
A		☐	☐		☐	
B		☐	☐	☐	☐	
C	☐	☐			☐	☐
D	☐		☐		☐	

Your answer ☐

[1]

21(a). The figure shows some of the apparatus used in an experiment investigating water potential in potato tuber tissue.



The discs were placed in boiling tubes containing sucrose solutions of different concentrations for four hours. The percentage change of mass was then calculated.

The results are shown in the table.

Concentration of sucrose solution (mol dm^{-3})	**Change in mass of potato discs (%)**
0.00	+18.00
0.10	+12.50
0.20	+2.50
0.30	− 3.00
0.40	− 8.00
0.45	−11.50

(i) State **two** details of the procedure that must be followed to obtain valid results.

1

2

---

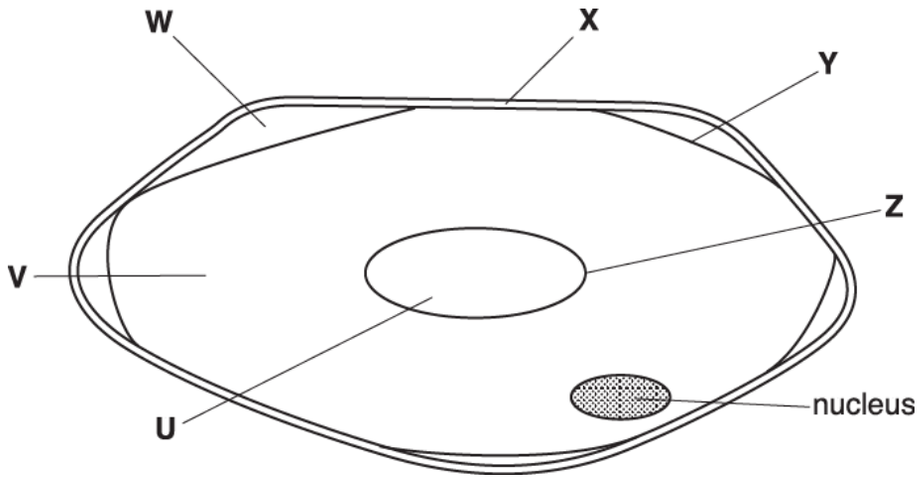
[2]

(ii) Explain how a student could use the data in the table to determine the water potential of the potato tuber tissue.

---

[3]

(b). The figure shows a diagram of a cell from a potato tuber disc that was placed in 0.45 mol dm^{-3} sucrose solution.



(i) Identify the parts of the cell labelled **X**, **Y** and **Z**.

X _____

Y _____

Z _____

[3]

(ii) What will be found at **W** in the immersed cell?

_____ **[1]**

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

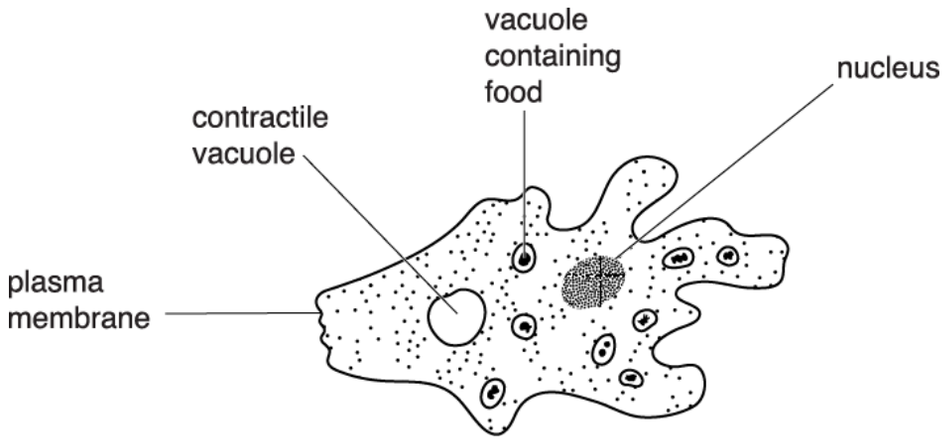


Fig. 1.1

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]

23(a). Describe the structure of a plasma (cell surface) membrane.

---

[3]

(b). A student investigated the movement of substances through the cell surface membrane of yeast cells using an indicator.

- The student was supplied with a suspension of yeast cells in a slightly alkaline solution.
- The indicator used is yellow in alkaline conditions but turns red in acidic conditions.

The student mixed the indicator with the yeast suspension and labelled the tube containing this suspension **A**. The suspension was red/pink in colour.

(i) The student took a small sample from tube **A** and centrifuged this sample.

After centrifuging, the student observed that the liquid portion was colourless but the cells at the bottom were red/pink.

Suggest the mechanism by which the indicator enters the cells and suggest the component of the membrane involved.

mechanism _____

component _____

[2]

(ii) The student took a small sample from suspension **A** and added alkaline ammonia solution. There was no colour change.

What could the student conclude about the permeability of the yeast plasma membrane?

---

[1]

(iii) The student then took another sample from suspension **A** and boiled it. When this boiled suspension was centrifuged the liquid portion was yellow and the cells at the bottom were red/pink.

The student suggested that the liquid in the suspension was yellow because boiling the yeast had damaged the plasma membrane, allowing the indicator out of the cells.

Describe the effect of high temperature on the structure of the yeast cell membranes.



In your answer you should use appropriate technical terms, spelled correctly.

---

[4]

24. This question considers some similarities and differences in plant and animal biology.

(i) Describe two **similarities** in the action of plant and animal hormones **in cell signalling**.

1 _____

_____

_____

2 _____

_____

_____ **[2]**

(ii) Asexual reproduction and the ability to produce natural reproductive clones is common in plants but rare in animals.

Explain why plants are more able to form **natural** reproductive clones than animals.

_____

_____

_____

_____

_____

_____

_____ **[2]**

(iii) Polyploidy is the possession of more than two sets of chromosomes in the nucleus.
Polyploidy is common in plants.

Suggest an explanation for the significance of polyploidy in forming new species of plant such as bread wheat, *Triticum aestivum*.

_____

_____

_____

_____

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---**[2]**

25(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.

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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:

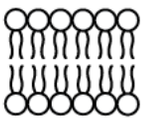
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[6]

26. When interpreting the results of an experiment to investigate the effect of detergent on plasma membranes, a student looked for a diagram to show what the phospholipids may look like in the presence of detergent.

Which of the diagrams, **A** to **D**, should the student use?

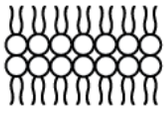
A



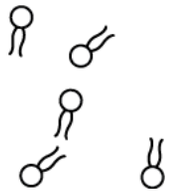
B



C



D



Your answer

[1]

27(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.

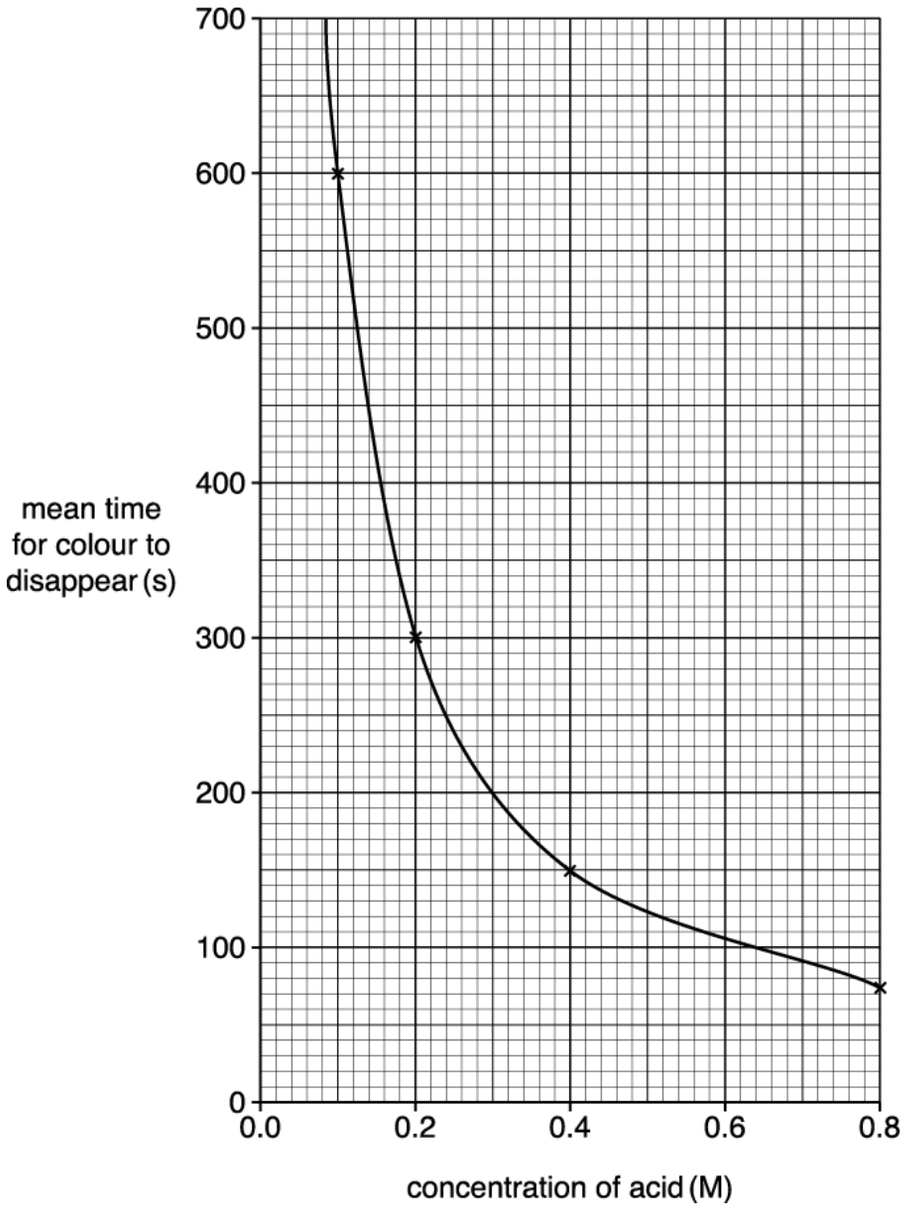


Fig. 19

(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.

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[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]

END OF QUESTION PAPER

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Question			Answer/Indicative content	Marks	Guidance
1		i	cell signalling ;	1	**Examiner's Comments** Most candidates gave the correct term for communication between cells.
		ii	1 attraction of cell(s) to folic acid from bacteria ; 2 attraction of cells to each other by cAMP ; 3 coordinated movement in grex ; 4 differentiation / described, of (grex / slime mould) cells in response to DIF ;	2 max	**NOTE** must name the chemical involved for description (except mp 3 coordinated movement) **ACCEPT** attraction of cells to bacteria by folic acid **IGNORE** makes cells stick together **Examiner's Comments** Most candidates could identify two stages in the life cycle where cell signalling takes place. In this case describing an example of cell signalling needed both the name of the signalling molecule and the response it produced in the receiving cells. A good number of candidates did not manage to provide this level of detail and candidates must be trained to understand that the command word 'describe' does require a reasonable level of detail in the response. Well-trained candidates were able to give full descriptions in clear and succinctly worded responses.
		iii	contains , receptors / glycoproteins / glycolipids / glycocalyx ; for , folic acid / cAMP / DIF ;	2	**DO NOT CREDIT** *consists* of receptors **Examiner's Comments** Most candidates appreciated that a cell surface membrane adapted for cell signalling would contain receptor molecules. Fewer candidates were able to specify that the receptor molecules must be specific to one of the named molecules used for cell signalling by the slime mould cells.
			Total	**5**	
2			D	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
3			A	1	
			Total	**1**	
4			D	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
5	a		detect the presence of acid / H^+ (1) measure end-point / dependent variable (1)	1	
	b	i	surface area to volume ratio on x-axis **and** time on y-axis (1) plotted points occupy at least half of available area **and** linear scale on both axes **and** line of best fit drawn (1) axes labelled time (min) **and** surface area to volume ratio / AW (1) all points plotted correctly (to +/– half a 2 mm grid square) (1)	4	 **DO NOT ALLOW** if units given for x-axis **ALLOW** ecf for correctly plotted points on incorrectly-scaled graph
		ii	time taken for diffusion (to centre of cube), increases as surface area to volume ratio decreases, ORA	1	Answer must mention surface area to volume ratio **DO NOT ALLOW** if colour change is discussed in place of diffusion **IGNORE** rate **ALLOW** a description consistent with the graph the candidate has drawn
		iii	0.44	1	**ALLOW** answer in the range of 0.40 – 0.48 depending on candidate's plotted graph Answer must be reported to 2 decimal places
		iv	test cubes of (known) length between 10 and 20 mm	1	
	c		0.35 / 0.347 (1) (1) mm min^{-1}	3	**ALLOW** 0.69 / 0.694 for 1 mark **ALLOW** 0.3 or 0.3472 for 1 mark **ALLOW** mm/min
	d	i	*cube **A**, because…* time for test 2 different from others (1) use of processed figures to support (1)	2	 **ALLOW** calculated rates for cube **A** - **E** **ALLOW** calculated range compared with that of cubes **B** - **E**

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Question			Answer/Indicative content	Marks	Guidance
		ii	*Limitation* inconsistency in surface area (1) cube **A** (1) *Because* It is the smallest cube so small error in cutting will have proportionately larger effect in a small cube / *idea that* error is a bigger proportion of total time (1) *Limitation* using human eye and judgement to determine end point (1) cube **E** (1) *Because* largest cube so harder to see through 2cm of jelly / AW (1)	3	**ALLOW** mark only if one of the other two marks is awarded **ALLOW** mark only if one of the other two marks is awarded
	e		*idea of* involvement of cytoskeleton / vesicles (1)	1	**IGNORE** reference to different diffusion resistance
			Total	**17**	
6	a	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
	b	i	*one from* volume of ethanol not given (1) same onion / size of onion epidermis / position of epidermis in onion not stated (1)		
		ii	20–30% (1) lowest concentration must be between 20 and 30% (1)	2	*idea that* 100% blue nuclei is not reached at 20% but is reached at 30%
		iii	*idea of* more accurate determination of permeability	1	
			Total	**9**	

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Question			Answer/Indicative content	Marks	Guidance
7		i	abnormal immune response (1) against tissues normally in the body (1)	2	
		ii	nuclear proteins normally, hidden in nucleus / not exposed to tissue fluids (1)	1	
			Total	**3**	
8			B	1	
			Total	**1**	
9			C	1	
			Total	**1**	
10			C	1	
			Total	**1**	
11		i	mitochondrion	1	**ALLOW** mitochondria.
		ii	*either* facilitated diffusion (1) conversion of ornithine into citrulline creates concentration gradients **or** (molecules are not lipid soluble so) require protein channels to cross membrane (1) ***or*** active transport (1) ornithine and citrulline need to be moved into and out of **D** more quickly than would be met by diffusion (1)	2	
		iii	deamination / removal of NH_2 group from amino acid (1)	1	
		iv	ATP (1)	1	
			Total	**5**	

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Question			Answer/Indicative content	Marks	Guidance
12		i	deactivation of RuBisCO will reduce, carbon dioxide fixation / light independent reaction (1) the light dependent reaction will reduce when the supply of NADP is reduced (1) reduction in stomatal aperture will reduce carbon dioxide available for fixation (1)	3	
		ii	*four from* damage to chlorophyll / reduction in pigment (1) which will reduce the light dependent stage (1) damage to membranes in chloroplast / reduction in sites for light capture (1) which will reduce the light dependent stage (1) damage to membranes in chloroplast / reduction in reaction sites for electron transfer (1) which will reduce, photophosphorylation / ATP production in the light dependent stage (1) damage to membrane around chloroplast / release of enzymes (1) which will reduce, light independent stage / Calvin cycle (1)	4	**Award 1 mark for the alteration of the ultrastructure (max 2) and 1 further mark for details of its effect on photosynthesis (max 2).**
			Total	**7**	
13		i	(hCG is a) peptide hormone / hCG is not a lipid-based hormone (1) (hCG) binds to cell surface receptor (1) *idea that* cell signalling is involved in action of hCG (1) (hCG) uses cAMP / second messenger, to bring about response in cell (1)	3	
		ii	DNA / deoxyribonucleic acid	1	**ALLOW** transcription(al) factor / repressor protein **DO NOT ALLOW** RNA / histone / DNA polymerase
			Total	**4**	

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Question			Answer/Indicative content	Marks	Guidance
14		i	initial / AW, glucose concentration (on both sides on the membrane) (1) volume of solution (1) length / diameter, of dialysis tubing (1) type / brand, of dialysis tubing (1)	2	
		ii	*alpha glucose* H above ring / OH below ring, on, carbon 1 / C1 **ORA** (1)	1	**ALLOW** a suitable annotated diagram
		iii	*(less reabsorption because)* *idea of* fewer H^+ ions in PCT cells (1) less / no, co-transport / facilitated diffusion, of Na^+ ions, into cells / from lumen (1) less / no, active transport of Na^+ ions into, blood (1)	3	
			Total	**6**	
15			(binds to) receptor in, cell surface / plasma, membrane (1) glycoprotein (1)	2	
			Total	**2**	
16		i	too large / not fat soluble	1	**IGNORE** 'no channels'
		ii	water / H_2O, **and**, lactase / enzyme	1	**Mark the first two answers.** If they are correct and any other word is written that is incorrect or contradicts the correct answer then **0 marks.** **DO NOT ALLOW** H_2O with incorrect case or subscript **IGNORE** refs to pH, buffers, hydrocarbonate etc.
			Total	**2**	
17			*two from* different pathogens have different antigens (1) antigens have specific shape (1) shape of antibody must be complementary to (specific) antigen (1) *any of the above linked to* different antibody needed for each pathogen (1)	3	
			Total	**3**	

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Question			Answer/Indicative content	Marks	Guidance
18			detergent (1) works as an emulsifier / attracts phospholipid molecules and water molecules (1) it will break up the plasma / nuclear membranes (1)	2	
			Total	**2**	
19		i	DNA / RNA / nucleic acid	1	
		ii	lower / reduce / make more negative	1	
		iii	*two from* **1** strip is impervious to, water / solutions (1) **2** forces water / solutions, to pass through, plasma / cell surface, membrane (1) **3** phospholipid (bilayer), repels / AW, ions / charged particles (1)	2	**1 IGNORE** ref to suberin. **3** The idea of charge / ion impermeability is wanted here. **ALLOW** answer in terms of ions / charged particles needing channels because phospholipid bilayer does not allow charged particles through.
			Total	**4**	
20			A	1	**Examiner's Comments** Candidates had a lot to process in this question. They not only had to consider the implications of the test results but also to relate these to the 'cytoplasm' at the start and the 'extracellular fluid' at the end and then to work out what they would have expected to happen in the given scenario. Practical work that they had carried out would have been of considerable help here, but with so much having to be assimilated, drawing on various aspects of the specification, it is not unexpected that candidates found this to be a challenging question. Many candidates failed to appreciate that the enzyme is a protein.
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
21	a	i	1 discs same, size / thickness / surface area / surface area to volume ratio / diameter ☐ 2 same (variety / part, of) potato ☐ 3 no skin on potato ☐ 4 *ref to* removing excess water before (re)weighing ☐ 5 same, number / amount, of discs (in each solution) ☐ 6 same volume (sucrose) solution ☐ 7 same temperature ☐ 8 cover the tubes ☐	max 2	*Mark first **two** answers only, ignoring the numbered sections* **IGNORE** mass / balance used / soak time / repeats **IGNORE** a list of variables unqualified 1 **ACCEPT** same cork borer used **ACCEPT** 'pieces of potato' etc. for 'discs' **ACCEPT** 'length' as equivalent to 'diameter' **IGNORE** same shape/similar size etc 4 e.g. blotting / shaking 7 **ACCEPT** in context of room / environment / solution **Examiner's Comments** This question was relatively well answered but many candidates stated soak time as a factor, despite the question specifying four hours. Some candidates correctly named the variable but failed to keep it the same. A significant number of students did not appreciate that the question referred to the **validity** of the results and gave responses relating to ensuring the accuracy or reliability of results, e.g. using suitable measuring equipment for the volumes or to doing repeats. Candidates did not always use the term volume rather than 'amount', or refer to the discs rather than just the potato tuber.

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Question	Answer/Indicative content	Marks	Guidance
ii	1 *idea that* no change of mass occurs when the water potential of (sucrose) solution = water potential of potato (tissue) ☐ 2 ref. to no change in mass (of potato) between 0.2 and 0.3 mol dm^{-3} ☐ 3 plot graph of concentration of, sucrose / solution, against (%) change in mass **and** find which (sucrose) concentration gives no change in mass of potato **OR** carry out the experiment again with more (sucrose) concentration intervals between 0.2 and 0.3 mol dm^{-3} ☐ 4 look up the water potential of the (sucrose) solution (e.g. on calibration curve or table), of that concentration / of the concentration which gives no mass change ☐	max 3	**ACCEPT** Ψ for water potential throughout **IGNORE** ref to solute potential / isontonic 2 correct units must be stated once **ACCEPT** 'between 0.2 and 0.3 mol dm^{-3} the water potential of the solution and the potato will be the same' 3 x and y axes interchangeable When an axis has been identified it can be referred to by letter later. Needs some ref to the mass change being 0. If the change in mass axis has previously been identified, then ref to that axis value being 0 is equivalent to no change in mass e.g. '*Should draw a graph of sucrose concentration on the x axis and change in mass of potato discs on the y axis. The point where the line of best fit crosses the x axis (when the y axis = 0) is the concentration of sucrose in the potato discs.*' will get the mark '*Draw a graph with change in mass of potato discs on the y axis and concentration of sucrose solution on the x axis and draw a line of best fit. Where the line intercepts the x axis is where the change in mass of potato discs is zero.*' will get the mark 3 correct units must be stated once **Examiner's Comments** Most candidates did not read the question carefully enough and just described why the discs gained or lost mass in the various sucrose solutions. Typically they gave statements such as 'when the increase in mass is high then the water potential of the solution is higher than in the potato and

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Question			Answer/Indicative content	Marks	Guidance
					when mass is lost the water potential of the solution is lower'. There was no indication they understood that the water potential of the potato tissue could be quantified from the results or the significance of the sucrose concentration where no mass change occurred. Several candidates appreciated that the mass difference changed from positive to negative between two stated sucrose solution concentrations, but did not develop the idea further. Candidates who, presumably, had done this as a practical exercise or had analysed similar data, knew that a graph of the results would yield an estimate but most of these said that the water potential could be obtained directly from the point where the line of best fit crossed the zero mass value (rather than the equivalent sucrose concentration).
	b	i	X (cellulose) cell wall ☐ Y cell surface membrane / plasma membrane ☐ Z vacuole membrane / tonoplast ☐	max 3	*If additional incorrect answer given, then 0 marks* Y **ACCEPT** plasmalemma Z **IGNORE** vacuole **Examiner's Comments** Almost all candidates correctly identified X as the cell wall. Few however went on to gain both of the other marks. The vast majority of candidates knew Y was the 'cell membrane' but failed to use the correct A Level terminology of cell surface membrane or plasma membrane. Z was typically identified as the vacuole rather than the vacuole membrane, although label line U was to the vacuole. Some candidates thought the label line pointed to the nuclear membrane, despite the nucleus being clearly labelled.

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Question			Answer/Indicative content	Marks	Guidance
		ii	sucrose solution □	1	*If additional incorrect answer given, then 0 marks* **ACCEPT** sugar solution / external solution / solution placed in **DO NOT CREDIT** 'solution' unqualified **Examiner's Comments** It seems that the majority of candidates did not appreciate that the cell wall is fully permeable and so sucrose solution would therefore enter the space at W. Typical wrong responses were water/air/nothing.
			Total	**9**	

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Question			Answer/Indicative content	Marks	Guidance
22	a	i	phospholipids / phospholipid bilayer;	1	**Mark the first answer.** **IGNORE** cholesterol **DO NOT CREDIT** phosphate / heads **ACCEPT** phospholipid tails / lipid tails / fatty acids **Examiner's Comments** This question asked what component of the membrane would act as a barrier to movement of mineral ions – most candidates knew that the phospholipid bilayer would prevent movement of ions but a significant minority apparently misread the question and gave the answer as ‘protein channels’.

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Question			Answer/Indicative content	Marks	Guidance
		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 **Examiner's Comments** Many candidates had not read the question sufficiently carefully and responded by restating the stem of the question. No mark was awarded for describing anything to do with the plasma membrane acting as a barrier between the cell and its surroundings. It is apparent that many candidates do not consider the roles of membranes within cells and concentrate only on the roles of the plasma membrane. However, candidates still gained marks for the ideas of compartmentalisation and cell signalling.
	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)** **Examiner's Comments** Most candidates correctly named the process as exocytosis. The most common error was to name it as ‘osmosis’.

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Question			Answer/Indicative content	Marks	Guidance
		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 **Examiner's Comments** Most candidates knew that the cell would burst although a good number thought that an animal cell could become turgid and some confused this with 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 **Examiner's Comments** This question caused confusion for some candidates. Many weaker candidates simply described the process of osmosis to explain why water entered the Amoeba without attempting to explain why more water would enter at the higher water potential. Some candidates described water moving into the vacuole rather than into the cell from its surrounding, while others had osmosis causing water to leave the cell despite the contractile vacuole performing that function several times a minute. It was pleasing to see that stronger candidates did have a good grasp of the concepts and were able to explain why the contractile vacuole had to empty more frequently very clearly and succinctly.
			Total	**7**	

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Question			Answer/Indicative content	Marks	Guidance
23	a		phospholipid bilayer containing proteins; head / hydrophilic region, facing outwards **OR** tail / hydrophobic region, facing inwards; ref to intrinsic **and** extrinsic (glyco)proteins / described; *idea of*: glycoproteins / glycolipids, sticking out (of bilayer / membrane); cholesterol, inside bilayer / between phospholipids;	3 max	**Marks can be awarded for an annotated diagram** **IGNORE** ref to 'fluid mosaic model' **ACCEPT** glycoprotein / channel protein / carrier protein / etc. for protein **DO NOT CREDIT** ref to hyrophobic heads or hydrophillic tails **ACCEPT** transmembrane for intrinsic **and** on surface for extrinsic **IGNORE** ref to functions such as 'carrier / channel' etc. **IGNORE** glycoproteins / glycolipids are, extrinsic / on the outside / on surface **CREDIT** between fatty acid tails **Examiner's Comments** The level of difficulty in this question was generally considered to be appropriate and candidates performed well. However, where the knowledge had to be applied in an unfamiliar context candidates performed less well. The majority of candidates had a fairly good idea of the structure of the plasma membrane but it was obvious that many had not read the question or fully understood what was required. Many candidates churned out a rote-learned response about the functions of the components of the membrane without actually describing in detail the structure of the membrane – ie: how the positions of the various components actually relate to one another. Some candidates used diagrams but these were generally poorly annotated, if at all, and so gained little credit. Almost all candidates gained credit for noting that the phospholipids are found in a bilayer which also contains proteins. More able candidates correctly used the terms hydrophobic and hydrophilic in reference to the parts of the phospholipids but often failed to correctly describe their

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Question			Answer/Indicative content	Marks	Guidance
					orientation in the membrane. Quite a few candidates used the terms intrinsic and extrinsic in reference to proteins but those attempting to describe the position of the proteins in the membrane often gave muddled answers and failed to gain credit. This was often confused by attempts to give the functions of the proteins which were not required. Many candidates discussed the functions of cholesterol, glycoproteins and glycolipids but again failed to fully describe their position in the membrane structure.
	b	i	<u>active</u> transport / uptake; (transport / carrier) protein;	2	**Mark the first answer on each prompt line.** If the answer is correct and a further answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** intrinsic protein / transmembrane protein **DO NOT CREDIT** channel protein / extrinsic protein **Examiner's Comments** It was important that candidates read and understood the information given in the question. The majority of candidates gave the answer ‘facilitated diffusion’. However, since the liquid portion of the solution was colourless after centrifugation all the indicator must have entered the cells. Therefore, the only correct response must be active transport. Those candidates who realised it was active transport also achieved the second point.

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Question			Answer/Indicative content	Marks	Guidance
		ii	not permeable to, ammonia / NH_3 / ammonium / NH^+_4;	1	Response must be specific to permeability to ammonia **CREDIT** ammonia cannot pass through membrane **ACCEPT** selectively permeable so does not allow passage of ammonia (into the cells) **IGNORE** 'selectively / partially, permeable' unqualified **IGNORE** 'not permeable to alkalis' **Examiner's Comments** Many candidates referred to the membrane being 'partially permeable' or 'selectively permeable' which is correct, but does not fully answer the question. Since the test refers to ammonia solution the student can only conclude something about the permeability to ammonia or ammonium ions. Only the most able candidates gave the correct response – that the membrane is impermeable to ammonia or ammonium ions.
		iii	**phospholipids** / (named) molecules, vibrate more / move around more / have more **kinetic energy**; increases, size / number, of gaps, in membrane / between phospholipids; **bilayer**, becomes more fluid / melts; proteins / glycoproteins, **denatured**; **max 3** **QWC**; **max 1**	4 max	**IGNORE** refs to increase in permeability / leaky as the question asks about structure not properties **CREDIT** creates gaps in membrane **ACCEPT** holes for gaps **IGNORE** ref to pores, ref to gaps created by proteins denaturing **IGNORE** membrane / phospholipids become more fluid **ACCEPT** description of denaturing e.g. 30 shape / tertiary structure, changes **IGNORE** enzymes denature , ref to active site Any **two** technical terms from the list below used appropriately and spelled correctly : **phospholipid(s) bilayer** **kinetic energy** (ref to molecules - do not

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Question			Answer/Indicative content	Marks	Guidance
					credit in ref to membrane or cell) **denature(d)** (must refer to proteins or glycoproteins) **Examiner's Comments** Most candidates have a good idea about the effects of high temperature on the structure of the membrane, however, marks were often lost as a result of imprecise wording of the responses. Many candidates appreciated that increasing the temperature increases the kinetic energy but this was often described in ways that brought to mind membranes being thrown into wave patterns that become so large that the membrane is eventually broken apart. More able candidates knew that it is the kinetic energy of individual molecules that is increased and as the phospholipids move about more at random this creates gaps in the membrane. Candidates also knew that proteins are denatured by excessive temperatures but many only referred to enzymes, perhaps forgetting that the question was about the effect of high temperature on a cell membrane and not an enzyme controlled reaction. In addition, there were numerous references to changes in the properties of the membrane such as 'the membrane becomes leaky' with no further qualification about changes to the structure of the membrane.
			Total	**10**	

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Question			Answer/Indicative content	Marks	Guidance
24		i	1 (hormone) binds to <u>receptor</u>; 2 causing, cascade of events / enzyme reactions; 3 may involve switching, on / off, genes; 4 only, present / needed, in small, concentrations / quantities (to have an effect); 5 may have effect on more than one, location / target tissue; 6 *idea that* effect may involve interaction of more than one hormone;	2 max	**IGNORE** prompt lines and mark as prose **1 ACCEPT** (hormone) complementary shape to <u>receptor</u> **1 ACCEPT** attach **1 IGNORE** fit **3 CREDIT** ref to changing gene expression **Examiner's Comments** This question discriminated well, with only the most able candidates gaining full marks. The most common correct answer given was for saying that hormones bind to receptors on target cells, gaining 1 mark. Several answers gave descriptions of how hormones are transported in animals and plants as a similarity, or generic statements about being released and affecting a target tissue, which gained no credit. Those gaining full marks described how hormones bind to receptors, leading to a series of enzyme reactions taking place inside the target cell.

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Question			Answer/Indicative content	Marks	Guidance
		ii	1 (most) plant cells retain ability to differentiate / totipotent; 2 plants have, meristems / meristematic tissue; 3 *idea that* plant cells can de-differentiate and then differentiate into a different cell type; 4 (most) animal cells are, differentiated / not totipotent / not pluripotent / only able to differentiate into the same type(s) of cell / are multipotent;	2 max	**2 ACCEPT** named meristematic tissue e.g. shoot apex / root apex / cambium **4 ACCEPT** 'stem cells found in few (named) tissues' 'bone marrow cells only differentiate into blood cells' **Examiner's Comments** Candidates seemed to find this question a challenge with only a few gaining marks for recalling that plants have meristematic tissue. Good answers would then go on to describe this tissue as totipotent with higher-scoring candidates demonstrating a clear understanding of the need for meristem / undifferentiated cells in asexual reproduction. A few candidates correctly described the role of stem cells in animals. Several answers gave long extended descriptions of vegetative propagation which gained no credit. However, some candidates still struggle to understand that because most animal cells have become specialised they are unable to reproduce asexually. Many incorrect answers referred to animals only being able to reproduce sexually without giving explanations or reasons of why this was the case. A few candidates confused self-fertilization with clones, describing self pollination in plants as a type of asexual reproduction.
		iii	1 (inter-species / triploid) hybrids, are sterile / cannot reproduce sexually;	2 max	**1 CREDIT** hybrid from named examples e.g. einkorn (wheat) ×, wild / goat, grass emmer (wheat) × wild grass

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Question			Answer/Indicative content	Marks	Guidance
			2 polyploidy (in the hybrid) provides duplicate of each chromosome; 3 (polyploidy) allows the hybrid to, carry out meiosis / form gametes **or** (polyploidy) restores fertility / overcomes sterility; 4 (hybrids are) <u>reproductively isolated</u> (from other species); 5 increased, cell size / grain size, increases yield; 6 sterile hybrids expensive for farming (especially in developing countries); 7 (plants) stronger / more vigorous / healthier;		**2 IGNORE** ref to 'more than two sets of chromosomes' as this is given in Q **3 ACCEPT** 'chromosome number doubling restores fertility' **3 ACCEPT** can reproduce sexually **4 ACCEPT** gametes incompatible with other species **5** seed size **7** must be a comparative statement **7 ACCEPT** less prone to disease / greater hybrid vigour **7 IGNORE** pest resistance **Examiner's Comments** Again this question posed a real challenge to candidates and showed a poor understanding of the term polyploidy. A sizeable number of candidates made no attempt to answer. Where candidates did gain a mark, this was generally for grains / cells being of increased size and therefore giving a higher yield. Very few candidates seemed to appreciate the role of polyploidy in overcoming hybrid sterility by facilitating meiosis (so failed to score MP1, 2, 3 or 4). Many candidates concentrated on dubious consequences arising from cells having more genes / alleles (such as masking undesirable recessive traits) or were side-tracked into brief accounts about artificially selected characteristics.

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Question			Answer/Indicative content	Marks	Guidance
			Total	**6**	

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Question			Answer/Indicative content	Marks	Guidance
25	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

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Question			Answer/Indicative content	Marks	Guidance
	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**	
26			B □	1	
			Total	**1**	

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Question			Answer/Indicative content	Marks	Guidance
27	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**	

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