Week 11

A-Level Biology

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

A-Level Biology   Name: ____________   Score: ______

1. In the phospholipid bilayer, the molecules arrange so that:
   - ☐ the hydrophilic heads face the water and the hydrophobic tails point inward
   - ☐ the tails face the water and the heads point inward
   - ☐ all heads point the same way
   - ☐ there is only one layer
2. Which molecules cross the membrane by simple diffusion through the bilayer?
   - ☐ small, non-polar molecules such as oxygen and carbon dioxide
   - ☐ large polar molecules such as glucose
   - ☐ charged ions only
   - ☐ whole vesicles
3. As a cell gets larger, its surface area to volume ratio:
   - ☐ gets smaller, because volume grows faster than surface area
   - ☐ gets larger
   - ☐ stays the same
   - ☐ becomes zero
4. Adding a solute to pure water:
   - ☐ lowers its water potential
   - ☐ raises its water potential
   - ☐ has no effect on water potential
   - ☐ makes it pure again
5. Why is the model called ”fluid mosaic”?
   - ☐ phospholipids slide past each other (fluid) and proteins are dotted through it (mosaic)
   - ☐ the membrane is frozen solid
   - ☐ it is made only of carbohydrate
   - ☐ proteins cannot move at all
6. Facilitated diffusion uses channel or carrier proteins but needs no energy — it is still passive.

   ☐ True   ☐ False

7. A cube has side length 2. Using ratio = 6/L, what is its surface-area-to-volume ratio?

____

8. Pure water has the highest possible water potential, which is defined as zero.

☐ True ☐ False

9. In the fluid mosaic model the phospholipids are locked in place and cannot move.

☐ True ☐ False

10. A cube has side length 3. Using ratio = 6/L, what is its surface-area-to-volume ratio?

____

A-Level Biology

1. **the hydrophilic heads face the water and the hydrophobic tails point inward**

   Heads are attracted to the water on both sides; the tails hide in the middle, away from water.

2. **small, non-polar molecules such as oxygen and carbon dioxide**

   Only small or non-polar molecules can pass straight through the oily bilayer, down the gradient.

3. **gets smaller, because volume grows faster than surface area**

   Volume (L^3) grows faster than surface area ($6L^2$), so the ratio 6/L falls as L increases.

4. **lowers its water potential**

   Pure water has the highest water potential; dissolving a solute lowers it.

5. **phospholipids slide past each other (fluid) and proteins are dotted through it (mosaic)**

   "Fluid" = the phospholipids move; "mosaic" = proteins scattered through the bilayer like tiles.

6. **True**

   Ions and large polar molecules cross via proteins, but movement is still down the gradient, so no ATP is used.

7. **3**

   ratio = 6 / L = 6 / 2 = 3 (i.e. 3 : 1).

8. **True**

   Pure water is defined as having a water potential of 0 kPa; adding solute makes it negative (lower).

9. **False**

   "Fluid" means the opposite — the phospholipids slide past one another, so the membrane can bend and move.

10. **2**

    ratio = 6 / L = 6 / 3 = 2 (i.e. 2 : 1) — smaller than the side-2 cube, because it is bigger.

A-LEVEL BIOLOGY • EXERCISE SHEET

4.1 Fluid mosaic membranes

Name: ______________ Class: __________ Date: ____________ **Total: 14 marks**

KEY WORDS cell surface membrane 细胞膜 • phospholipid 磷脂 • bilayer 双层 • protein 蛋白质 • cholesterol 胆固醇

Objective

Build the skills to answer exam questions on **fluid mosaic membranes** — the structure and roles of the membrane components, and the stages of **cell signalling** 细胞信号传递.

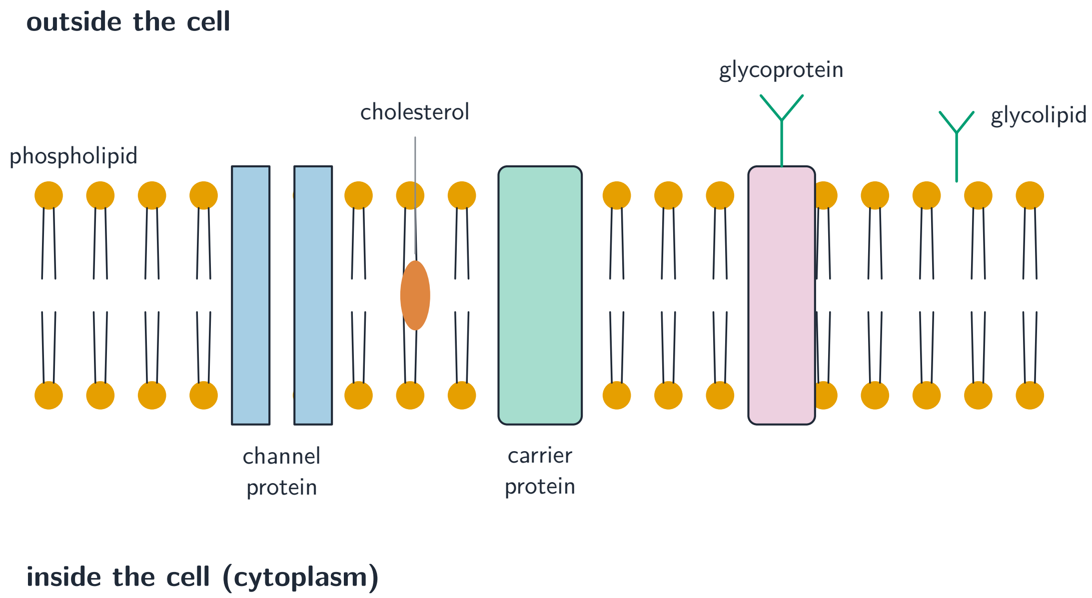
You must be able to:

- describe the **fluid mosaic model** 流动镶嵌模型 and the hydrophobic/hydrophilic interactions that form the **bilayer** 双层
- describe the roles of phospholipids, **cholesterol** 胆固醇, proteins and **glycoproteins** 糖蛋白
- outline the stages of cell signalling (ligand → receptor → response)

1 Worked examples

■ The fluid mosaic model

The membrane is a **bilayer** of **phospholipids** 磷脂: **hydrophilic** 亲水 heads face the water, **hydrophobic** 疏水 tails hide inside. It is “fluid” because the phospholipids slide past each other, and a “mosaic” because proteins are dotted through it.



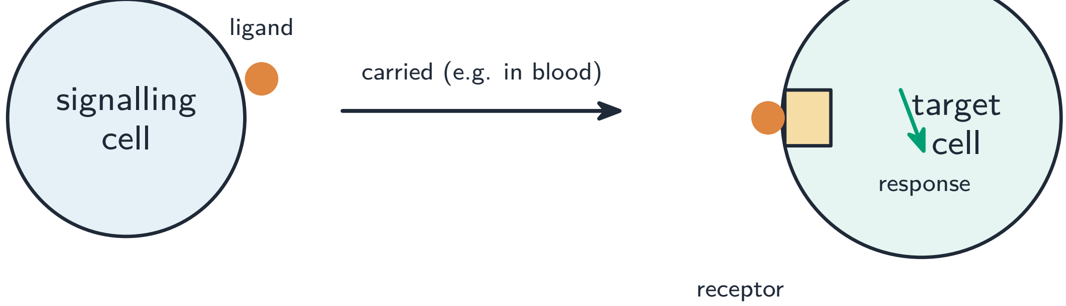
Proteins, cholesterol and carbohydrate chains sit in a fluid phospholipid bilayer

Roles of the components

component	**role**
phospholipids	form the basic barrier
channel/carrier proteins 通道/载体蛋白	transport substances across
cholesterol	controls **fluidity** 流动性 and adds strength
glycoproteins / glycolipids	cell recognition; some act as **antigens** 抗原
surface receptor proteins	bind signalling molecules (cell signalling)

Cell signalling

A cell secretes a **ligand** 配体 (e.g. a **hormone** 激素); it travels to a **target cell** 靶细胞; it binds a **receptor** 受体 of matching shape, triggering a response inside.



The ligand fits one receptor shape only, so only cells with that receptor respond

2 Practice

2.1 State the role of each membrane component. [3]

component	role
cholesterol	
carrier protein	
glycoprotein	

2.2 Explain why the phospholipids form a bilayer in water. [2]

3 Exam-style questions

3.1 Which part of the membrane is responsible for cell recognition? [1]

- **A** cholesterol
- **B** glycoproteins
- **C** the hydrophobic tails
- **D** channel proteins

3.2 Why does only the target cell respond to a particular hormone? [1]

- **A** only the target cell is near the gland
- **B** only the target cell has a receptor with a complementary shape
- **C** the hormone is only made near the target cell
- **D** the hormone is hydrophobic

3.3 An electron micrograph shows a cell surface membrane that is 7.0 mm thick at a magnification of $\times 1\,000\,000$.

(a) Calculate the actual thickness of the membrane, in nm. [2]

(b) Explain why a phospholipid bilayer forms a good barrier to ions and large polar molecules. [2]

3.4 Describe the main stages of cell signalling that lead to a response in a target cell. [3]

Solutions

2.1 cholesterol — controls fluidity / adds strength; carrier protein — carries specific molecules across; glycoprotein — cell recognition / receptor / antigen.

2.2 the hydrophilic heads are attracted to water on both sides while the hydrophobic tails are repelled by water; so the tails face inward and heads outward, forming two layers.

3.1 B. Glycoproteins (carbohydrate chains) are used for cell recognition.

3.2 B. The receptor's shape is complementary to that ligand only.

3.3 (a) $\dfrac{7.0\text{ mm}}{1\,000\,000} = 7.0 \times 10^{-6}\text{ mm} = 7.0\text{ nm}$.
(b) the hydrophobic tail region repels charged/polar molecules, so ions and large polar molecules cannot pass straight through.

3.4 a cell secretes a ligand; it is carried to and binds a complementary receptor on the target cell's membrane; binding triggers a specific response inside the target cell.

15 What are the main roles of glycolipids in cell surface membranes?

1 to help cells to attach to each other to form tissues

2 to act as antigens for cell-to-cell recognition

3 to increase fluidity for the cell surface membrane

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

A-Level Biology: **w25 12**

17 What can increase the fluidity of the cell surface membrane at low temperatures?

1 double bonds between carbon atoms in the fatty acid chains

2 cholesterol

3 fatty acids having shorter chains

A 1, 2 and 3 **B** 1 and 3 only **C** 1 only **D** 2 and 3 only

18 Which statements about the proteins and glycoproteins in cell surface membranes are correct?

1 They can allow cells to bond together to form tissues.

2 They can recognise messenger molecules like hormones.

3 They can be antigens and allow cell-to-cell recognition.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

A-Level Biology: **w25 13**

14 Which statement about phospholipids in the bilayer of a cell surface membrane is correct?

A The non-polar phosphate heads face outwards and the polar fatty acid tails face inwards.

B The polar phosphate heads face outwards and the non-polar fatty acid tails face inwards.

C The non-polar fatty acid tails face outwards and the polar phosphate heads face inwards.

D The polar fatty acid tails face outwards and the non-polar phosphate heads face inwards.

18 Proteins in the cell surface membranes of human cells and mouse cells were labelled with fluorescent dyes. The human cells were labelled with a red dye and the mouse cells were labelled with a green dye.

A human cell and a mouse cell were then fused to form a hybrid cell.

At first, the different dyes remained separate. After 40 minutes, the two dyes were evenly distributed in the hybrid cell surface membrane.

What explains this observation?

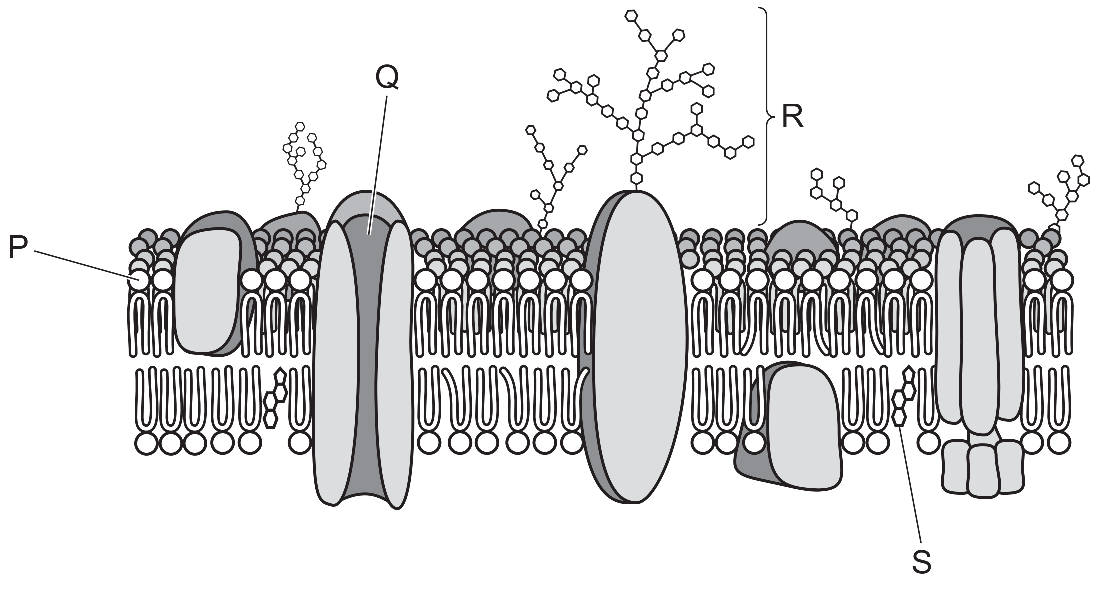
A All protein molecules in the cell surface membrane are fixed to structures within the cell, but phospholipid molecules move freely between them.

B Groups of protein and phospholipid molecules in the cell surface membrane are attached to each other and move together.

C Only protein molecules in the outer layer of the cell surface membrane can move freely between phospholipid molecules.

D Protein molecules in the outer layer of the cell surface membrane and those which span the bilayer can move freely between phospholipid molecules.

16 The diagram shows a section through a cell surface membrane.



What is a correct role for a labelled molecule?

A P is involved in controlling membrane stability.

B Q is involved in active transport.

C R is involved in cell signalling.

D S is involved in diffusion of ions.

1 Fig. 1.1 shows a diagram of the fluid mosaic model of the structure of the cell surface membrane.

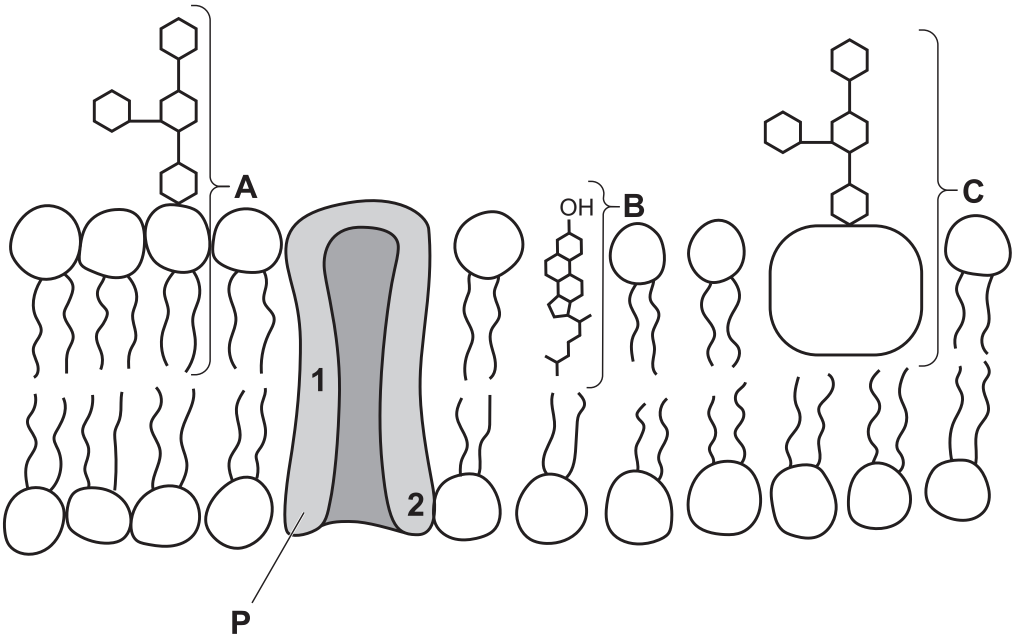


Fig. 1.1

(a) Name the structures labelled **A**, **B** and **C** in Fig. 1.1.

A ....

B ....

C ....
[3]

(b) Draw an arrow on Fig. 1.1 to show the movement of a molecule across the membrane into the cell by facilitated diffusion. [2]

(c) Explain how the fluidity of the membrane would change if the proportion of unsaturated fatty acids in the phospholipid bilayer increased.

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.... [3]

(d) The R-groups of amino acids give them different properties.

Suggest how the properties of the R-groups of the amino acids at position **1** of **P** may differ from the R-groups of the amino acids at position **2**.

....

....

.... [1]

[Total: 9]

4.2 Movement into and out of cells

Name: ____________ Class: ________ Date: __________ **Total: 17 marks**

KEY WORDS volume 体积 • distilled water 蒸馏水 • diffusion 扩散 • water potential 水势 • surface area 表面积

Objective

Build the skills to answer exam questions on **movement into and out of cells** — the transport processes, **surface area to volume ratio** 表面积体积比, and the effect of **water potential** 水势 on cells.

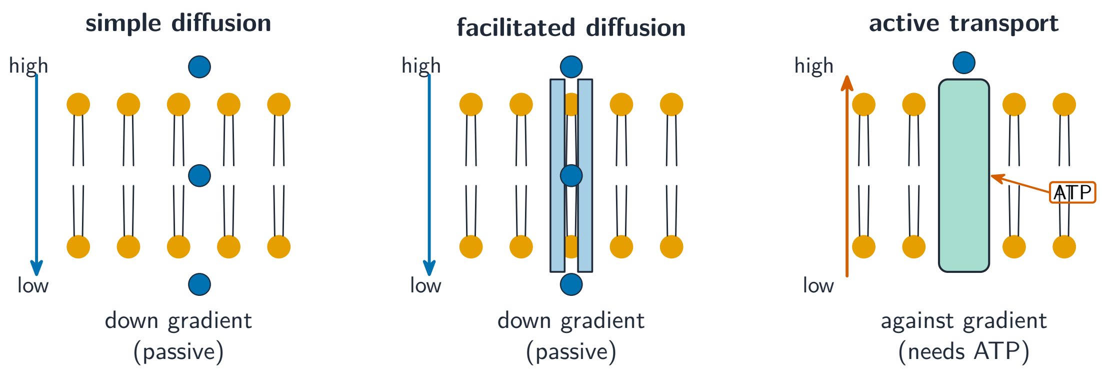
You must be able to:

- describe and explain simple diffusion, facilitated diffusion, osmosis, active transport, endocytosis and exocytosis
- calculate surface area, volume and their ratio for simple shapes and link the ratio to diffusion
- explain water movement by water potential and its different effects on plant and animal cells

1 Worked examples

■ The transport processes

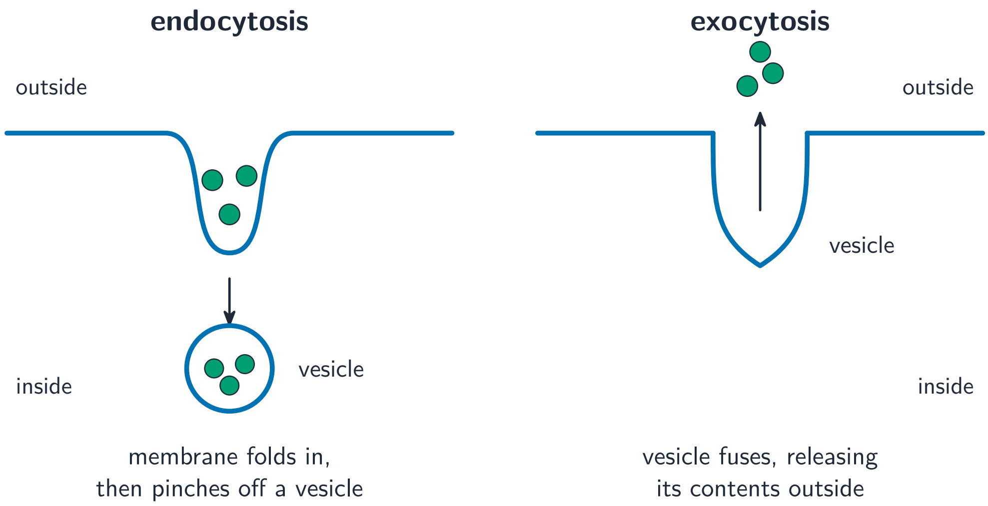
Some are **passive** 被动 (no energy, down the gradient); some are **active** (use ATP).



Diffusion and facilitated diffusion are passive (down the gradient); active transport goes against it and needs ATP

- **simple diffusion** — small/non-polar molecules (O_2, CO_2) pass straight through, down the gradient.

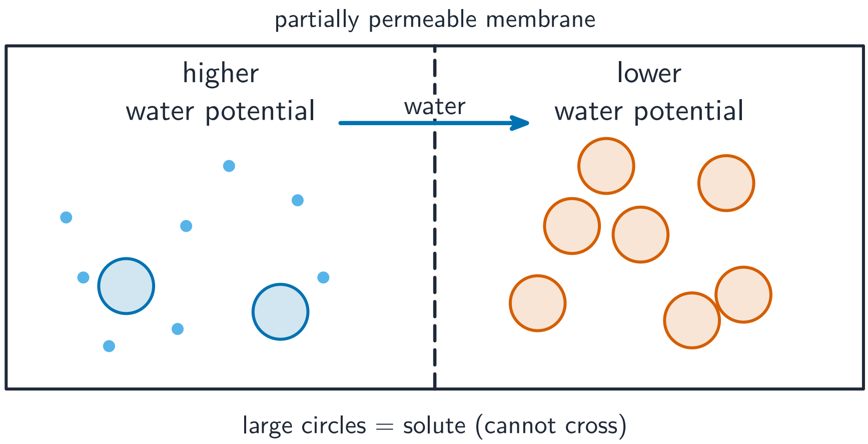
- **facilitated diffusion** 易化扩散 — ions and large polar molecules pass through channel/carrier proteins, down the gradient.
- **active transport** 主动运输 — carrier proteins pump a substance **against** the gradient, using ATP.
- **endocytosis/exocytosis** 胞吞/胞吐 — bulk transport using vesicles and ATP.



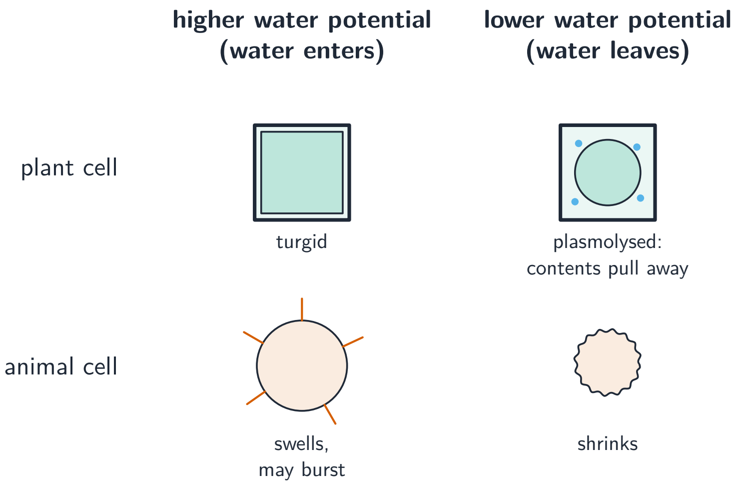
Endocytosis brings material in; exocytosis releases it

■ Osmosis and water potential

Osmosis 渗透 is the diffusion of water across a partially permeable membrane from **higher** to **lower** water potential. Pure water has the highest water potential (0); adding **solute** 溶质 lowers it.



Water moves to the lower water potential; the solute cannot cross

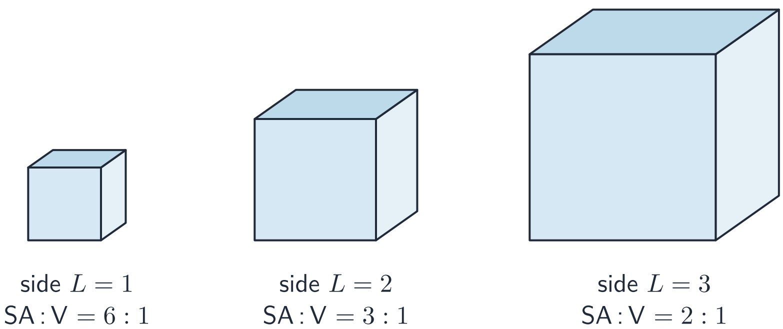


Plant cell: turgid or plasmolysed. Animal cell: may burst (haemolysis) or shrink

■ Surface area to volume ratio

As a cell grows, its volume rises faster than its surface area, so the ratio **falls**. For a cube of side L:

$$\text{surface area} = 6L^2, \quad \text{volume} = L^3, \quad \text{ratio} = \frac{6L^2}{L^3} = \frac{6}{L}.$$



a bigger cube (or cell) has a **smaller** surface area : volume ratio

As a cube (or cell) grows, its surface area : volume ratio gets smaller

A small ratio means slow exchange by diffusion — so large organisms need transport systems.

2 Practice

2.1 State whether each process is passive or active: simple diffusion · active transport · osmosis · exocytosis. [2]

2.2 A cube-shaped block has side 2 cm. Calculate its surface area, its volume, and its surface area to volume ratio. [3]

3 Exam-style questions

3.1 Glucose enters a cell through a carrier protein, moving down its concentration gradient, without using ATP. This is: [1]

- **A** active transport
- **B** facilitated diffusion
- **C** osmosis
- **D** simple diffusion

3.2 A red blood cell is placed in distilled water. What happens, and why? [1]

- **A** it shrinks, because water leaves by osmosis
- **B** it bursts, because water enters by osmosis
- **C** nothing, because the cell wall protects it
- **D** it becomes turgid, because water enters by osmosis

3.3 Agar blocks of different sizes are soaked in dye to model diffusion into cells.

(a) Explain why the smallest block becomes fully coloured fastest. [3]

(b) Explain why large organisms cannot rely on diffusion alone to supply their cells. [2]

3.4 Pieces of potato are placed in sucrose solutions of different water potentials and their change in mass is measured.

(a) Explain how the results can be used to estimate the water potential of the potato tissue. [2]

(b) A plant cell is placed in a solution of lower water potential than its contents. Describe and name what happens to the cell. [3]

Solutions

2.1 simple diffusion — passive; active transport — active; osmosis — passive; exocytosis — active.

2.2 surface area $= 6 \times 2^2 = 24$ cm^2; volume $= 2^3 = 8$ cm^3; ratio $= 24 : 8 = 3 : 1$.

3.1 B. Through a protein and down the gradient with no ATP = facilitated diffusion.

3.2 B. Distilled water has a higher water potential, so water enters by osmosis and the cell, having no wall, bursts (haemolysis).

3.3 (a) the smallest block has the largest surface area to volume ratio; so dye diffuses across a relatively larger surface for the volume inside; and the diffusion distance to the centre is shorter.
(b) large organisms have a small surface area to volume ratio, so diffusion across the surface is too slow to supply all the inner cells — they need a transport system.

3.4 (a) find the solution that gives no change in mass; its water potential equals that of the potato tissue.
(b) water leaves the cell by osmosis; the contents shrink and the membrane pulls away from the cell wall; this is plasmolysis.

16 A sample of healthy plant cells taken from the same tissue is placed in a beaker containing distilled water.

The cells change in size.

What would explain this change in size?

A Water will leave the cells by active transport.

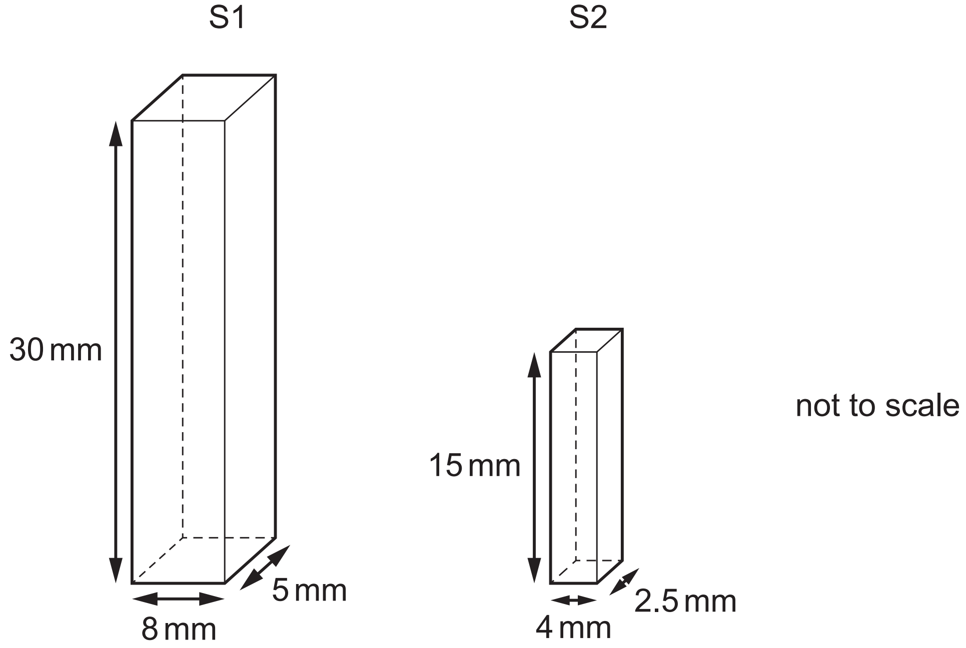
B Water will enter the cells by osmosis.

C Solutes will enter the cells by active transport.

D Solutes will leave the cells by osmosis.

17 A student studying surface area to volume ratio and diffusion made a cuboid, S1, using agar stained blue with a pH indicator. The dimensions of S1 are shown in the diagram.

The student made a second agar cuboid, S2. Each dimension of S2, (the length, the width and the height), was half that of S1.



The student placed each cuboid in a test-tube and covered it in acid. The time taken for each cuboid to completely change colour was recorded. All variables other than the size of the cuboids were standardised.

Which row shows the surface area to volume ratio of S1 and the time taken for S1 to change colour completely in acid compared to the time taken for S2 to change colour completely?

	surface area to volume ratio of S1	time taken for S1 to change colour completely in acid compared to S2
A	0.72 : 1	S1 takes less time than S2
B	0.72 : 1	S1 takes more time than S2
C	1.4 : 1	S1 takes less time than S2
D	1.4 : 1	S1 takes more time than S2

18 Two test-tubes, labelled X and Y, were set up containing equal volumes of solution X or solution Y respectively.

A large number of type P cells and a large number of type Q cells were added into test-tube X and also into test-tube Y.

After a few minutes, samples of the solutions were taken and the cells were observed with a microscope.

- In solution X, all of cell type P had burst and cell type Q had **not** burst.
- In solution Y, **no** cells had burst.

Which row correctly identifies cell type Q and solutions X and Y?

	cell type Q	solution X	solution Y
A	red blood cells	5% NaC*l* solution	distilled water
B	goblet cells	5% glucose solution	distilled water
C	liver cells	distilled water	5% glucose solution
D	root hair cells	distilled water	5% NaC*l* solution

19 In an experiment, four different-sized cubes of colourless agar were placed into a blue dye. The time taken for each cube to turn blue was recorded.

Which row shows the surface area and volume of the cube that took the longest time to turn completely blue?

	surface area / cm^2	volume / cm^3
A	6.0	1
B	9.5	2
C	12.5	3
D	38.0	16

19 Which statements about the cell surface membrane are correct?

1 Channel proteins allow water soluble ions and molecules across the membrane.

2 Glucose can pass into the cell via carrier proteins.

3 Oxygen passes freely through the membrane as it is soluble in lipids.

4 Some glycoproteins act as antigens.

A 1, 2, 3 and 4

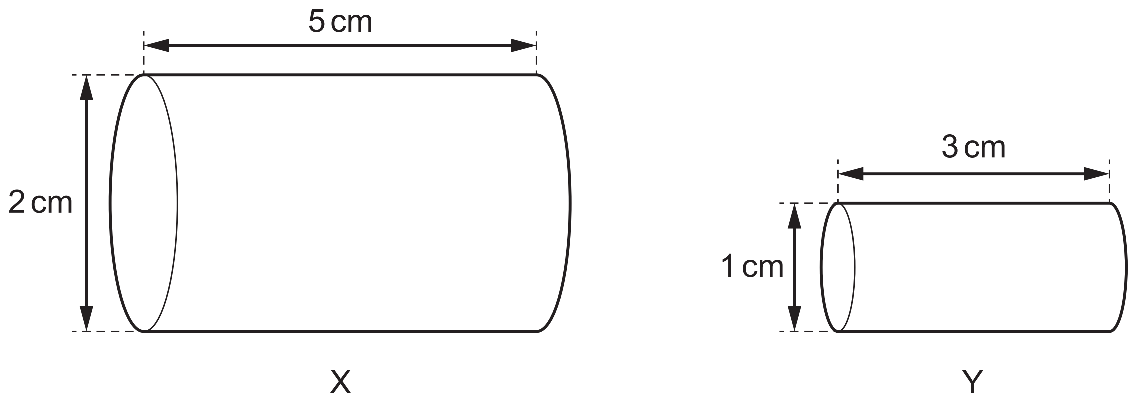
B 1, 3 and 4 only

C 1 and 2 only

D 2, 3 and 4 only

20 The diagram shows two cylinders of agar.

The agar cylinders are placed into a solution of dye at the same time. The time taken for the dye to diffuse into the centre of each cylinder is recorded.



Which statement explains why the dye reaches the centre of one agar cylinder faster than the other agar cylinder?

A The dye reaches the centre of X in a shorter time than the dye reaches the centre of Y because X has a larger surface area to volume ratio.

B The dye reaches the centre of X in a shorter time than the dye reaches the centre of Y because X has a larger surface area.

C The dye reaches the centre of Y in a shorter time than the dye reaches the centre of X because the dye has a shorter distance to diffuse to the centre.

D The dye reaches the centre of Y in a shorter time than the dye reaches the centre of X because Y has a smaller volume.

17 When red blood cells are put into distilled water they burst (haemolysis).

Which statements explain this haemolysis?

1 The water potential of the surrounding liquid is lower than the water potential of the contents of the red blood cell.

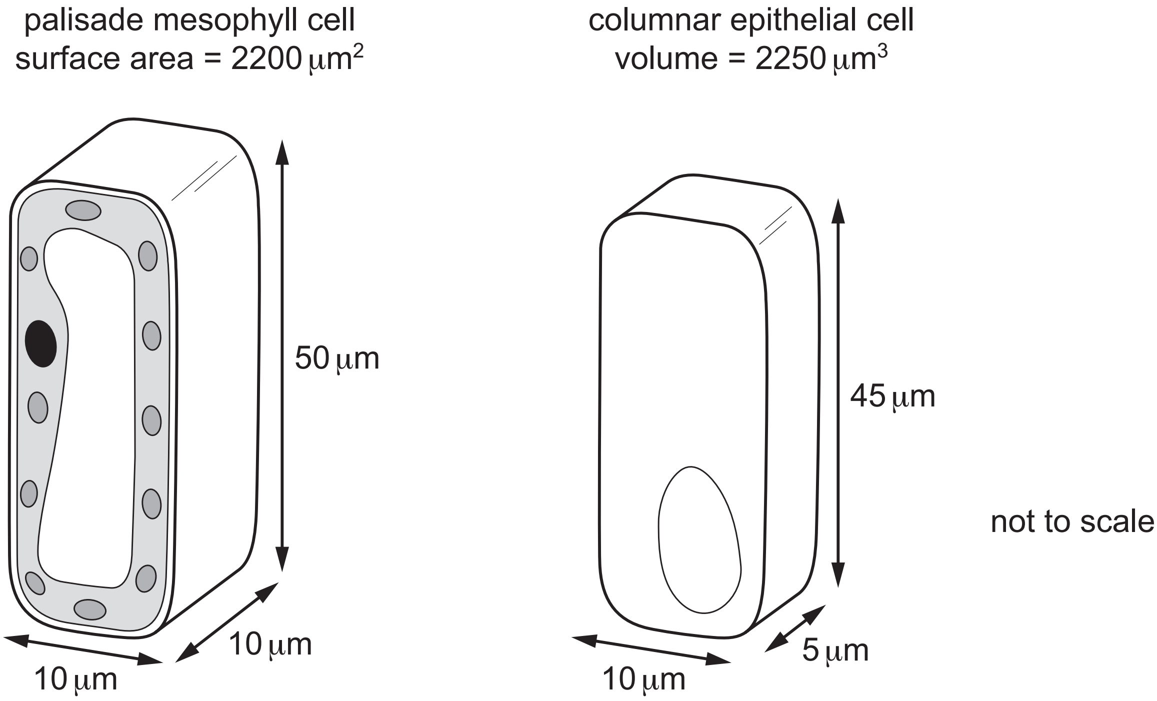
2 The cell surface membranes of red blood cells are **not** supported by cell walls.

3 More water moves into the red blood cells by osmosis than leaves the cells.

4 Water enters the red blood cells by osmosis but does **not** leave the cells.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

18 The diagrams show the shape and size of two types of cell.



Which statement about the palisade cell and epithelial cell shown in the diagrams is correct?

A An increase in surface area reduces the distance for gases to reach the centre of the cell.

B The surface area of the palisade mesophyll cell is 500 μm^2 greater than the columnar epithelial cell.

C The surface area to volume ratio is greater in the columnar epithelial cell than the palisade mesophyll cell.

D The volume of the palisade mesophyll cell is 2500 μm^3 greater than that of the columnar epithelial cell.

1 Many substances can move through cell surface membranes between the cytoplasm of animal cells and the extracellular environment.

(a) A student made a drawing to summarise the movement of substances across the cell surface membranes of mammalian red blood cells.

Fig. 1.1 shows the drawing made by the student:

- Each arrow indicates the movement of a substance through the membrane.
- The number of each of the 4 shapes represents the relative concentrations of each substance in the cytoplasm and in the blood plasma.

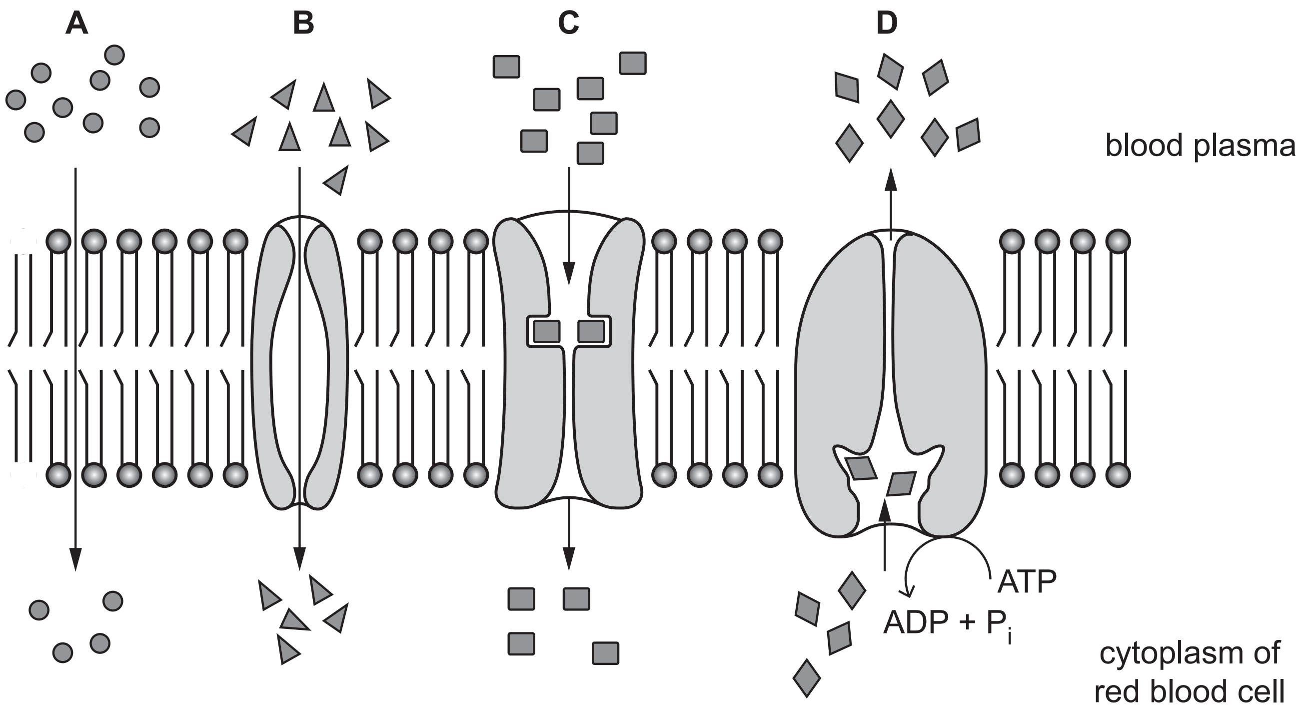


Fig. 1.1

The student carried out research and made a list of some of the substances found in red blood cells as shown in Fig. 1.2.

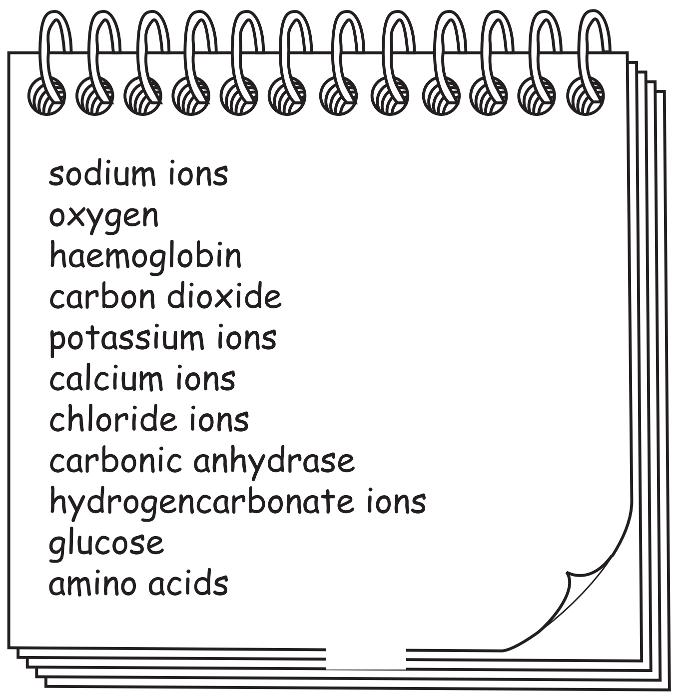


Fig. 1.2

Table 1.1 shows information about the 4 types of movement of substances across the cell surface membranes of red blood cells as shown in Fig. 1.1.

Complete Table 1.1 using the information in Fig. 1.1 and Fig. 1.2.

Table 1.1

letter from Fig. 1.1	type of movement	name of part of membrane involved	example of a substance that moves across the membrane (from Fig. 1.2)
A	simple diffusion	phospholipids	
B	facilitated diffusion		calcium ions
C	facilitated diffusion		
D			

[5]

(b) Some viruses infect plants through the surfaces of damaged leaves. These plant viruses can travel from one leaf cell to another without having to pass through any cell surface membranes.

Explain how some plant viruses can travel from one cell to another without passing through cell surface membranes.

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.... [2]

[Total: 7]

1 *Beta vulgaris vulgaris*, as shown in Fig. 1.1, is a food crop with a swollen, edible root known as beetroot.

Fig. 1.1

A student determined the concentration of a sucrose solution that has the same water potential as the cells of the beetroot.

The student used distilled water and a stock solution of 2.0 mol dm^{-3} sucrose to prepare a range of sucrose solutions.

Each sucrose solution was prepared using proportional dilution and had a final volume of 30 cm^3.

(a) Complete Table 1.1 to show how the concentrations were made.

Table 1.1

final concentration of sucrose solution / mol dm^{-3}	**volume of distilled water / cm^3**	**volume of 2.0 mol dm^{-3} stock sucrose solution / cm^3**
2.0	0.0	30.0
....	....	....
....	....	....
....	....	....
....	....	....
0.0	30.0	0.0

[2]

(b) Describe a method the student could use to collect the data needed to determine the concentration of a sucrose solution that has the same water potential as the cells of the beetroot.

The student was supplied with the sucrose solutions prepared in **1(a)** and standard laboratory equipment.

Do **not** include details of how the student:

- prepared the sucrose solutions in **1(a)**
- would use the data collected to determine the concentration of a sucrose solution that has the same water potential as the cells of the beetroot.

Your method should be set out in a logical order and be detailed enough to allow another person to follow it.

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(c) The student calculated the mean percentage change in mass of the beetroot for each concentration of sucrose solution.

(i) The student plotted these calculated values to obtain a line graph.

Complete Fig. 1.2 by:

- labelling the axes
- sketching the line that the student obtained.

Fig. 1.2

[2]

(ii) Explain how the student used the completed line graph in Fig. 1.2 to estimate the concentration of sucrose solution that has the same water potential as the cells of the beetroot.

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.... [1]

(iii) The cells of the beetroot contain a red pigment which can leak out into the solution when the tissue is cut. The student noticed that each sucrose solution was coloured red at the end of the investigation.

Suggest **one** improvement the student could make to the method to reduce the amount of red pigment in each sucrose solution.

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.... [1]

[Total: 13]

Question 2 starts on page 6.