

Exercise walk-through

Movement into and out of cells ■ 4.2

eXercise

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

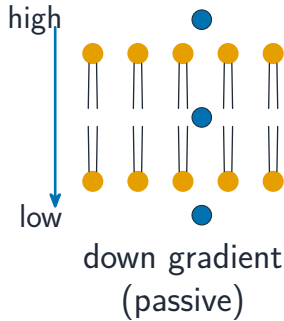
Method — The transport processes

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

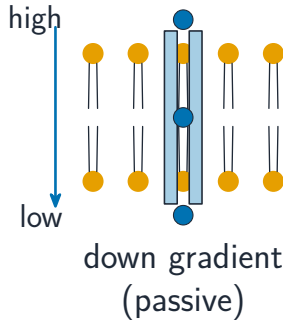
- **simple diffusion** — small/non-polar molecules (O_2 , CO_2) pass straight through, down the gradient.
- **facilitated diffusion** 易化扩散 — ions and large polar molecules pass through channel/carrier proteins, down the gradient.
- **active transport** 主动运输 — carrier proteins pump a substance **against** the gradient, using ATP.
- **endocytosis/exocytosis** 胞吞/胞吐 — bulk transport using vesicles and ATP.

Method — The transport processes

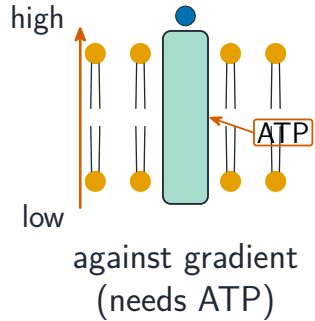
simple diffusion



facilitated diffusion

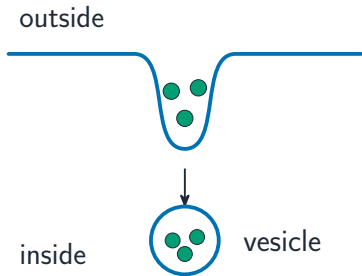


active transport



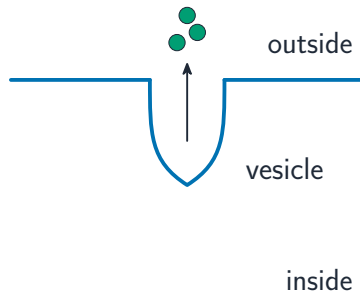
Method — The transport processes

endocytosis



membrane folds in,
then pinches off a vesicle

exocytosis

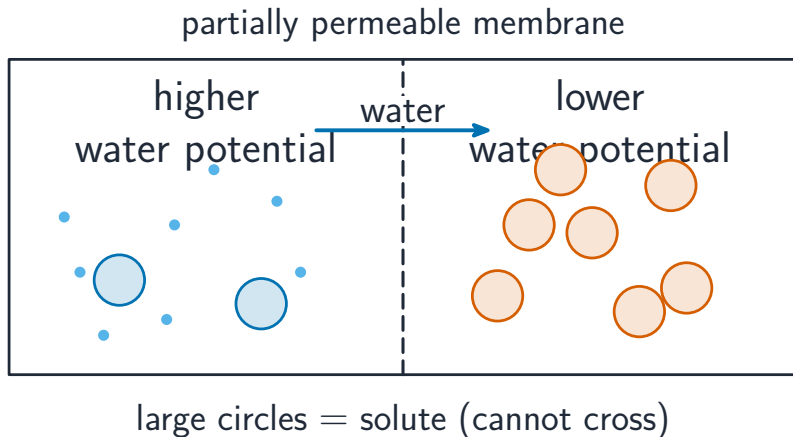


vesicle fuses, releasing
its contents outside

Method — 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.

Method — Osmosis and water potential



Method — Osmosis and water potential

higher water potential (water enters) lower water potential (water leaves)

plant cell

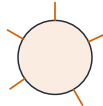


turgid



plasmolysed:
contents pull away

animal cell



swells,
may burst



shrinks

Method — 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 :

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

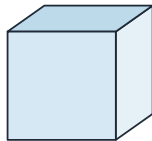
A small ratio means slow exchange by diffusion — so large organisms need transport systems.

Method — Surface area to volume ratio



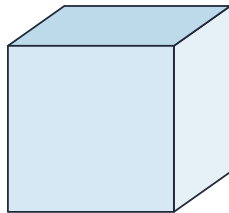
side $L = 1$

SA:V = 6 : 1



side $L = 2$

SA:V = 3 : 1



side $L = 3$

SA:V = 2 : 1

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

Three cubes of side 1, 2 and 3 with surface-area-to-volume ratios 6:1, 3:1 and 2:1

Practice 2.1 ■ 2 marks

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

Solution 2.1

Method: The transport processes

Worked steps

simple diffusion — passive; active transport — active; osmosis — passive; exocytosis — active **B1** *for each pair correct, 2 marks total.*

Practice 2.2 ■ 3 marks

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

Solution 2.2

Method: Surface area to volume ratio

Worked steps

surface area = $6 \times 2^2 = 24 \text{ cm}^2$ **B1**; volume = $2^3 = 8 \text{ cm}^3$ **B1**; ratio = $24 : 8 = 3 : 1$ **B1**.

Exam-style 3.1 ■ 1 mark

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

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

Solution 3.1

Method: The transport processes

A active transport

B facilitated diffusion



C osmosis

D simple diffusion

Worked steps

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

Exam-style 3.2 ■ 1 mark

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

- 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

Solution 3.2

Method: Osmosis and water potential

- 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

Worked steps

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

Exam-style 3.3 ■ 3 marks

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

- (a) Explain why the smallest block becomes fully coloured fastest.
- (b) Explain why large organisms cannot rely on diffusion alone to supply their cells.

Solution 3.3

Worked steps

(a) the smallest block has the largest surface area to volume ratio **M1**; so dye diffuses across a relatively larger surface for the volume inside **M1**; and the diffusion distance to the centre is shorter **A1**.

(b) large organisms have a small surface area to volume ratio **M1**, so diffusion across the surface is too slow to supply all the inner cells — they need a transport system **A1**.

Exam-style 3.4 ■ 2 marks

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

Solution 3.4

Method: Osmosis and water potential

Worked steps

- (a) find the solution that gives no change in mass **M1**; its water potential equals that of the potato tissue **A1**.
- (b) water leaves the cell by osmosis **B1**; the contents shrink and the membrane pulls away from the cell wall **B1**; this is plasmolysis **B1**.