Exercise walk-through

Movement into and out of cells ▪ 4.2

eXercise

You must be able to

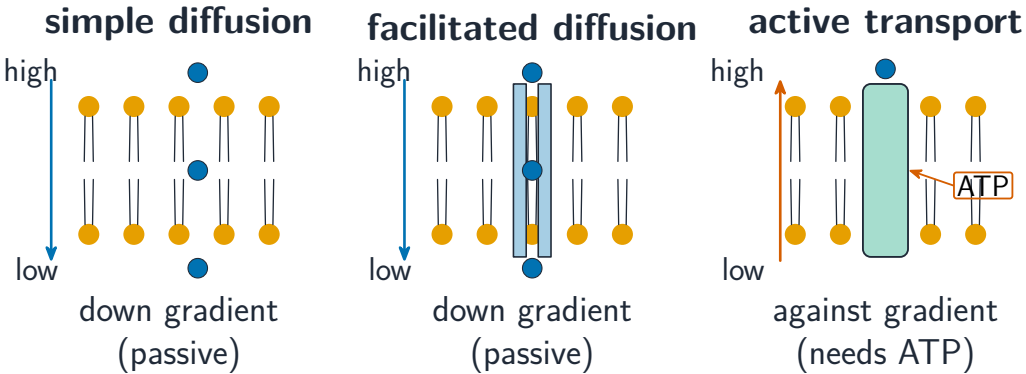
- describe and explain simple diffusion, facilitated diffusion, osmosis, active transport, endocytosis and exocytosis
- calculate surface area, volume and their ratio for simple shapes and link the ratio to diffusion
- explain water movement by water potential and its different effects on plant and animal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

Method — The transport processes

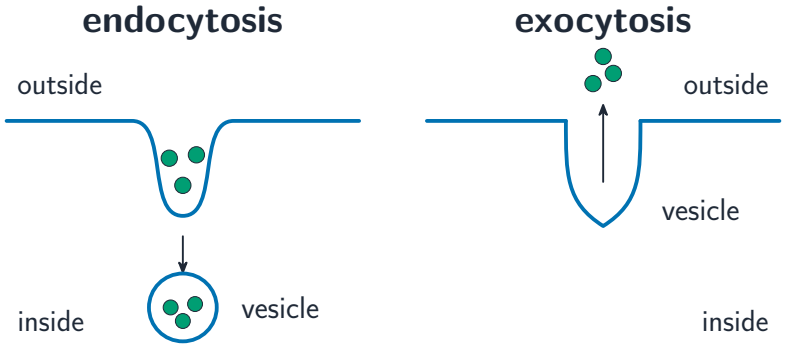
Some are **passive** 被动 (no energy, down the gradient); some are **active** (use ATP).

- **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



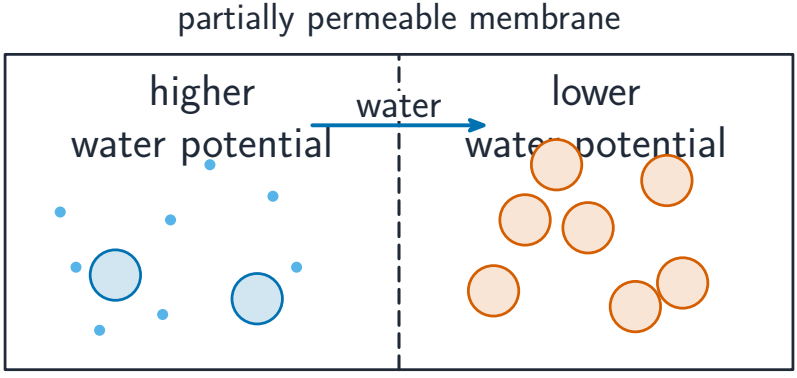
Method — The transport processes



Method — Osmosis and water potential

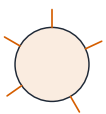
Osmosis 渗透 is the diffusion of water across a partially permeable membrane from **higher** to **lower** water potential. Pure water has the highest water potential (0); adding **solute** 溶质 lowers it.

Method — Osmosis and water potential



large circles = solute (cannot cross)

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

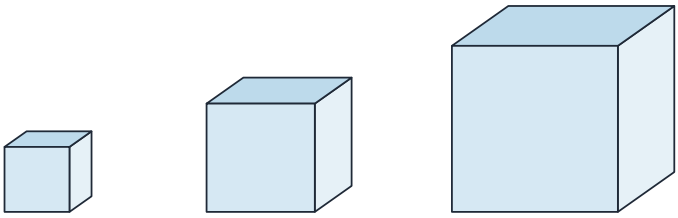
Method — Surface area to volume ratio

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 $= 6 \times 2^2 = 24$ cm^2 B1; volume $= 2^3 = 8$ 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**.