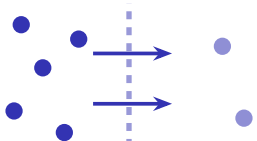
Movement Into & Out of Cells

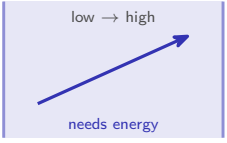
IGCSE Biology ▪ Topic 3

IGCSE Biology



What we will cover

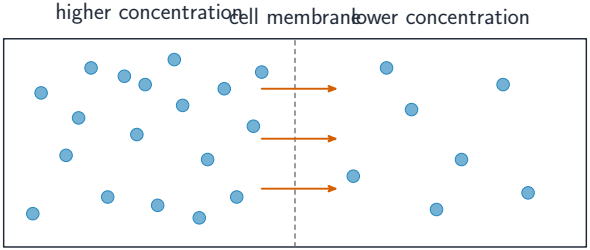
1. Diffusion
2. Osmosis
3. Osmosis & plant cells
4. Active transport
5. Comparing the three



active transport

1 Passive movement

Diffusion



net movement of particles down the concentration gradient

The particles spread out because of their own **random movement** 随机运动.

The **energy** 能量 for diffusion comes from the **kinetic energy** 动能 of the random movement of **molecules** 分子 and **ions** 离子 – so diffusion needs **no** extra energy.

Down a gradient, and why water matters

The gradient	Particles spread from where they are crowded to where they are not: they move **down a concentration gradient** 顺浓度梯度, and no energy is needed.
Why water	Water is the solvent of life. This matters for **digestion** 消化 (food must dissolve before it can be used), **excretion** 排泄 (wastes leave dissolved in water) and **transport** 运输 (substances travel dissolved in blood and sap).
Where it stops	Diffusion is fast over micrometres and hopeless over centimetres – which is why large organisms need a transport system.

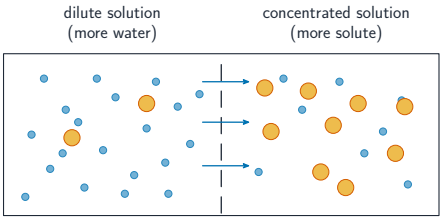
Always say *down* the gradient, and say what is moving. "Particles move" on its own scores nothing.

The four factors that change the rate of diffusion

the gradient	a steeper concentration difference means faster **net movement** 净移动 **down the gradient** 顺浓度梯度
surface area 表面积	more area means more molecules crossing per second
distance	a thinner barrier is quicker to cross
temperature 温度	warmer molecules have more kinetic energy, so they move faster
where it matters	alveoli, villi and root hairs all maximise the first two and minimise the third
the gases	**oxygen** 氧气 in and **carbon dioxide** 二氧化碳 out both move by diffusion alone

> Every "how is this surface adapted" answer is these four factors applied. Name the factor, then the feature that exploits it.

Osmosis



water moves by osmosis to the concentrated side; solute is too big to cross

- In **pure water or a dilute solution**, water moves **into** the cells. The cells swell and become firm, or **turgid** 膨胀 – the cell wall stops them bursting.
- In a **concentrated solution**, water moves **out** of the cells. The cells lose their firmness and become soft, or **flaccid** 松软.
- **(Supplement)** If even more water leaves, the cell membrane pulls away from the cell wall. This is **plasmolysis** 质壁分离.

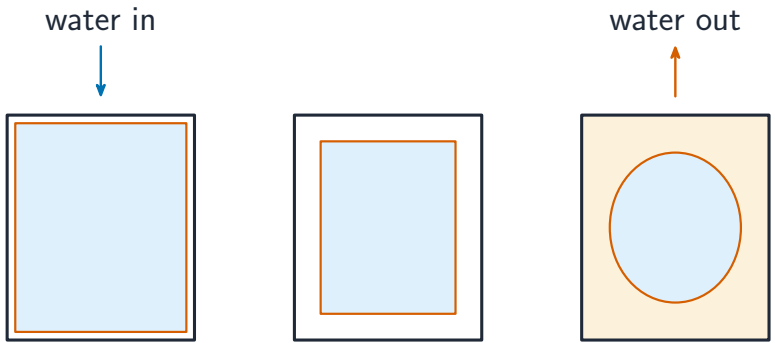
Water as a solvent

Water is a very good **solvent** 溶剂 – many substances **dissolve** 溶解 in it to make a **solution** 溶液.

> This matters for **digestion** 消化 (food must dissolve before it can be used).

Osmosis and plant cells

- water in → **turgid** 膨胀 (firm; supports the plant)
- water out → **flaccid** 松软 (soft)
- more out → **plasmolysis** 质壁分离



Osmosis in the words the Supplement uses

Water potential	Osmosis is the net movement of water from a region of **higher water potential** 较高水势 (a dilute solution – more water) to one of lower water potential, through a partially permeable membrane.
Turgor pressure	Water entering a plant cell presses outward on the cell wall; that outward push is the **turgor pressure** 膨压, and it holds a soft plant upright.
When it is lost	In a concentrated solution water leaves, the cell becomes **flaccid** 松弛, and eventually the membrane pulls away from the wall (**plasmolysis** 质壁分离).
Testing it	Investigate with **dialysis tubing** 透析袋 – an artificial partially permeable membrane – or with cylinders cut from a potato.

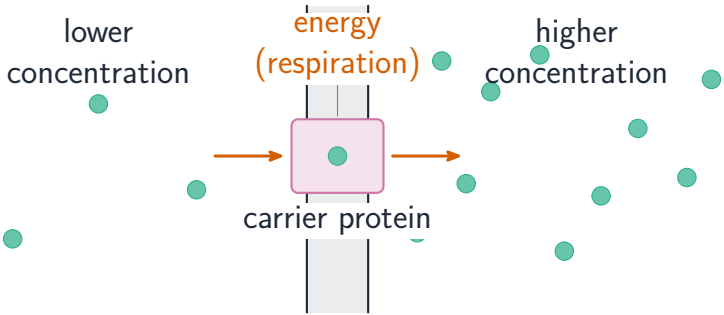
> The cell wall is what makes turgor possible: an animal cell in the same solution simply bursts.

2 Active transport

Active transport

Active transport 主动运输 moves particles against the gradient (low → high).

> It needs energy from **respiration** 呼吸作用 & a **carrier protein** 载体蛋白 – e.g. root hairs take up minerals.



Active transport: uphill, and it costs

Against the gradient	Movement from a lower to a higher concentration – the opposite of diffusion.
Protein carriers	**Protein carriers** 载体蛋白 in the membrane pick up the molecule or ion and carry it across, using energy from respiration.
Where it is used	Root hair cells taking up mineral ions from dilute soil water; the gut absorbing the last of the glucose.
The tell	Anything that stops respiration stops active transport – and stops nothing else on this list.

Three transport processes, one question to ask: is energy needed, and is a carrier protein involved?

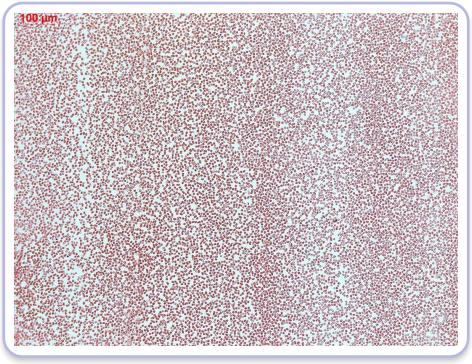
Comparing the three

diffusion – high → low; no energy; particles, gases, solutes

osmosis – high → low water potential; no energy; water only

active transport – low → high (against); needs energy; ions & molecules

Osmosis, continued



Red blood cells: water moves in and out of cells by osmosis.

Osmosis and plant cells, continued

Plasmolysed red onion cells: the purple contents have pulled away from the cell walls

Exam tips

- Always write **net** movement: particles move both ways, but the overall flow is down the gradient (for diffusion and osmosis).
- Osmosis moves **water only**, and **only** through a partially permeable membrane. Diffusion can move many kinds of particle.
- Only **active transport** uses energy from respiration, and only it goes **against** the gradient.
- For the potato or plant experiment: water in $\rightarrow$ turgid, longer and heavier; water out $\rightarrow$ flaccid, shorter and lighter; equal concentration $\rightarrow$ no change.
- A larger surface area, higher temperature, steeper concentration gradient and shorter distance all make diffusion faster.

3 Recap

Worked example – percentage change in mass

A potato cylinder is $5.0\,\mathrm{g}$ before soaking and $5.6\,\mathrm{g}$ after. Find the percentage change.

- Change in mass $= 5.6 - 5.0 = 0.6\,\mathrm{g}$ (a gain).
- % change $= \dfrac{\text{change}}{\text{starting mass}} \times 100$
- $= \dfrac{0.6}{5.0} \times 100 = +12\%$
- It gained water, so the solution was more dilute than the cell sap.

Always divide by the starting mass, and keep the $+$ or $-$ sign. Gain $\Rightarrow$ water moved in by osmosis $\Rightarrow$ the outside was more dilute.

Topic 3 – key takeaways

1 Diffusion

down the gradient; no energy

2 Osmosis

water only, partially permeable membrane

3 Plant cells

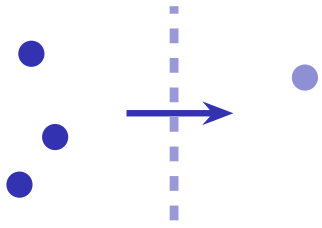
turgid, flaccid or plasmolysed

4 Active transport

against the gradient; needs energy

Check yourself

1. Which way do particles diffuse along a gradient?
2. What substance moves in osmosis?
3. What does a plant cell become in pure water?
4. Which process needs energy from respiration?



Answers **1.** high to low concentration **2.** water **3.** turgid (firm) **4.** active transport