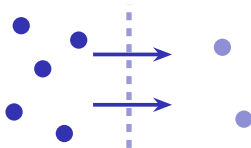


Movement Into & Out of Cells

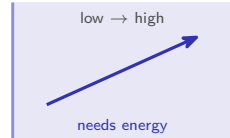
IGCSE Biology ■ Topic 3

IGCSE Biology



What we will cover

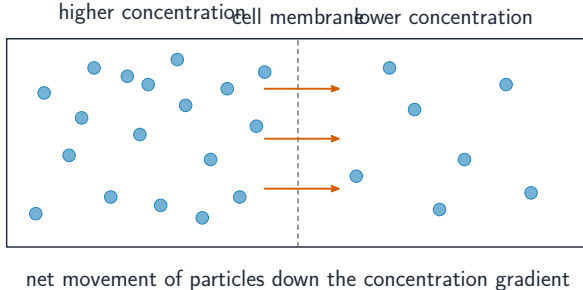
- 1 Diffusion
- 2 Osmosis
- 3 Osmosis & plant cells
- 4 Active transport
- 5 Comparing the three



active transport



Diffusion



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

The **energy** for diffusion comes from the **kinetic energy** of the random movement of **molecules** and **ions** – 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**, and no energy is needed.

Why water

Water is the solvent of life. This matters for **digestion** (food must dissolve before it can be used), **excretion** (wastes leave dissolved in water) and **transport** (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 down the gradient**

surface area

more area means more molecules crossing per second

distance

a **thinner barrier** is quicker to cross

temperature

warmer molecules have more kinetic energy, so they move faster

where it matters

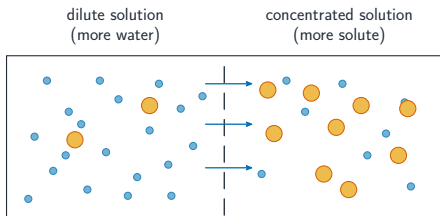
alveoli, villi and root hairs all maximise the first two and minimise the third

the gases

oxygen in and **carbon dioxide** 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

Osmosis is the net movement of **water** across a **partially permeable membrane** – one whose holes pass water but hold back the larger **solute** particles.

- **concentrated**: much solute, little water; **dilute**: the reverse
- net flow: **dilute** side → **concentrated** side
- in a cell, through the **cell membrane**

A special case of diffusion, so it needs no energy – but only **water** moves, and only through a partially permeable membrane.

Water as a solvent

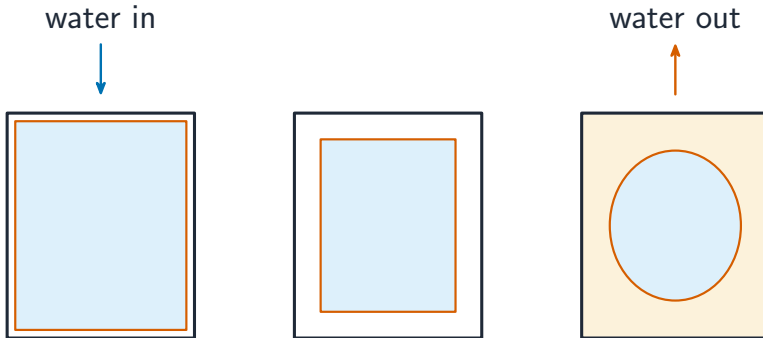
Water is a very good **solvent** – many substances **dissolve** in it to make a **solution** .

- **digestion** – food must dissolve before it can be used
- **excretion** – wastes are carried away dissolved in water
- **transport** – substances travel dissolved in blood and in sap

Every one of those three is a substance *in solution*: no solvent, no transport and no reaction.

Osmosis and plant cells

- water in → **turgid** (firm; supports the plant)
- water out → **flaccid** (soft)
- more out → **plasmolysis**



Osmosis in the words the Supplement uses

Water potential

Osmosis is the net movement of water from a region of **higher water potential** (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**, and it holds a soft plant upright.

When it is lost

In a concentrated solution water leaves, the cell becomes **flaccid**, and eventually the membrane pulls away from the wall (**plasmolysis**).

Testing it

Investigate with **dialysis tubing** – an artificial partially permeable membrane – or with cylinders cut from a potato.

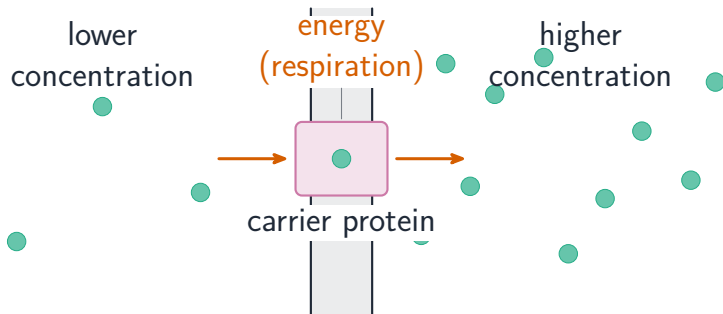
The cell wall is what makes turgor possible: an animal cell in the same solution simply bursts.



Active transport

Active transport moves particles **against** the gradient (low $\rightarrow$ high).

It needs energy from **respiration** & a **carrier protein** – 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 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?

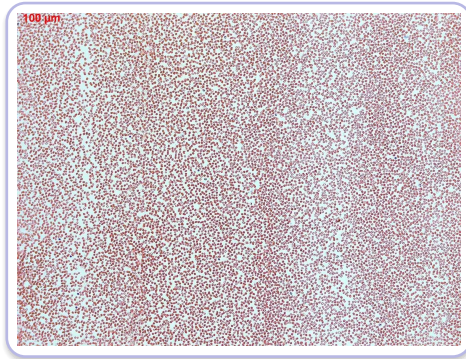
Comparing the three

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

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

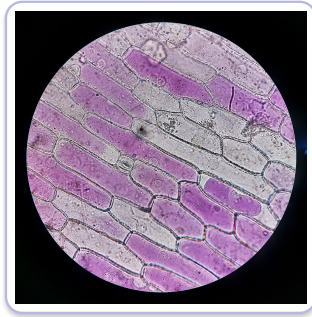
active transport – low → high (against); **needs** energy; ions & molecules

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 → turgid, longer and heavier; water out → flaccid, shorter and lighter; equal concentration → no change.
- A larger surface area, higher temperature, steeper concentration gradient and shorter distance all make diffusion faster.



Worked example – percentage change in mass

A potato cylinder is 5.0 g before soaking and 5.6 g after. Find the percentage change.

- Change in mass = $5.6 - 5.0 = 0.6$ g (a gain).
- $\% \text{ change} = \frac{\text{change}}{\text{starting mass}} \times 100$
- $= \frac{0.6}{5.0} \times 100 = +12\%$
- 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

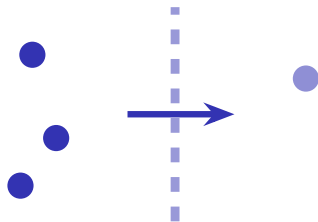
4

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