Movement into and out of cells

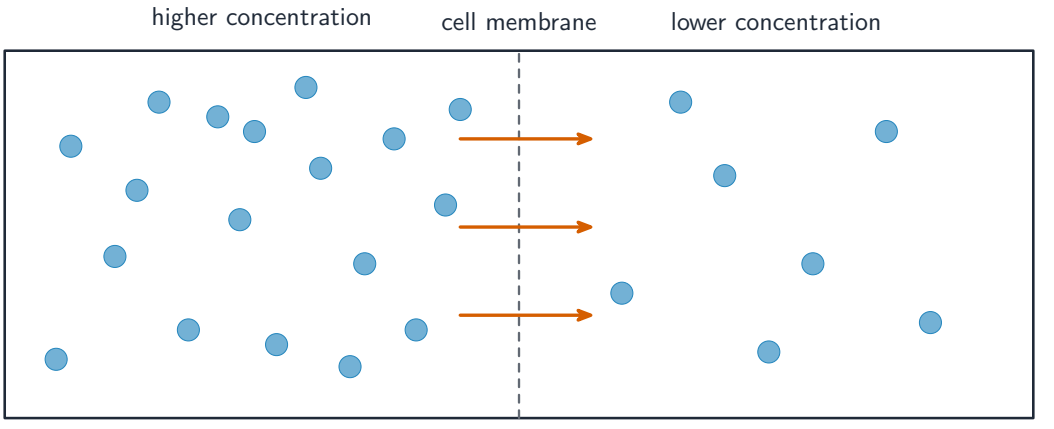
IGCSE Biology

Diffusion

Diffusion is the **net movement** of **particles** from a region of their higher **concentration** to a region of their lower concentration. We say the particles move **down a concentration gradient**.

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.

Some substances pass into and out of cells by diffusion through the **cell membrane**.



net movement of particles down the concentration gradient

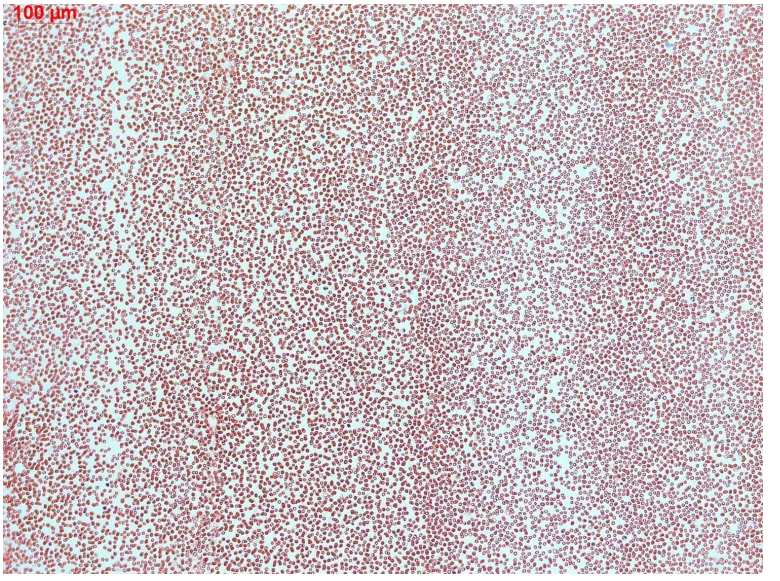
Diffusion: particles move from higher to lower concentration, down the gradient

Why diffusion matters. Many **gases** and dissolved substances (**solutes**) move by diffusion in living things. For example, **oxygen** diffuses into cells for respiration, and **carbon dioxide** diffuses out.

The rate of diffusion changes with four factors:

Factor	Diffusion is faster when...
surface area	the surface is larger
temperature	it is hotter (particles move faster)
concentration gradient	the difference in concentration is bigger
distance	the distance to travel is shorter (a thinner barrier)

Osmosis



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

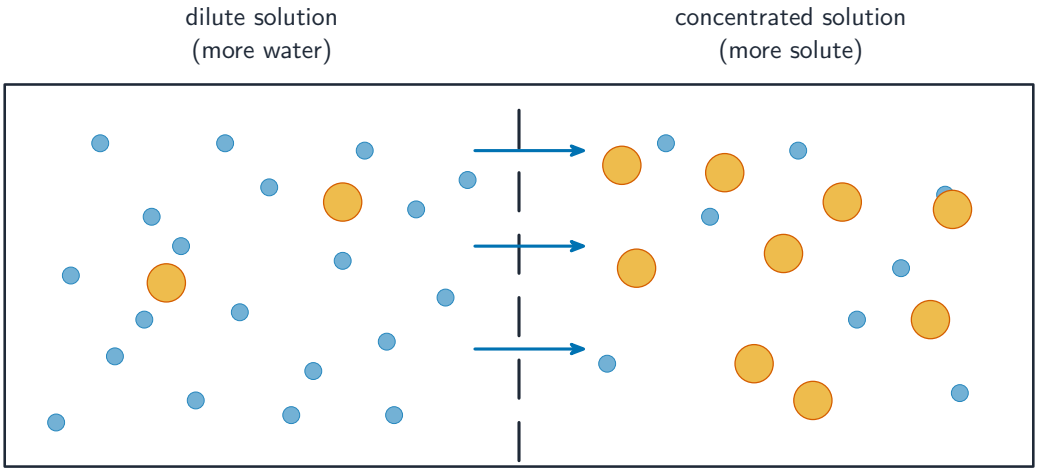
■ Water as a solvent

Water is a very good **solvent** – many substances **dissolve** in it to make a **solution**. This matters for **digestion** (food must dissolve before it can be used), **excretion** (wastes are carried away dissolved in water) and **transport** (substances travel around the body dissolved in blood and sap).

■ What osmosis is

Osmosis is a special kind of diffusion: the net movement of water across a **partially permeable membrane**. This kind of membrane has tiny holes that let small water molecules through but hold back larger solute particles. Water moves into and out of cells by osmosis through the cell membrane.

A **concentrated** solution has a lot of dissolved solute and little water. A **dilute** solution has little solute and a lot of water.



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

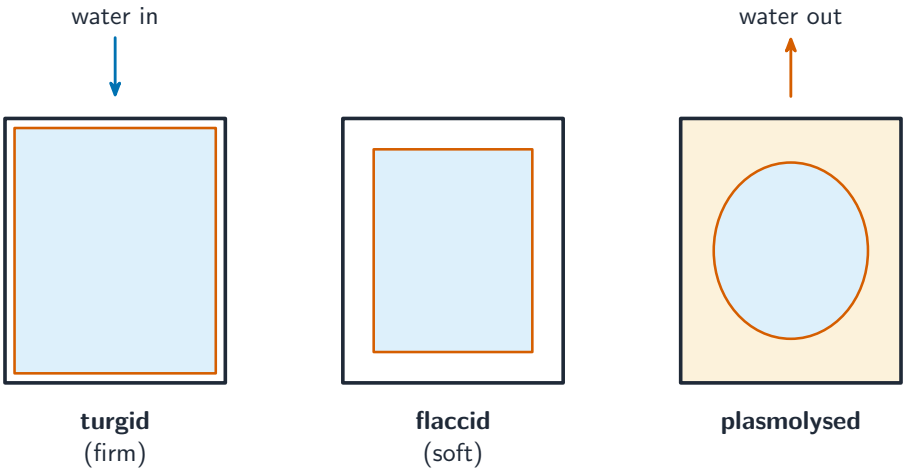
Osmosis: water crosses the partially permeable membrane; the solute cannot

(Supplement) Osmosis is the net movement of water molecules from a region of **higher water potential** (a dilute solution – more water) to a region of lower water potential (a concentrated solution – less water), through a partially permeable membrane.

■ Osmosis and plant cells

When you put plant tissue into different solutions, water moves by osmosis:

- In **pure water or a dilute solution**, water moves **into** the cells. The cells swell and become firm, or **turgid** . The water presses outward on the cell wall; this outward push is the **turgor pressure** . Turgid cells make a plant stand up straight – this is how plants are supported.
- In a **concentrated solution**, water moves **out** of the cells. The cells lose their firmness and become soft, or **flaccid** .
- **(Supplement)** If even more water leaves, the cell membrane pulls away from the cell wall. This is **plasmolysis** .



Water entering or leaving a plant cell makes it turgid, flaccid or plasmolysed

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

You can investigate osmosis using **dialysis tubing** (an artificial partially permeable membrane), or using cylinders cut from a potato. Measure their length or mass before and after soaking. Cylinders in pure water or a dilute solution gain length and mass; cylinders in a concentrated solution lose length and mass; in a solution of equal concentration there is no change.

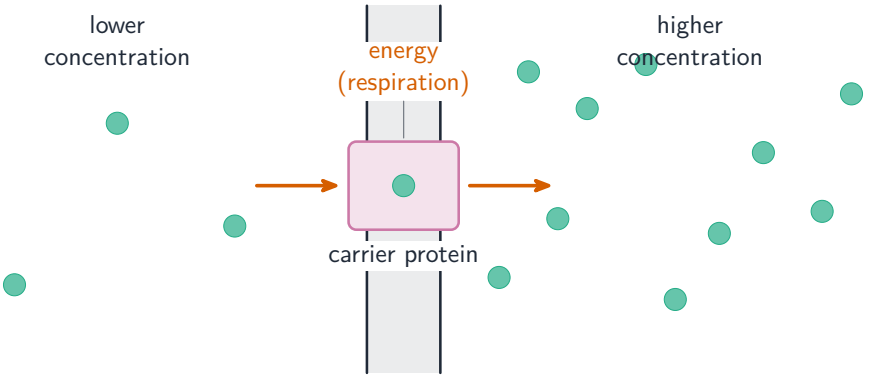
> **Worked example.** A potato cylinder has a mass of 5.0 g before soaking and 5.6 g after soaking in a dilute solution. Find the percentage change in mass.

- change in mass = 5.6 - 5.0 = 0.6 g (a gain).
- percentage change = change ÷ starting mass × 100 = 0.6 ÷ 5.0 × 100 = +12%.

A positive answer means the cylinder gained water, so the solution was more dilute than the cell contents. Always work out the *percentage* change, not just the change in grams – it lets you compare cylinders that started at different masses fairly.

Active transport

Active transport is the movement of particles through a cell membrane from a region of **lower** concentration to a region of **higher** concentration – that is, **against** the concentration gradient. Because this is "uphill", it needs energy from **respiration**.



Active transport uses energy and a carrier protein to move particles against the gradient

(Supplement) Active transport lets a cell take in useful molecules or ions even when they are already more concentrated inside the cell. For example, **root hairs** take up mineral ions from the soil by active transport. **Protein carriers** in the membrane pick up the molecules or ions and carry them across, using energy.

Comparing the three processes

Process	Direction	Energy from respiration?	What moves
diffusion	high → low concentration	no	particles, gases, solutes
osmosis	high → low water potential	no	water only
active transport	low → high concentration (against the gradient)	yes	molecules and ions

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.