

Diffusion

Revision notes · Diffusion is the net movement of particles down a concentration gradient; learn why it matters and what changes its rate.

For Cambridge IGCSE Biology 0610 (and 0970, which has the same content). **Supplement** is Extended content, only examined on Papers 2 and 4.

Diffusion Spec 3.1

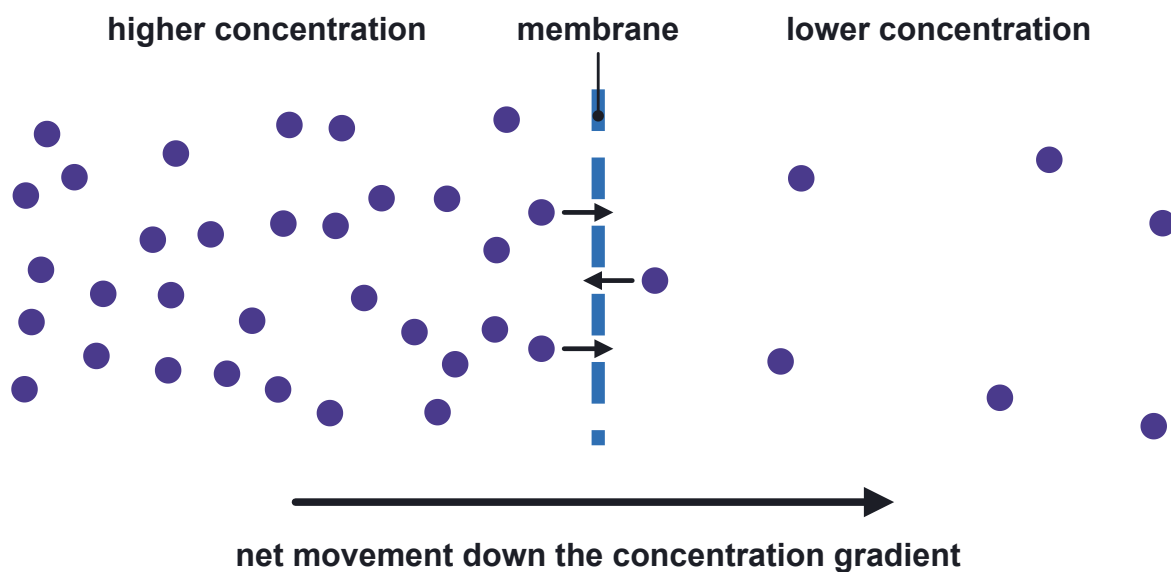
Diffusion Spec 3.1.1, 3.1.2, 3.1.3, 3.1.4

Particles in a gas or in a solution are always moving in random directions. This random movement spreads the particles out. The result is **diffusion**.

Diffusion

The net movement of particles from a region of their higher concentration to a region of their lower concentration (i.e. down a concentration gradient), as a result of their random movement.

The energy for diffusion comes from the **kinetic energy** of the random movement of molecules and ions. The cell does not need to supply any energy of its own.



Particles move both ways, but there is a **net movement** from higher to lower concentration.

Some substances move into and out of cells by diffusion through the **cell membrane**. Small molecules such as oxygen, carbon dioxide and water can pass through easily.

Why diffusion is important

- Oxygen diffuses into cells for aerobic respiration, and carbon dioxide diffuses out as a waste product.
- In a leaf, carbon dioxide diffuses into the cells for photosynthesis and oxygen diffuses out.
- Digested food molecules (solutes) diffuse from the gut into the blood.
- Urea, a waste solute, diffuses out of cells into the blood plasma to be excreted.

Exam tip: Always write 'net movement' and 'down a concentration gradient'. Particles move in both directions, but more move from the region of higher concentration.

Common mistake: Do not say that particles 'want' to spread out or that the cell 'pulls' them in. Diffusion is passive: it only depends on random movement.

Investigating the factors that affect diffusion Spec 3.1.5

You need to investigate four factors that affect the rate of diffusion: **surface area**, **temperature**, **concentration gradient** and **distance**.

Factors affecting the rate of diffusion		
Factor	Effect on rate	Reason
Surface area	Larger surface area, faster diffusion	More particles can cross at the same time
Temperature	Higher temperature, faster diffusion	Particles have more kinetic energy and move faster
Concentration gradient	Steeper gradient, faster diffusion	A bigger difference in concentration gives a greater net movement of particles
Distance	Shorter distance, faster diffusion	Particles have less far to travel

Practical skill: Investigate surface area using cubes of agar jelly containing indicator. Use phenolphthalein in dilute sodium hydroxide (pink in alkali) and place the cubes in dilute hydrochloric acid. The acid diffuses in and the pink colour disappears. Wear eye protection.

1. Cut agar cubes of different sizes (for example 0.5 cm, 1 cm and 2 cm sides) with a scalpel on a tile.
 2. Put each cube in the same volume of dilute hydrochloric acid at the same temperature.
 3. Time how long each cube takes to turn colourless all the way through.
 4. Repeat each size and calculate a mean time.
 5. To test temperature, use the same size of cube in acid at different temperatures, for example 20, 30, 40 and 50 °C.
- Independent variable: cube size (or temperature, or acid concentration).
 - Dependent variable: time taken to turn colourless.
 - Control variables: volume and concentration of acid, temperature, how the cubes are cut and timed.

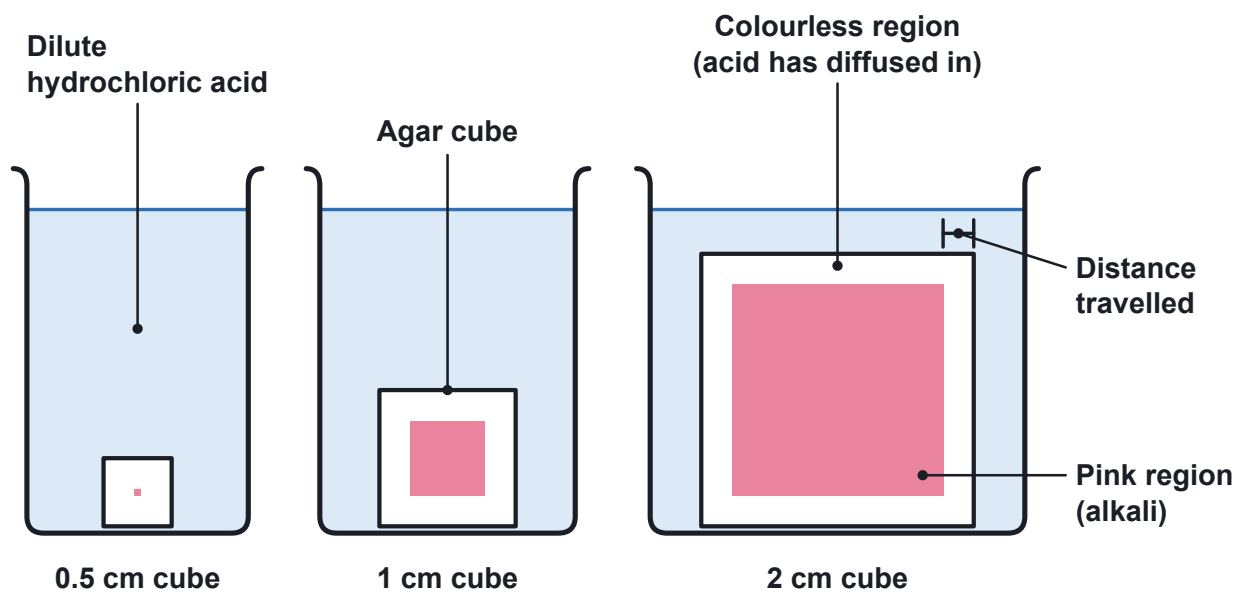
The smallest cube loses its colour first. Small cubes have a larger surface area compared with their volume, and the acid has a shorter distance to travel to the centre.

Surface area to volume ratio

Calculate the surface area to volume ratio of a 2 cm cube.

1. Surface area = $6 \times (2 \times 2) = 24 \text{ cm}^2$.
2. Volume = $2 \times 2 \times 2 = 8 \text{ cm}^3$.
3. Ratio = $24 \div 8 = 3$.

Answer: 3 : 1 (a 1 cm cube has a ratio of 6 : 1, so it is larger and diffusion into it is faster).



After the same time the acid has travelled the **same distance** into each cube, so the smallest cube turns colourless first.

Quick check

1. Describe diffusion.
2. Where does the energy for diffusion come from?
3. Name two substances that move into or out of cells by diffusion.
4. Name the four factors you investigate that affect the rate of diffusion.

Quick check answers

Diffusion

- 1 . The net movement of particles from a region of their higher concentration to a region of their lower concentration (i.e. down a concentration gradient), as a result of their random movement.
- 2 . The kinetic energy of the random movement of molecules and ions.
- 3 . Any two from: oxygen, carbon dioxide, urea, digested food molecules.
- 4 . Surface area, temperature, concentration gradient and distance.