

# Factors affecting the rate of diffusion

Revision notes · How surface area, concentration gradient and diffusion distance change the rate of diffusion, and how to use Fick's law.

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

## Factors affecting the rate of diffusion **Spec 8.4B-8.5B** **Triple only**

### Factors affecting the rate of diffusion **Spec 8.4B**

Three factors affect how fast particles diffuse across an exchange surface.

| Factors affecting the rate of diffusion               |                                                                                   |                                                                                               |
|-------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Factor                                                | Effect on rate of diffusion                                                       | Example in the body                                                                           |
| <b>Surface area</b>                                   | Larger surface area means a faster rate, because more particles can cross at once | Millions of alveoli in the lungs                                                              |
| <b>Concentration gradient</b>                         | A steeper gradient (bigger difference in concentration) means a faster rate       | Blood flow and breathing keep the oxygen concentration lower in the blood than in the alveoli |
| <b>Diffusion distance (thickness of the membrane)</b> | A shorter distance means a faster rate                                            | Alveolus and capillary walls are one cell thick                                               |

Diffusion is the net movement of particles from a region of higher concentration to a region of lower concentration. The bigger the difference, the faster the net movement.

*Common mistake: A short diffusion distance means a thin membrane. Do not say that a thin membrane gives a larger surface area, because these are two separate factors.*

### Fick's law **Spec 8.5B**

Fick's law combines the three factors. The rate of diffusion is **proportional to** the surface area multiplied by the concentration difference, divided by the thickness of the membrane.

$$\text{rate of diffusion} \propto (\text{surface area} \times \text{concentration difference}) \div \text{thickness of membrane}$$

The symbol  $\propto$  means is proportional to. So doubling the surface area doubles the rate, doubling the concentration difference doubles the rate, and doubling the thickness halves the rate.

#### Using Fick's law

A membrane has a surface area of 30 units and a thickness of 2 units. The concentration difference across it is 5 units. Calculate the rate of diffusion in arbitrary units.

1. Multiply surface area by concentration difference:  $30 \times 5 = 150$ .
2. Divide by thickness:  $150 \div 2 = 75$ .

**Answer:** 75 arbitrary units

*Maths skill: Because the law uses proportionality, the answer is a relative rate and is often given in arbitrary units. Show each step of your working to get method marks.*

### **Quick check**

- 1 . Name the three factors that affect the rate of diffusion.
- 2 . What happens to the rate of diffusion if the membrane becomes twice as thick?
- 3 . Write Fick's law in words.

## Quick check answers

### Factors affecting the rate of diffusion

1. Surface area, concentration gradient and diffusion distance.
2. It halves, if the other factors stay the same.
3. Rate of diffusion is proportional to surface area  $\times$  concentration difference  $\div$  thickness of membrane.