Edexcel GCSE Biology

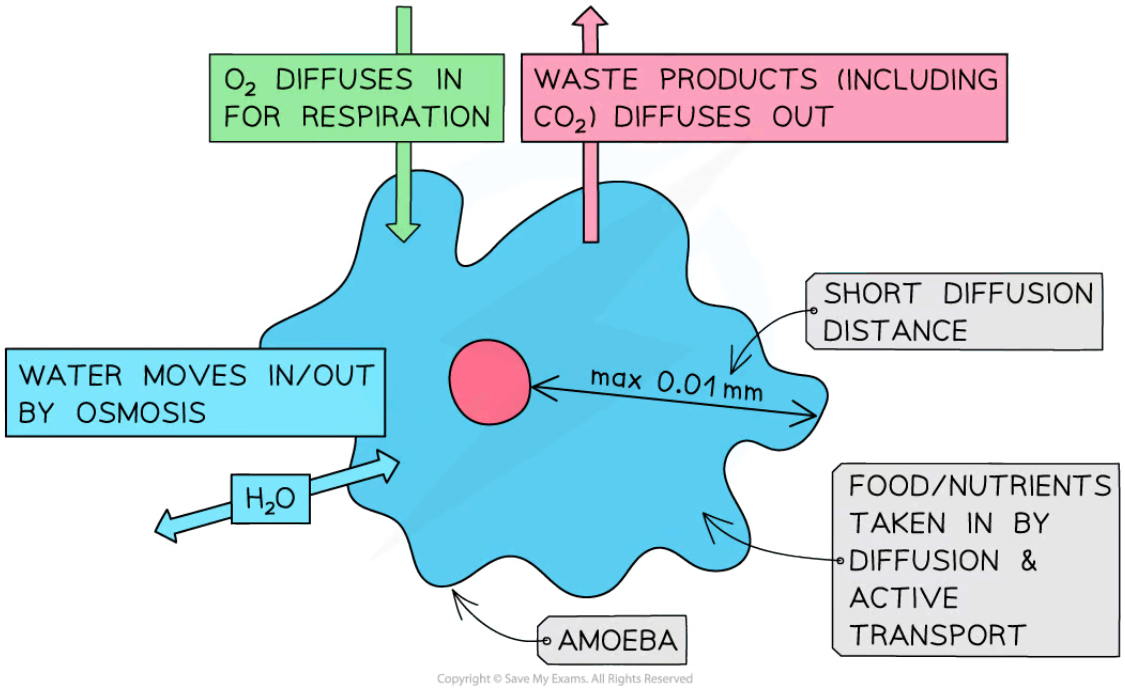
Your notes

Transport in Animals

Contents

The Need for Transport

- In order for any organism to function properly, it needs to **exchange substances** between itself and the environment such as:
  - Oxygen
  - Carbon dioxide
  - Water
  - Dissolved food molecules
  - Mineral ions
  - Urea
- This exchange of substances occurs across the **cell membrane**
- There are three transport processes that living organisms use for exchange: **diffusion**, **osmosis** and **active transport**
- **Unicellular (single-celled) organisms** like amoeba have very large surface areas (**SA**) in comparison to their **volumes**
  - This means that the distance between the surface of the organism to its centre is very small
- As a result, unicellular organisms do not need to have specialist exchange surfaces or transport systems; as **diffusion**, **osmosis** and **active transport** through the cell membrane occur at a sufficient rate to meet the needs of the organism



Unicellular organisms such as amoeba do not require transport systems due to their large surface area to volume ratio

Multicellular organisms

- For larger, multicellular organisms the distance between the surface of the organism to its centre is relatively long
- This is why larger organisms usually have exchange surfaces and transport systems; as **diffusion**, **osmosis** and **active transport** cannot happen sufficiently to meet a larger organism's needs otherwise
- **Transport systems** in animals include:
  - The **blood and circulatory system** - carries the necessary substances around the body
- **Transport systems** in plants include:
  - The **xylem** - moves water and mineral ions from roots to shoots
  - The **phloem** - moves sugars and amino acids to where they are needed in the plant

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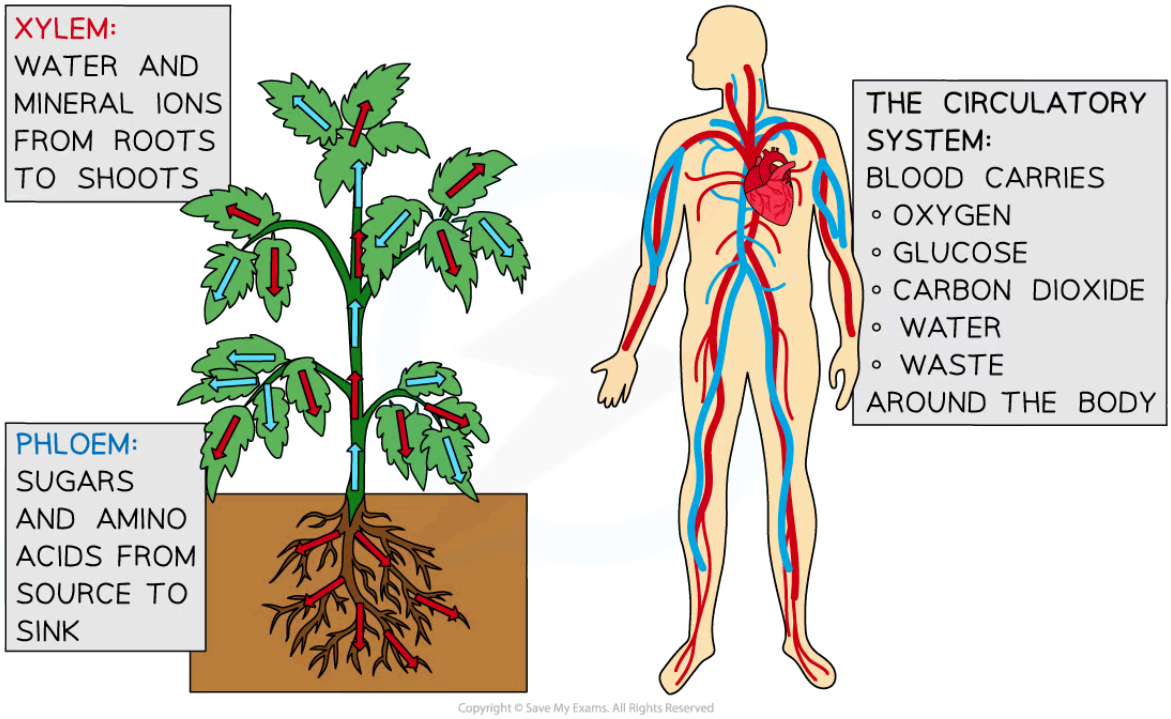

Some examples of transport systems in plants and animals

The Need for Exchange Surfaces

- **Large, multicellular organisms** like humans have relatively **small surface areas** (**SA**) in comparison to their **volumes**
- This is why larger organisms need exchange surfaces within their transport systems to carry out **diffusion**, **osmosis** and **active transport** at a sufficient rate
- **Exchange surfaces** in animals include:
  - The **lungs and alveoli** for gas exchange
  - The **small intestines and villi** for absorption of digested food
- **Exchange surfaces** in plants include:
  - **Roots and root hairs** where mineral ions and water are absorbed
  - The **leaves** for gas exchange

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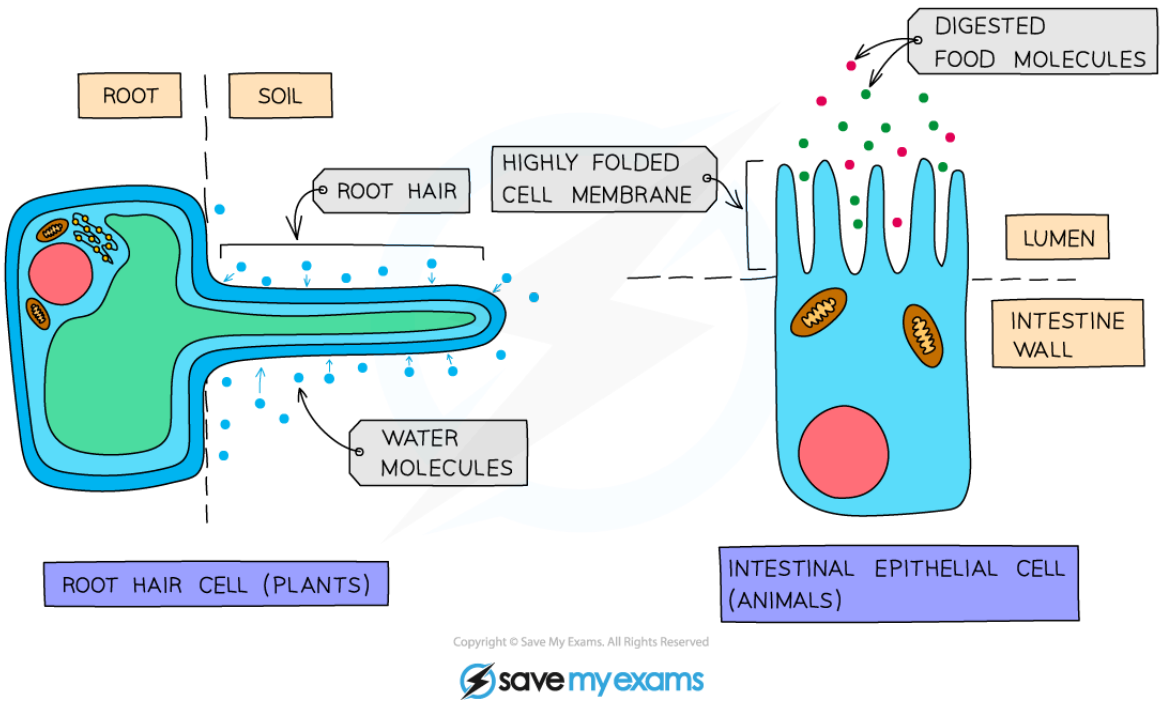

Some examples of exchange surfaces in plants and animals

Properties of exchange surfaces

- Multicellular organisms have surfaces and organ systems that **maximise the exchange of materials** by increasing the efficiency of exchange in a number of ways:
  - Having a **large surface area** to increase the rate of transport
  - A barrier that is as thin as possible to separate two regions, to provide as **short a diffusion path** as possible for substances to move across
- In addition, animals have:
  - A large network of blood vessels throughout the body:
    - To reduce the distance of exchange of materials between cells and the bloodstream
    - To move substances towards or away from exchange surfaces to **maintain concentration gradients**
  - Gas exchange surfaces that are well ventilated to maintain **concentration gradients**
- You should be able to **calculate and compare** surface area to volume ratios

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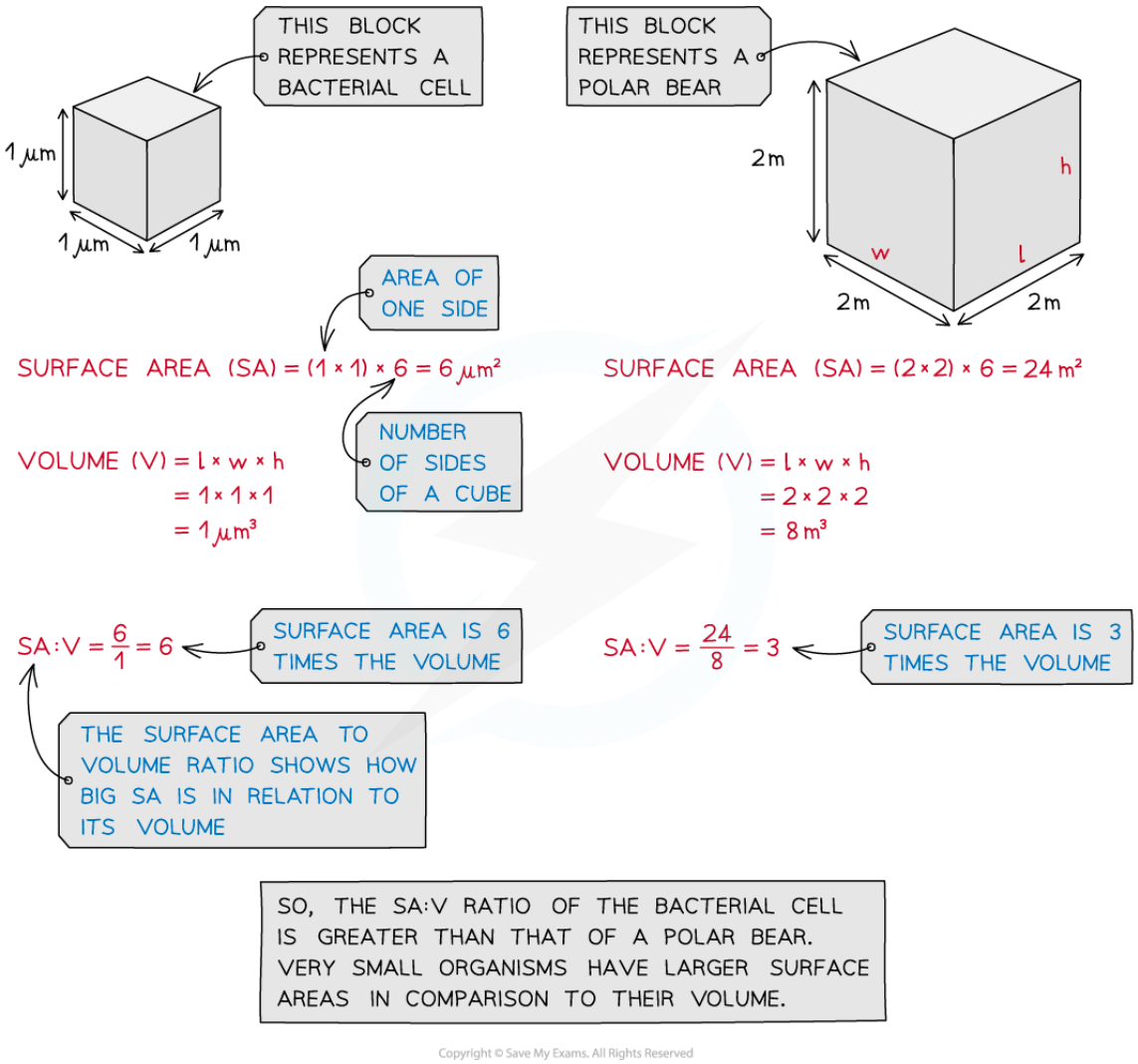
- You can model the effect of how increasing size affects surface area to volume ratio using simple cubes:



Calculating the surface area to volume ratio

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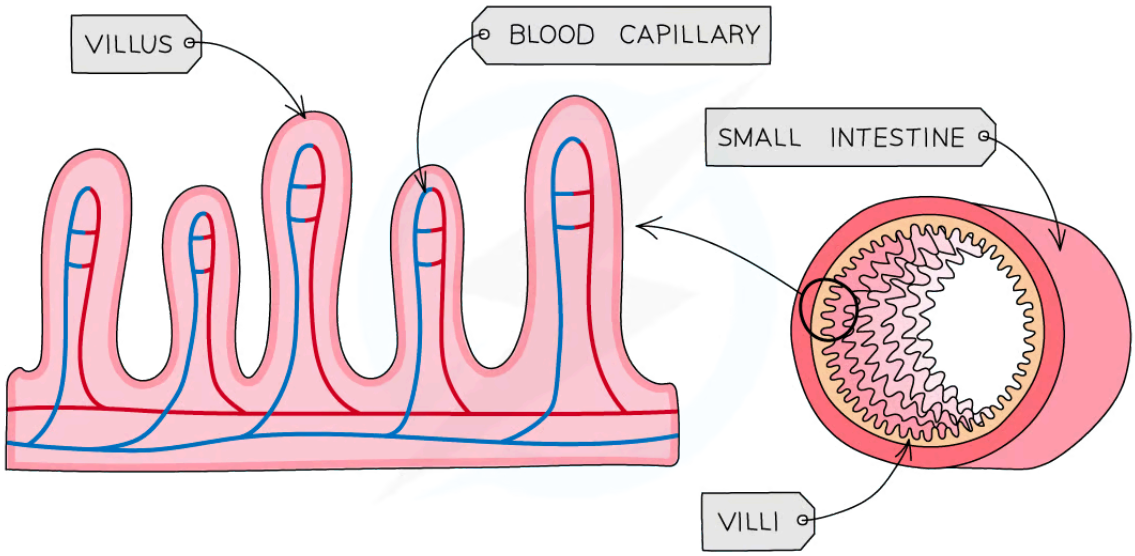
Factors Affecting the Rate of Diffusion

- The rate of diffusion in an organism can be affected by the surface area, diffusion distance, concentration gradient and temperature

Surface area

- The **bigger** a cell or structure is, the **smaller its surface area to volume ratio** is, slowing down the rate at which substances can move across its surface
- Many cells which are adapted for diffusion have **increased surface area** in some way - e.g. root hair cells in plants (which absorb water and mineral ions) and cells lining the ileum in animals (which absorb the products of digestion)



The highly folded surface of the small intestine increases its surface area

Diffusion distance

- The **smaller the distance** molecules have to travel the **faster** transport will occur

- This is why blood capillaries and alveoli have walls which are only one cell thick, ensure the rate of diffusion across them is as fast as possible

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Concentration gradient

- The **greater the difference** in concentration on either side of the membrane, the **faster** movement across it will occur
- This is because on the side with the higher concentration, more random collisions against the membrane will occur

Temperature

- The **higher** the temperature, the **faster** molecules move as they have more energy
- This results in more collisions against the cell membrane and therefore a faster rate of movement across them

Summary of Diffusion Factors Table

Factor	How it affects diffusion
Difference in concentrations (concentration gradient)	The greater the difference in concentration between two regions, the faster the overall rate of diffusion.
Temperature	The higher the temperature, the more kinetic (movement) energy the particles of that substance will have. They will move / spread faster compared to when at a lower temperature when they have less kinetic energy
Surface area of a membrane separating two regions	A membrane with a greater surface area will have a greater rate of diffusion across it (think of there being more 'entry or exit points' for particles to cross).

Fick's law

- The rate of diffusion can be described using Fick's law:

Rate of diffusion ∝ (surface area x concentration gradient) ÷ diffusion distance

- "∝" means proportional to
- According to the law, if the surface area or concentration gradient doubles, or the diffusion distance halves, then the rate of diffusion will double

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Examiner Tips and Tricks

Remember that diffusion is a passive process, so when it occurs in a living organism the cells of that organism do not provide the particles involved with energy to diffuse. The particles that are moving about randomly have their own kinetic energy.