

Movement of Substances:

1. Diffusion

- Diffusion is the net movement of molecules from a region of higher concentration to a region of lower concentration, down a concentration gradient. (Definition)
- It is a passive process as energy is not required
- Diffusion will continue to occur until the molecules are uniformly distributed throughout on both sides of the membrane. Concentration is equal in both regions A and B.
- The dye molecules are still moving, and will continue to move across the membrane at equal rates in both directions
- When the molecules have reached equilibrium between the two regions, the concentrations are the same and there will be no net movement of molecules.

2. Factors that affect the rate of diffusion

- Concentration gradient
 - The steeper the concentration gradient (difference in concentration) between two regions, the faster the rate of diffusion.
 - Concentration gradient is the difference in concentration between two regions (Extra knowledge)
- Size of particle
 - The larger the size of the particles, the slower the rate of diffusion as the larger particle require more kinetic energy to move compared to a smaller particle.
- Temperature
 - The higher the temperature, the faster the rate of diffusion. When temperature increases, the average kinetic energy possessed by the particles increases and they move faster, hence the rate of diffusion increases.
- Distance over which diffusion occurs
 - The shorter the distance over which diffusion occurs, the faster the rate of diffusion across the distance.
- Surface area to volume ratio
 - The larger the surface area to volume ratio, the faster the rate of diffusion.

- Density of medium in which diffusion occurs
 - Diffusion occurs at different rates in different media: gas > liquid > solid. Diffusion occurs fastest in gases and slowest in solids. Solids have higher density than liquids and gases as the particles within solids are more closely packed and hence diffusion occurs the slowest in them.

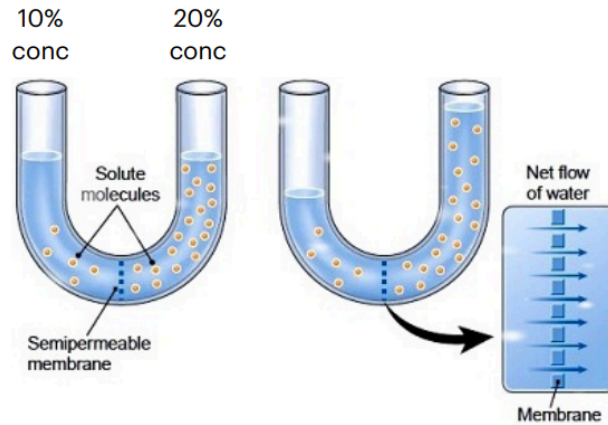
3. Concept of surface area to volume ratio

- The greater the area of a cell membrane per unit volume, the faster the rate of diffusion of a substance for a given concentration gradient. Cells need to maintain a large surface area to volume ratio to ensure the efficient exchange of materials across the cell membrane via diffusion.
- Cells depend on the surface area of the cell membrane for diffusion of materials such as nutrients, oxygen and waste. If cells cannot exchange materials quickly enough, they will die. The rate of movement of a substance across the surface of a cell depends on how large the surface area of the cell membrane per unit is i.e. surface area to volume ratio.
- The rate of diffusion of a substance across a cell membrane is dependent on:
 - Size: The smaller the cell, the larger the surface area to volume ratio, the higher the rate of diffusion.
 - Shape: Certain shapes increase the surface area to volume ratio, and thus increases the rate of diffusion.
E.g. long and narrow extension of a root hair cell, biconcave shape of a red blood cell.

4. Osmosis

- Osmosis is the net movement of water molecules from a solution of higher water potential to a solution of lower water potential, through a partially permeable membrane.
- Answering Technique:
 - I (Identify the area of higher water potential)
 - D (Direction)
 - P (Process)
 - E (Result/Outcome) -Effect

- For Example, (conc = concentrated)



- Identify area of higher water potential:

A has a higher water potential than B

- Direction and Process involved:

Hence, the water molecules from A will move to B (direction) by osmosis. (process).

- Result/Outcome:

- Thus, the water level increases in B and decreases in A.

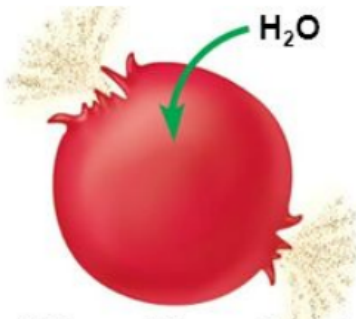
5. Effect of Osmosis on a non-woody plant

Condition	Plant watered regularly	Plant with insufficient water
State of plant cell	Turgid - water enters the plant cell.	Plasmolysed - water leaves the plant cell

Effect on whole plant (organism) (non-woody)	Firm and upright due to turgor pressure  Leaves are spread out, increasing the surface area of leaves exposed to sunlight, which results in a higher rate of photosynthesis.	Wilts due to lack of turgor pressure  Leaves droop and folds up, reducing the surface area of leaves exposed to sunlight, which results in a lower rate of photosynthesis.
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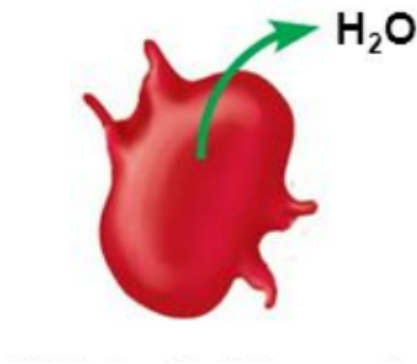
6. Effect of Osmosis on Animal Cells

An animal cell in a solution with higher water potential.



- When an animal cell is placed in a solution of higher water potential (e.g. distilled water), the cell has lower water potential than that of the solution outside the cell.
- Water enters the cell by osmosis.
- The animal cell swells and may even burst. This is cell lysis.

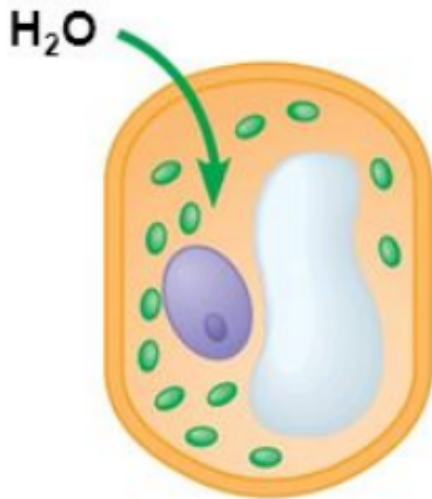
An animal cell in a solution with lower water potential (e.g. concentrated salt solution)



- When an animal cell is placed in a solution of lower water potential (e.g. concentrated salt solution), the cell has higher water potential than that of the solution outside the cell.
- Water leaves the cell by osmosis.
- The animal cell loses water, it shrinks and shrivels. Little spikes may appear on the cell membrane. The cells crenate.

7. Effects of osmosis on plant cells

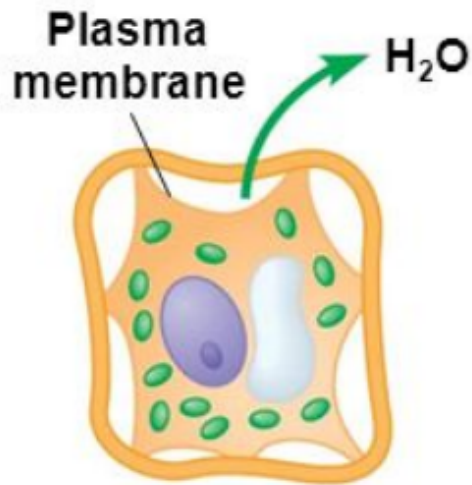
A plant cell in a solution with higher water potential (e.g. distilled water)



- When a plant cell is placed in a solution of higher water potential (e.g. distilled water), the cell sap has lower water potential than the solution outside the cell.
- Water enters the cell by osmosis. The large central vacuole increases in size and pushes the cell contents against the cell wall.
- The plant cell becomes turgid. The pressure exerted on the cell wall is known as turgor pressure.

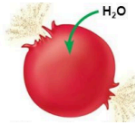
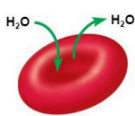
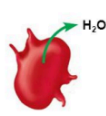
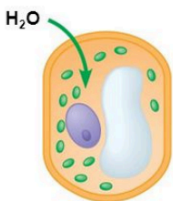
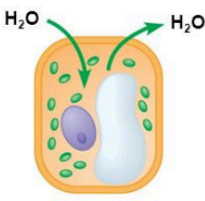
The cell does not burst because it is protected by the cell wall. The cell wall is strong and relatively inelastic. It prevents over-expansion of the cell by exerting an opposing pressure as water enters the cell. This prevents the entry of more water.

A plant cell in a solution with lower water potential (e.g. concentrated salt solution)



- When an animal cell is placed in a solution of lower water potential (e.g. concentrated salt solution), the cell sap has higher water potential than that of the solution outside the cell.
- Water leaves the cell by osmosis. The large central vacuole decreases in size.
- If water is continuously lost from the plant cell, the cytoplasm and cell membrane will eventually pull away from the cell wall. This is plasmolysis and the cell becomes plasmolysed.

8. Summary of the effect of osmosis:

	Hypotonic solution (water potential is higher than cell content)	Isotonic solution (water potential is same as cell content)	Hypertonic solution (water potential is lower than cell content)
Animal Cells	Lysed 	Normal 	Crenated 
Plant Cells	Turgid 	Normal 	Plasmolysed 