Topic 2:
Movement of substances

Chapter Analysis

FOCUS

- extremely important foundation for many future chapters

EXAM

- despite low weightage as a standalone topic, it is heavily incorporated with other chapters

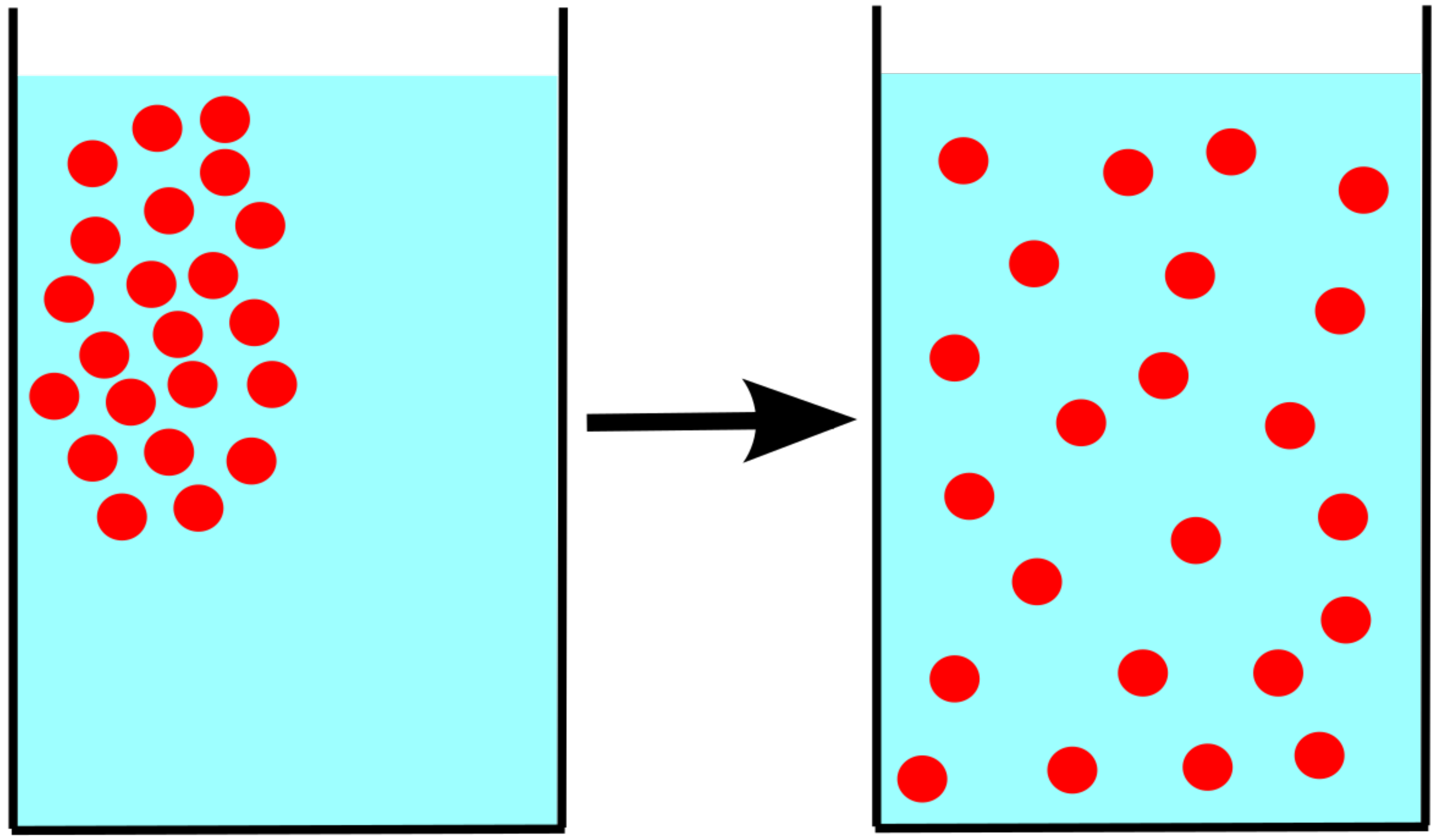
WEIGHTAGE

- Constitute to around 3% in Paper 2 in the past 5 years

Key Concept

diffusion
osmosis & effect of osmosis
active transport

Diffusion



- Diffusion is the **net movement** of **molecules** from **a region of higher concentration** to a region of **lower concentration,** down a concentration gradient.
- it is a **passive process** as energy is not required
- When the molecules have reached **equilibrium** between the two regions, the concentrations are the same and there will be **no net movement** of molecules.

ROLE OF DIFFUSION IN LIVING ORGANISMS

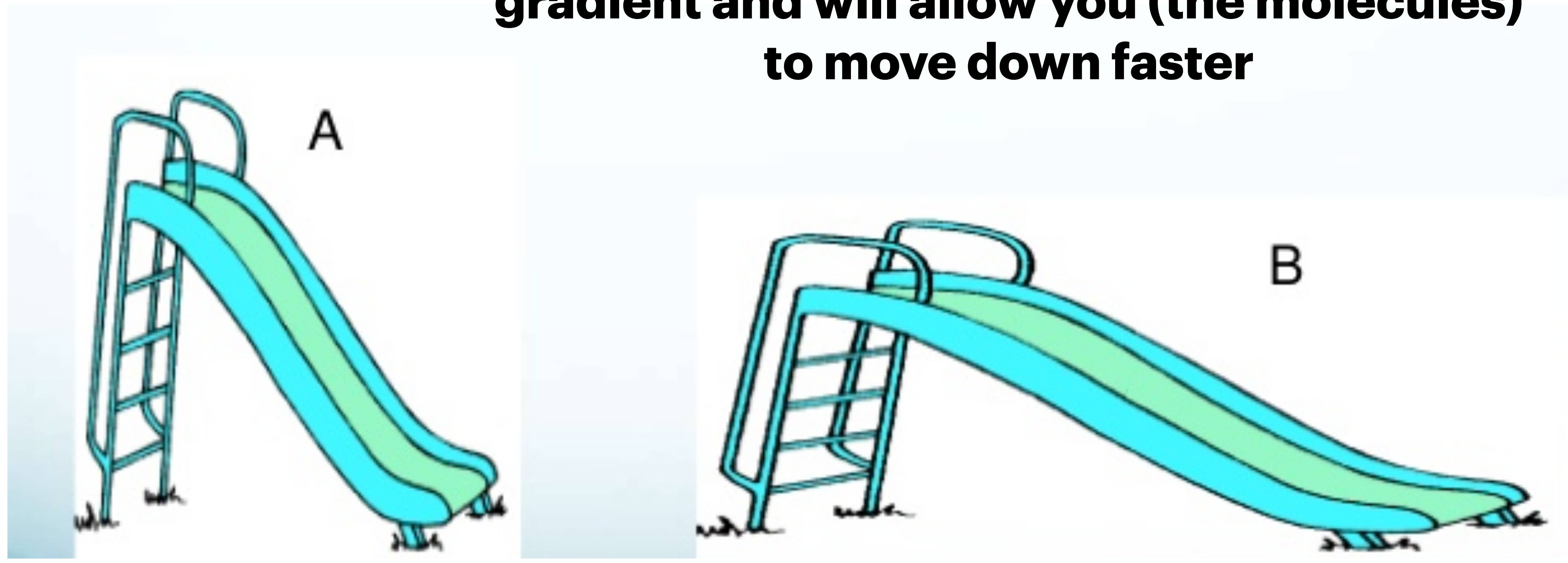
- Its role in **nutrient uptake** and **gaseous exchange** in plants and humans
- Diffusion enables living organisms, unicellular or multicellular, to survive by allowing the exchange of nutrients such as glucose, amino acid and fats, gases such as oxygen and waste substances such as carbon dioxide and urea

*** diffusion is a extremely relevant concept in future chapters**

Diffusion

FACTORS THAT AFFECT RATE OF DIFFUSION

Slide A represents a steeper concentration gradient and will allow you (the molecules) to move down faster



<u>FACTORS THAT AFFECT RATE OF DIFFUSION</u>

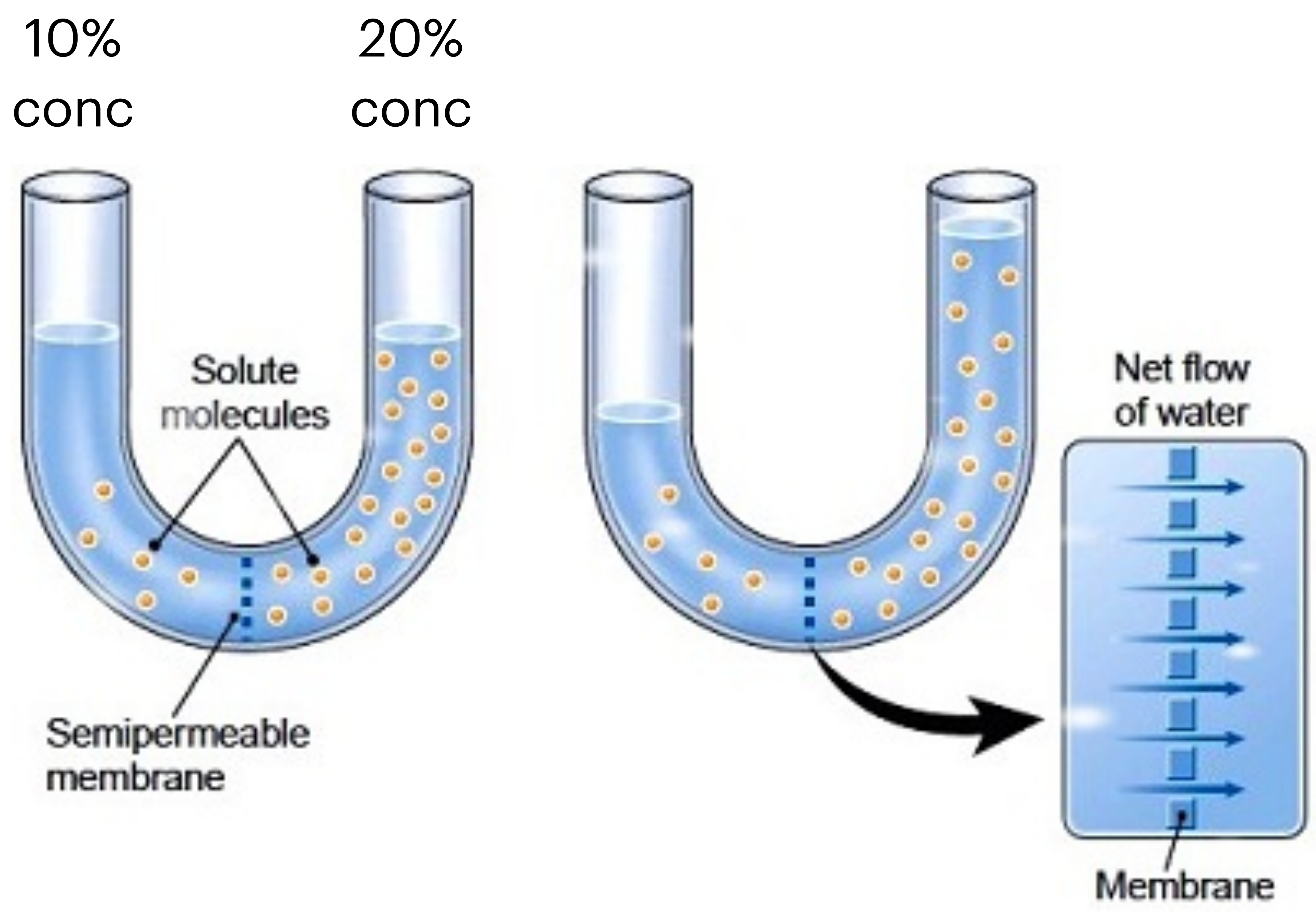
1. **Temperature**
   - ↑ in temperature, ↑ in kinetic energy of molecules

2. **Concentration gradient**
   - Concentration gradient is the difference in concentration between two regions
   - The steeper the concentration, the higher rate of diffusion

3. **Size of molecules**
   - Heavier molecules move more slowly than light molecules

4. **Diffusion distance**
   - Molecules do not have to travel far thus rate of diffusion is faster

Osmosis

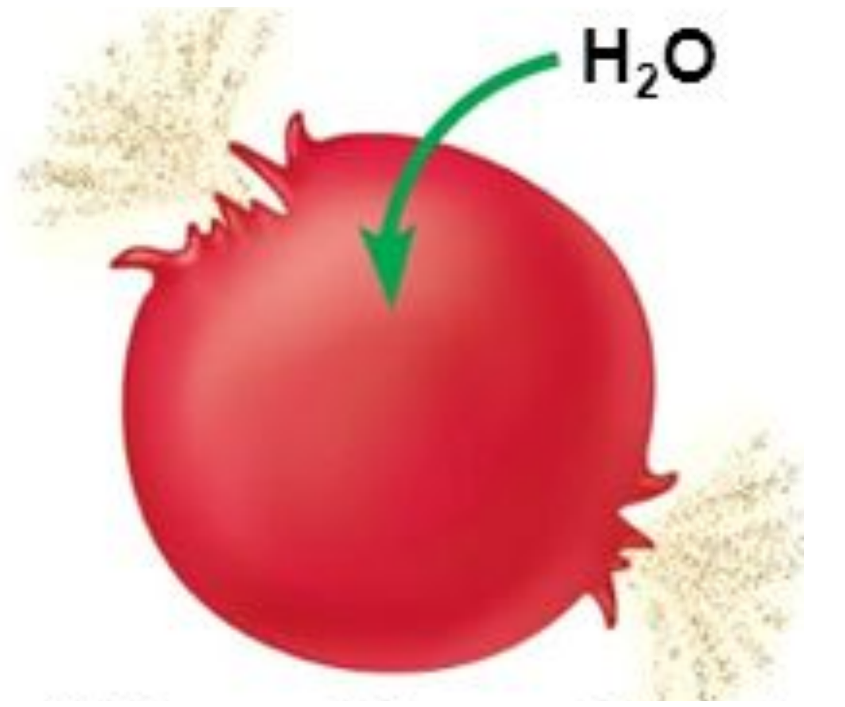


- Osmosis is the **net movement** of **water molecules** from a **region of higher water potential** to a region of **lower water potential**, through a **partially permeable membrane**
- Water potential refers to the tendency of water to move from one area to another
- **Plasma membrane or visking tubing** are examples of partially permeable membranes that only allow allow some substances such as water, gases like oxygen and carbon dioxide to pass through freely but not some other substances

Examples:

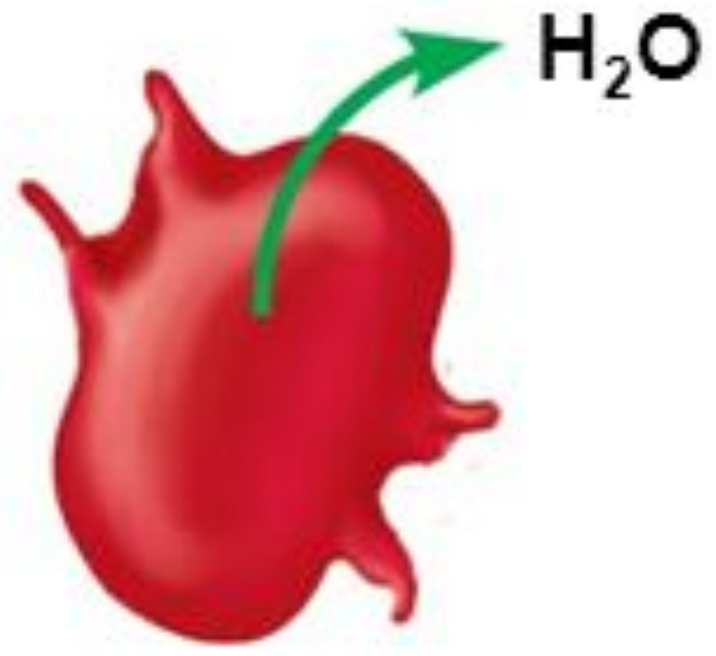
- The 20% solution is more concentrated than the 10% solution. Hence, 10% solution has a higher water potential than 20% solution. The partially permeable membrane does not allow solute molecules to pass through as it is too big.
- As a result, **water molecules** will move from the arm with the 10% solution which has a **higher water potential** to the arm with the 20% solution which has a **lower water potential,** passing through **semi permeable membrane** via **osmosis.**

Effect of osmosis on animal cells



When an animal cells is immersed in a solution with a higher water potential relative to its cytoplasm,

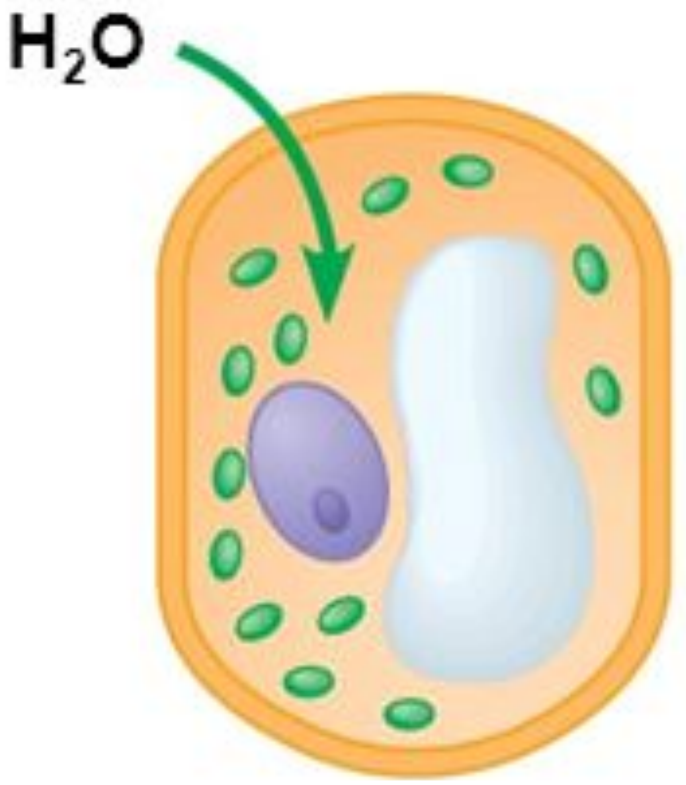
- Water moves into the cell by osmosis.
- Animal cells **do not have cell walls** to protect the cells from overexpansion. As more water enters the cell, it swells to such an extent that it **bursts**.
- **CYTOLYSIS** / the cell is lysed



When an animal cell is immersed in a solution with a lower water potential, relative to its cytoplasm,

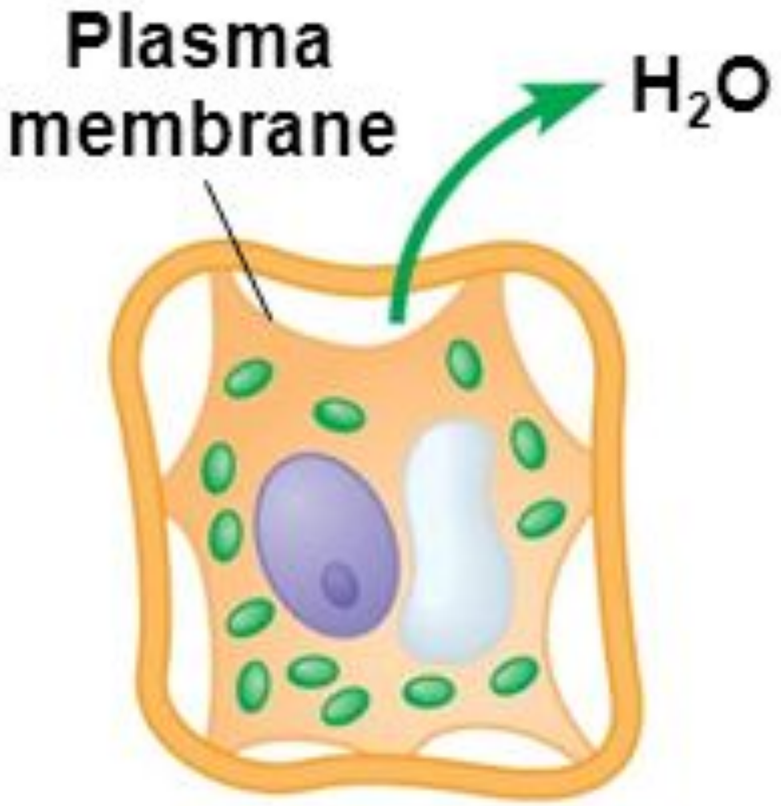
- Water moves out of the cell by osmosis.
- The cell shrinks and become dehydrated. In red blood cells, little spikes appear on the cell surface membrane.
- **CRENATION** / the cell is crenated

Effect of osmosis on plant cells



When a plant cell is immersed in a **solution of higher water potential** relative to its cell sap,

- Water molecules enter the cell by osmosis.
- The vacuole increases in size
- The cellulose cell wall of a plant cell is rigid and exerts an opposing pressure on the cell contents, preventing the entry of more water. This prevents the cell from overexpanding and bursting.
- At this point, the plant cell is very **turgid.** **TURGOR PRESSURE** provides mechanical support for many non-woody plants

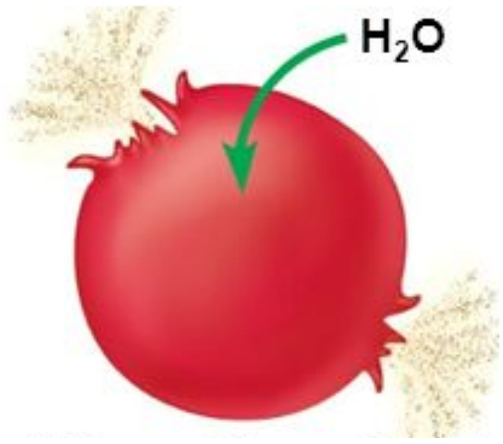
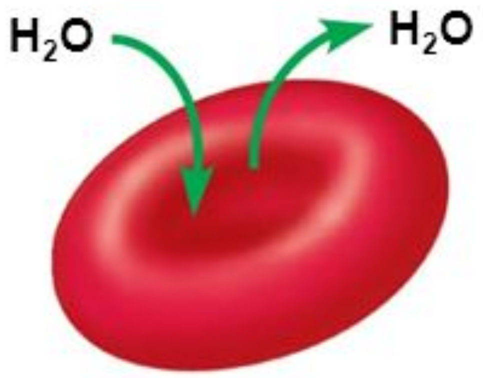
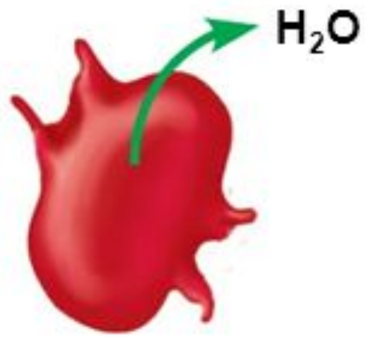
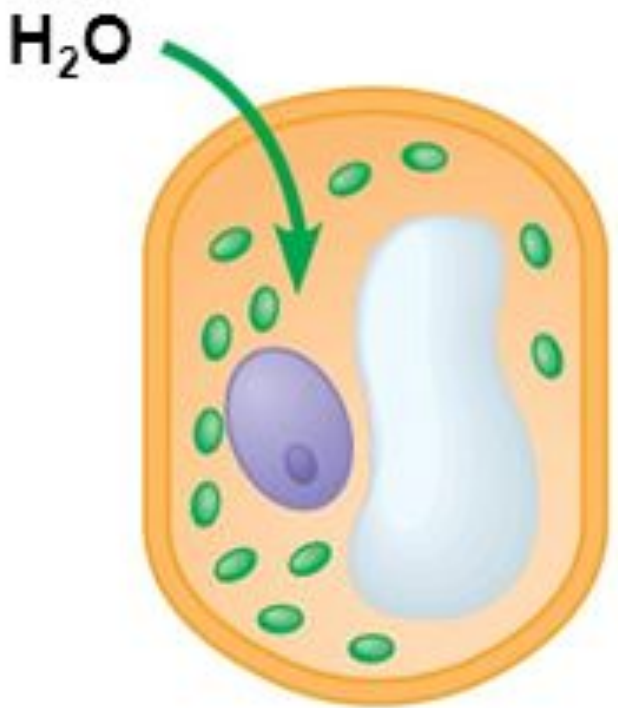
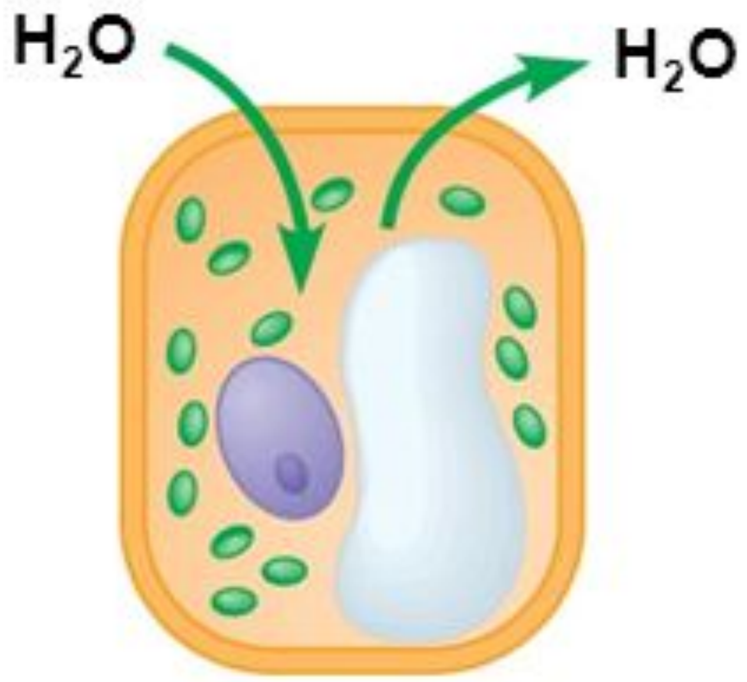


When a plant cell is immersed in a **solution with a lower water potential** relative to its cell sap,

- Water moves out of the cell into the solution by osmosis.
- The vacuole decreases in size and the cell is flaccid
- If more water leaves the cell, the vacuole and cytoplasm shrink to such an extent that the **cell surface membrane pulls away from the cell wall**
- **PLASMOLYSIS** / the cell is plasmolyse

Effect of osmosis

summary

	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