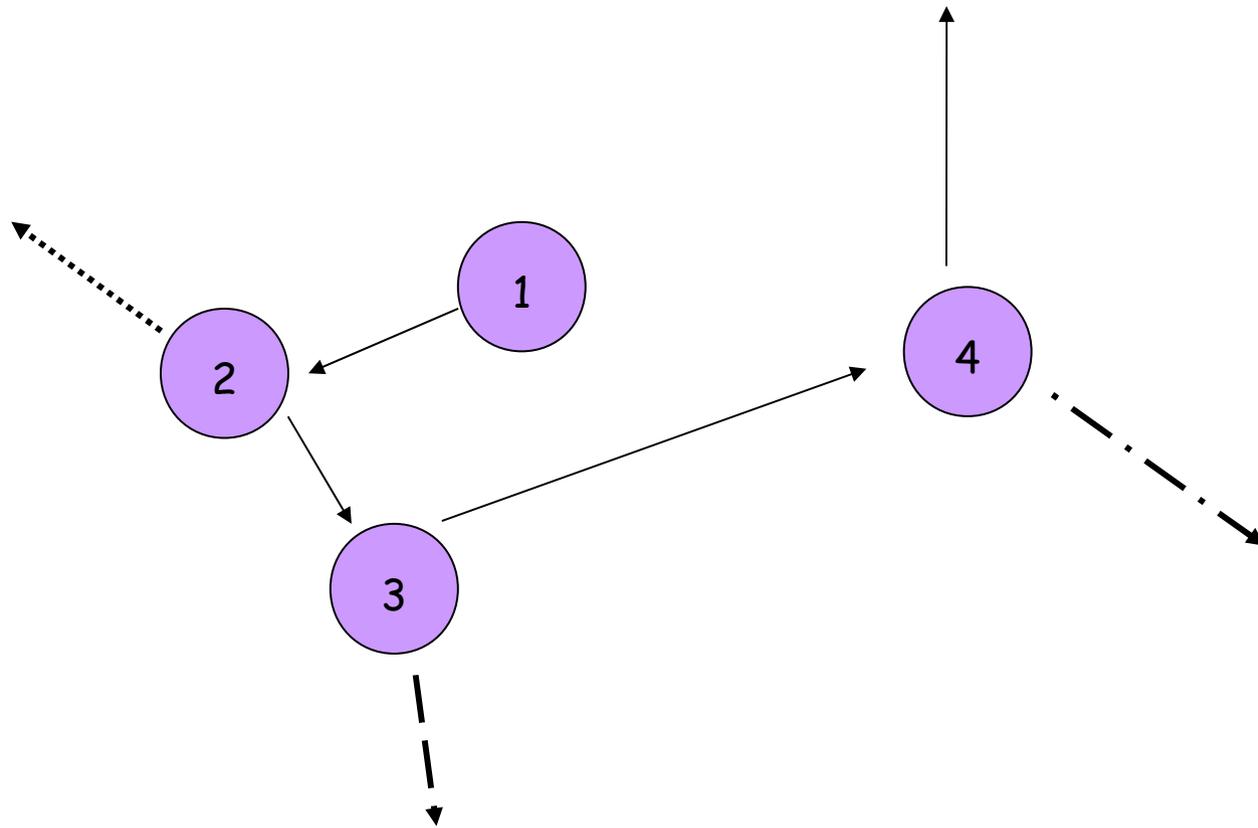


# DIFFUSION AND OSMOSIS



# Lesson 1

## Learning Objectives

1. Define diffusion and understand how it takes place.
2. Give examples of diffusion
3. Understand the term concentration gradient
4. Understand the factors that can affect the rate of diffusion.

## Outline

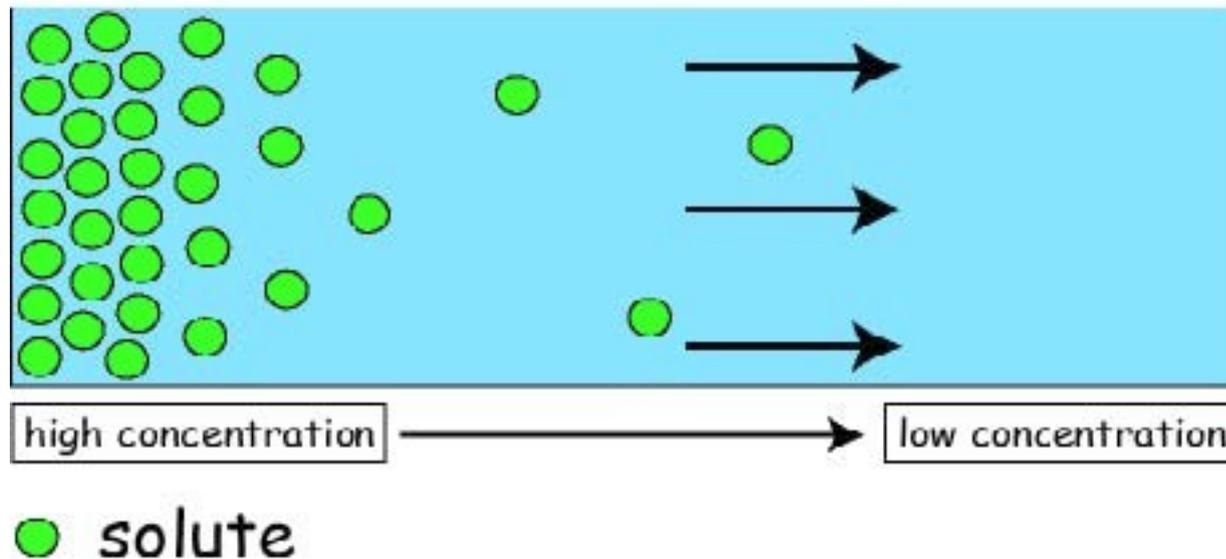
- Diffusion
  - Definition
  - Rate of diffusion

# Introduction

- Cells need to transport useful substances (e.g. food materials) and also remove waste products (e.g. carbon dioxide).
- These substances may pass through the membrane passively (i.e. without the need for energy) or actively (i.e. requires energy).
- There are two passive processes which can occur in cells: diffusion and osmosis.
- Substances may pass through the cell membrane actively by active transport.

# Diffusion

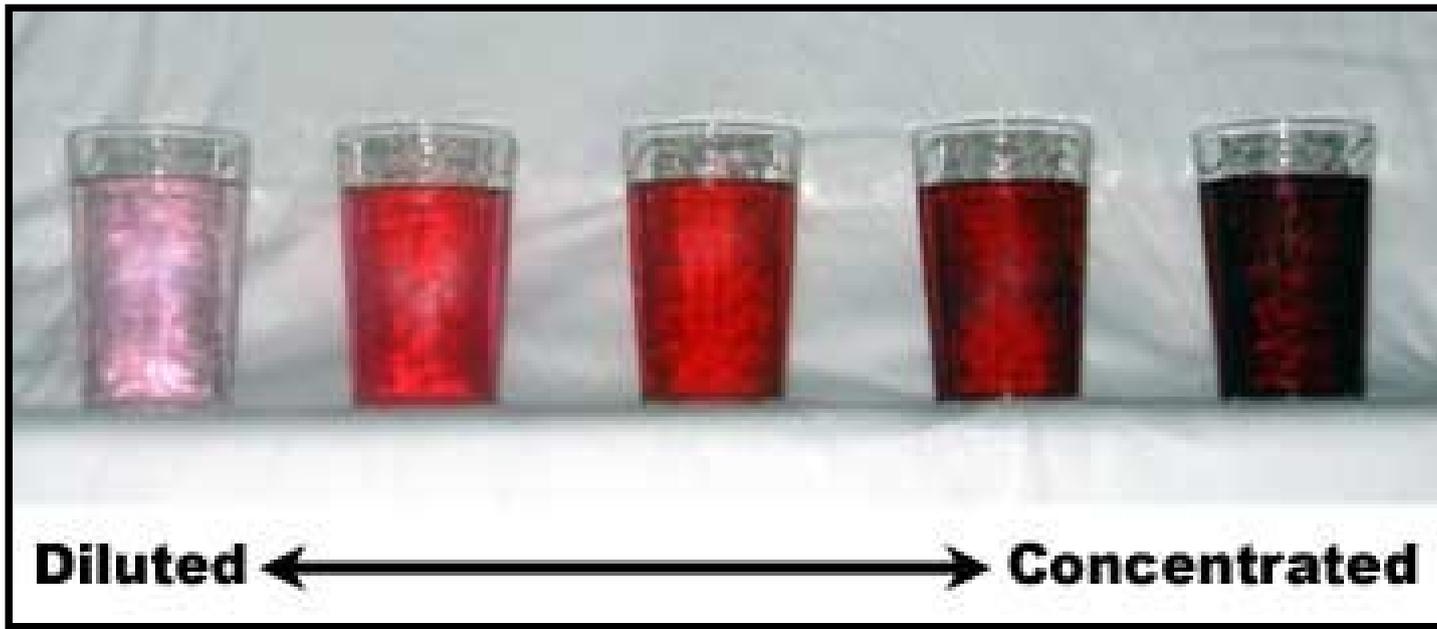
Diffusion is the movement of molecules from a region of higher concentration to a region of lower concentration, (i.e. down a concentration gradient).



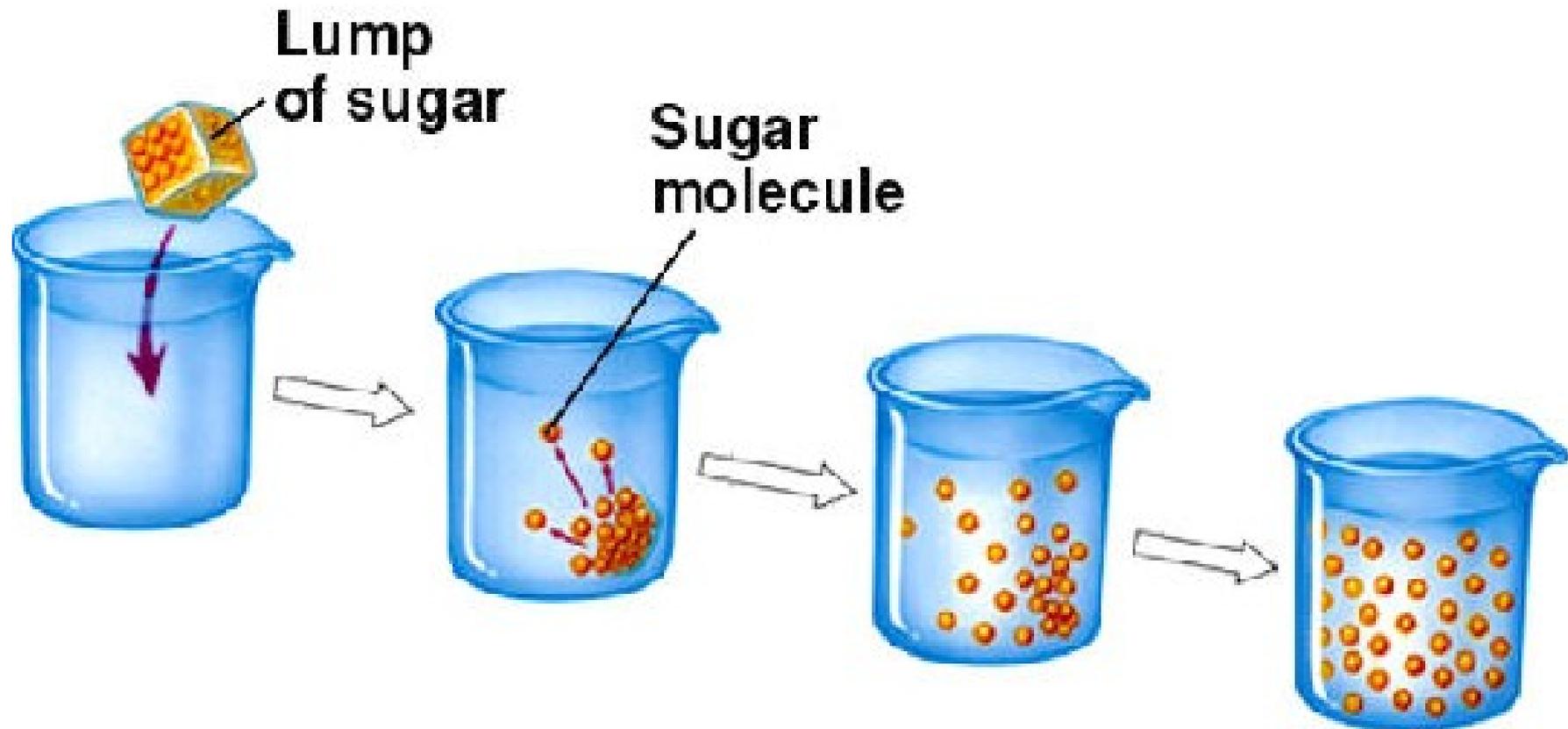
# Concentration



Concentration is amount of substance in a given volume.

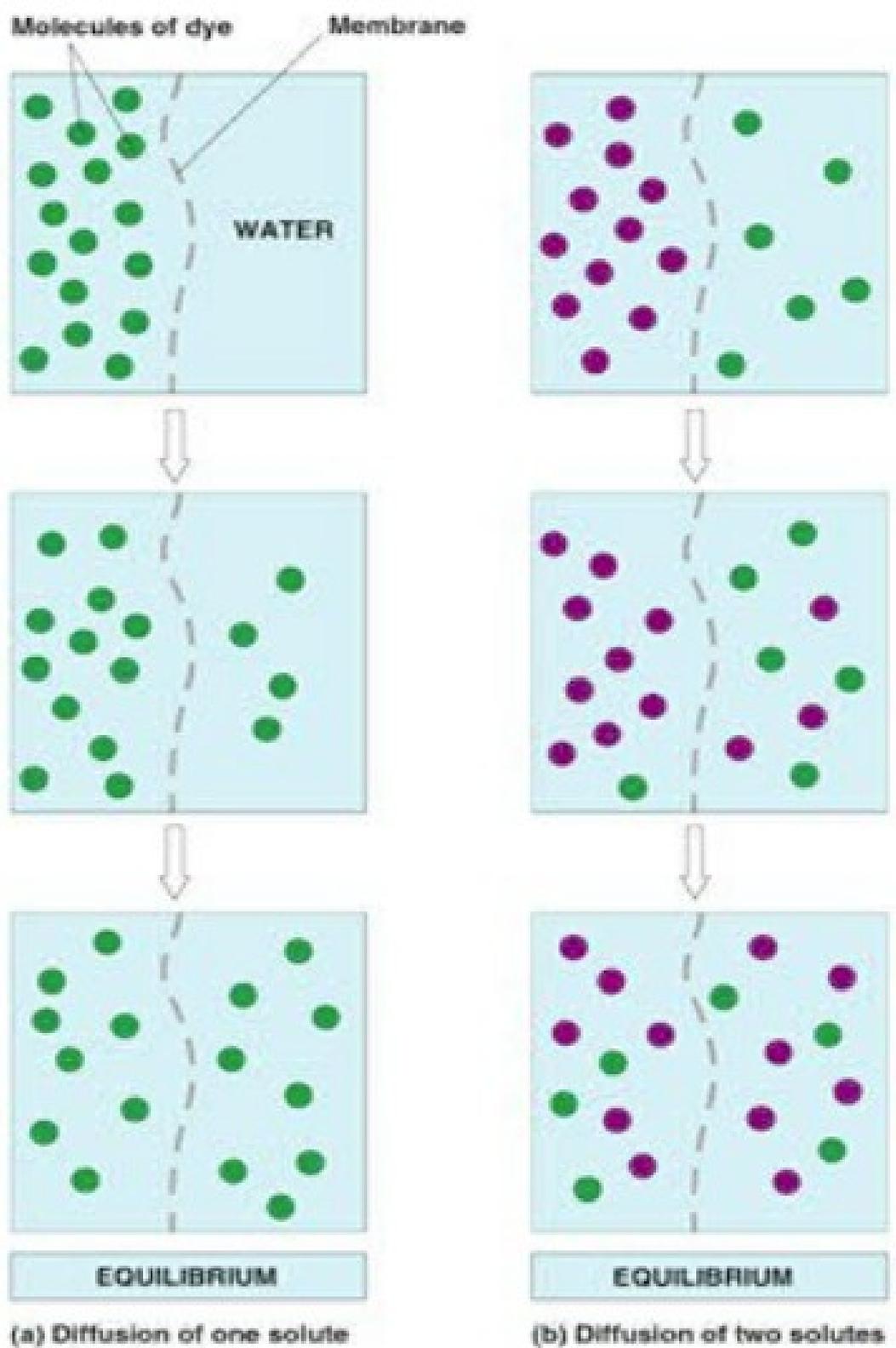


# Example of diffusion



Can you give another example of diffusion?

# Diffusion of dye

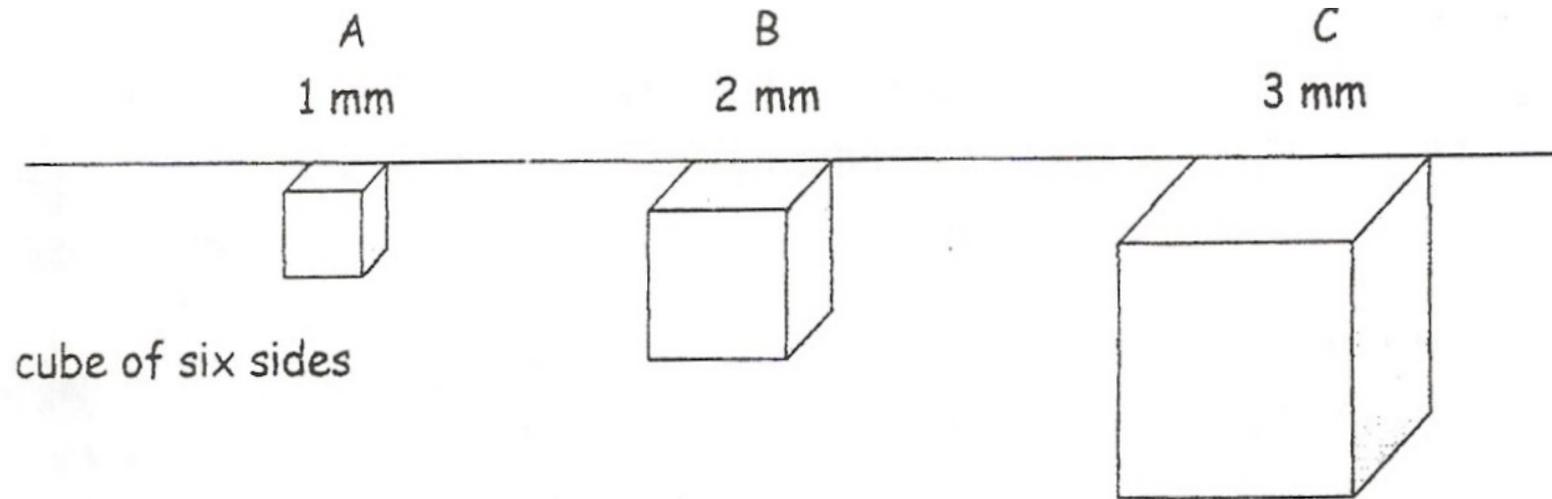


# Factors affecting rate of diffusion

Factor	Effects on diffusion
Distance	<p>The thickness of the cell membrane is generally the same amongst animal cell (i.e. <math>0.007\ \mu\text{m}</math>), but in plant cells, this might vary.</p> <p>Generally, the thicker the wall, the slower the rate of diffusion.</p>
Concentration inside and outside the cell	<p>The bigger the difference in concentration between two regions, the faster the rate of diffusion.</p> <p>The steeper the concentration gradient, the faster is the rate of diffusion.</p>

Factor	Effects on diffusion
The size of the molecules or ions	Generally, the larger the molecule or ion, the slower the rate of diffusion.
Surface area to volume ratio	Cells with a larger surface area to volume ratio have a faster rate of diffusion, and vice versa. This means that rate of diffusion is faster in smaller cells when compared to larger cells.
Temperature	The higher the temperature, the faster the rate.
Pressure	The higher the pressure, the faster the rate.

# Surface area to volume ratio



		Ratio		Ratio		Ratio
Surface area	$6 \text{ mm}^2$	= 6	$24 \text{ mm}^2$	= 3	$54 \text{ mm}^2$	= 2
Volume	$1 \text{ mm}^3$		$8 \text{ mm}^3$		$27 \text{ mm}^3$	

The smaller the size of an object (or cell), the larger the surface area to volume ratio.

# Importance of Diffusion

In animal,

- Absorption of products of digestion from the ileum (small intestine).
- Movement of oxygen from the lungs into the blood and movement of carbon dioxide from the blood into the lungs.

In plant,

- Movement of carbon dioxide from the air into the leaf.

# Lesson 2

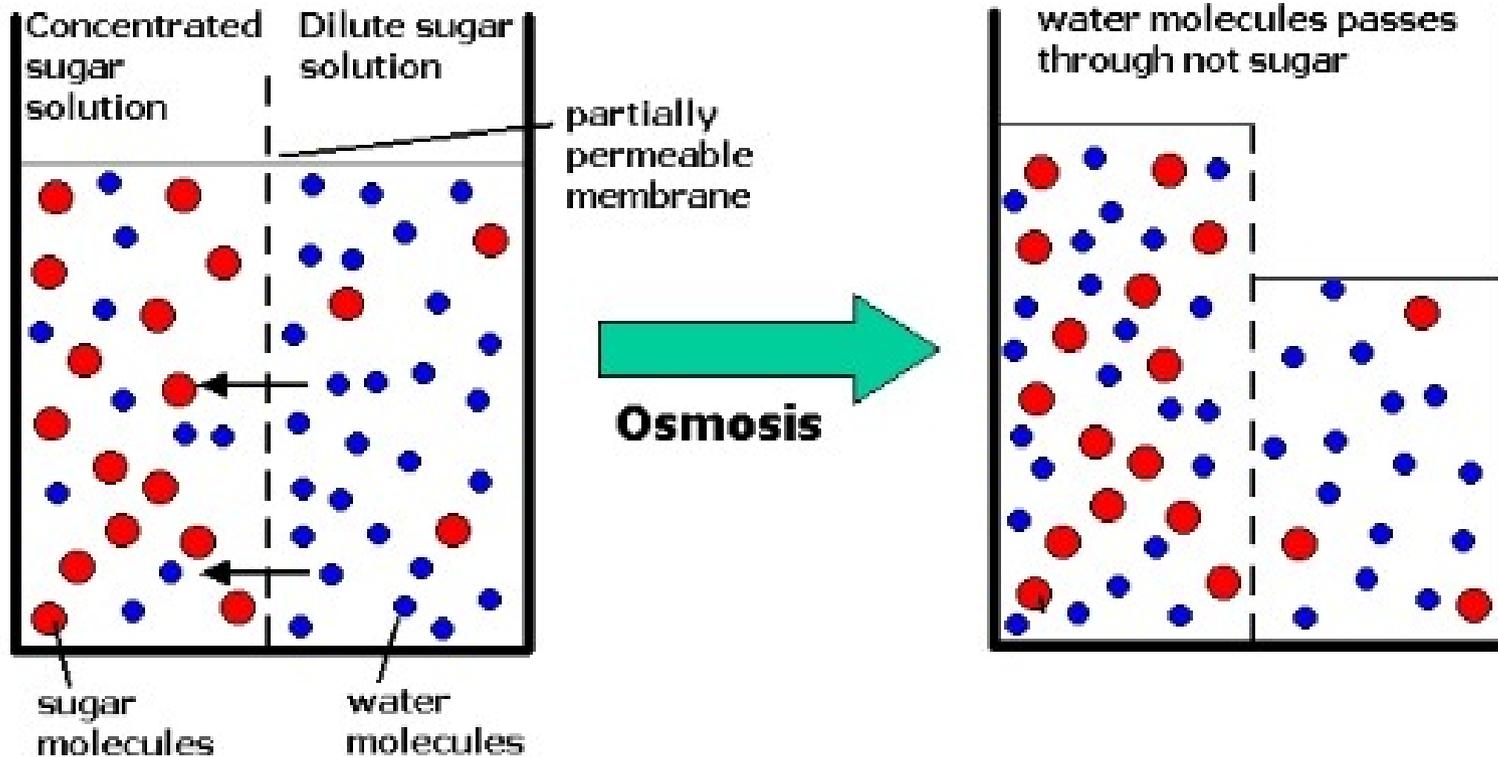
## Learning Objectives

1. Define osmosis
2. Understand the concept of water potential gradient
3. Understand the concept of hypotonic, isotonic and hypertonic solutions
4. Understand how animals and plant cells respond to immersion in solutions which are of different concentration to their cytoplasm.
5. Explain the term turgid, flaccid, turgor pressure, haemolysis, plasmolysis and crenation.
6. Describe the importance of a water potential gradient in the uptake of water by plants and turgidity in providing mechanical support to herbaceous or non-woody plants.

## Outline

- Osmosis
  - \_ Definition
  - \_ Types of solution
  - \_ Osmosis in plant and animal cells.

# Osmosis

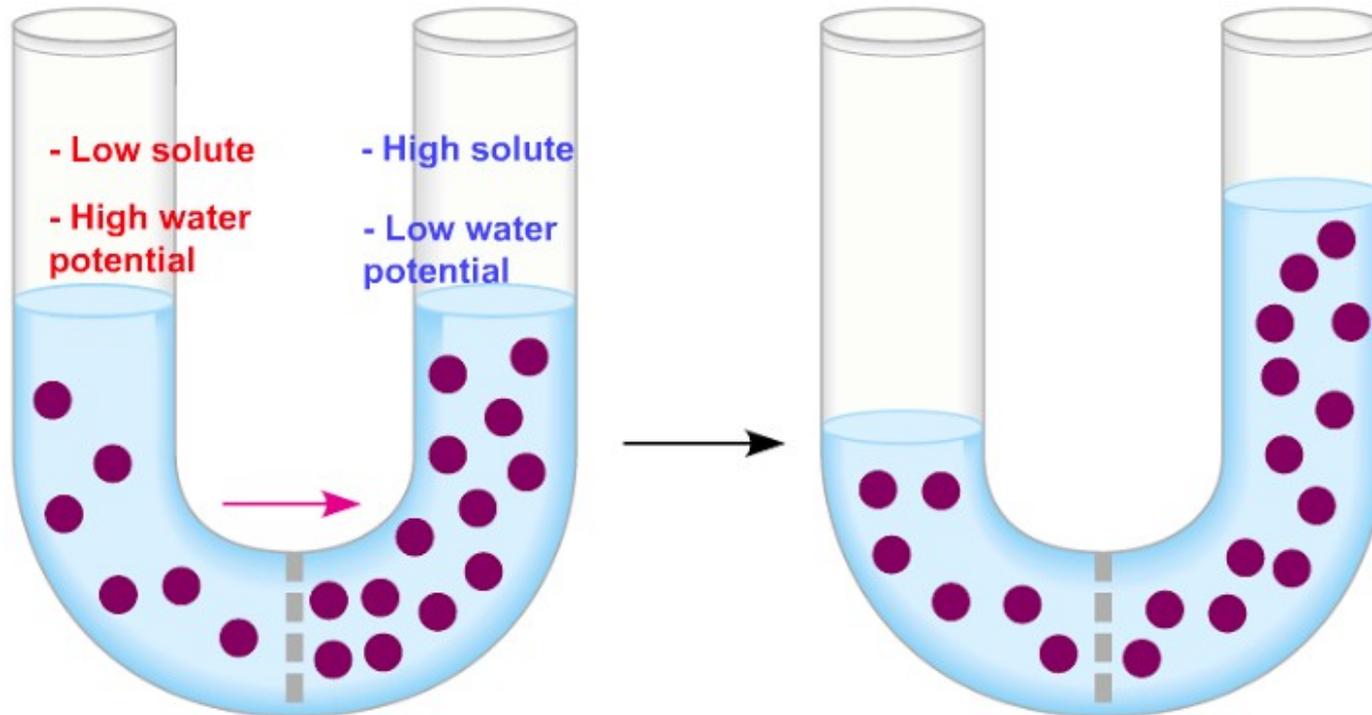


Definition:

Movement of water molecules from a region of high high water potential to a region of low water potential through a partially permeable membrane.

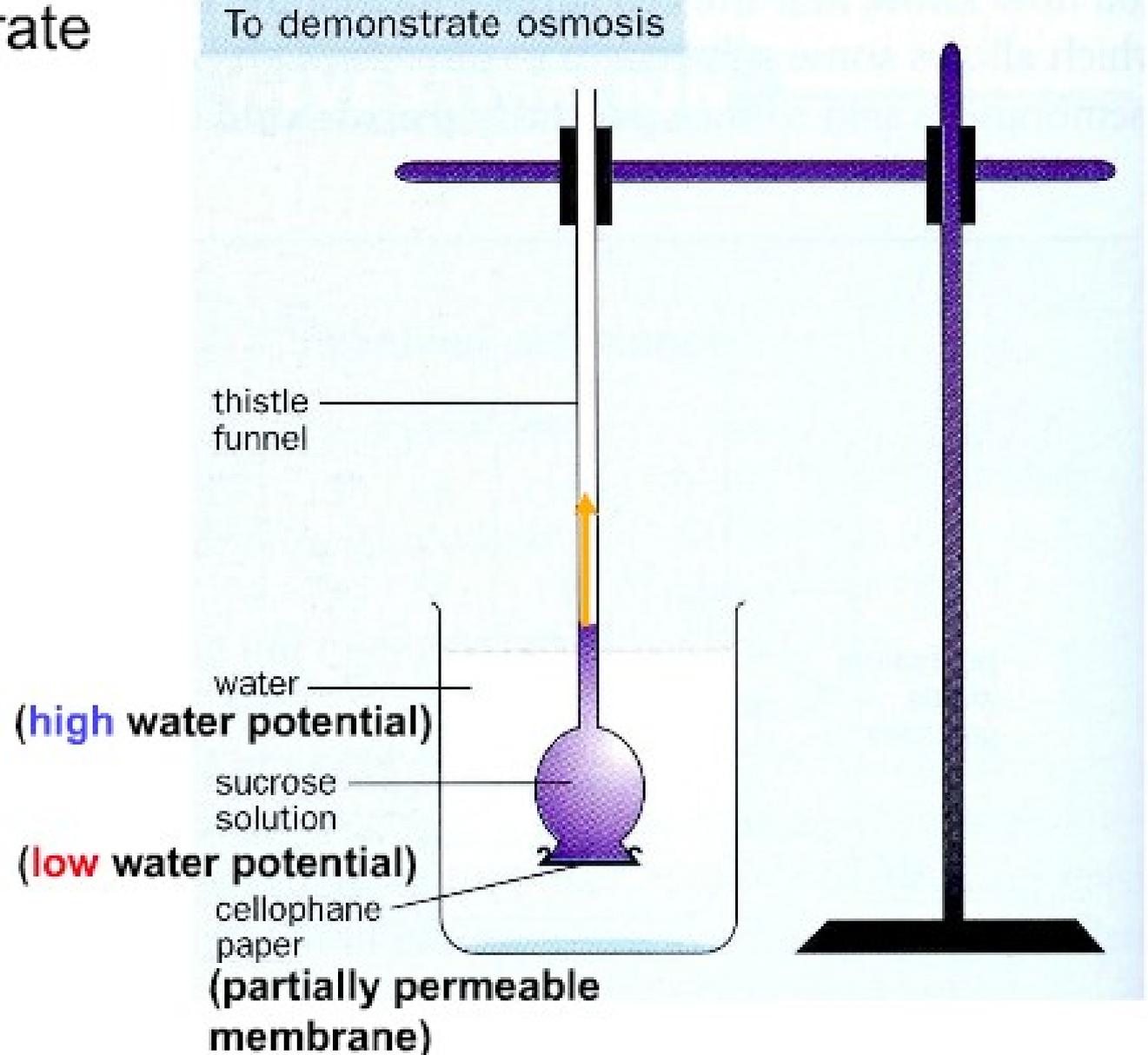
# Water Potential

- Water potential is a measure of the water molecule potential for movement in a solution.
- High solute content = Low water potential
- Low solute content = High water potential



# Osmosis Demo

Aim: To demonstrate osmosis

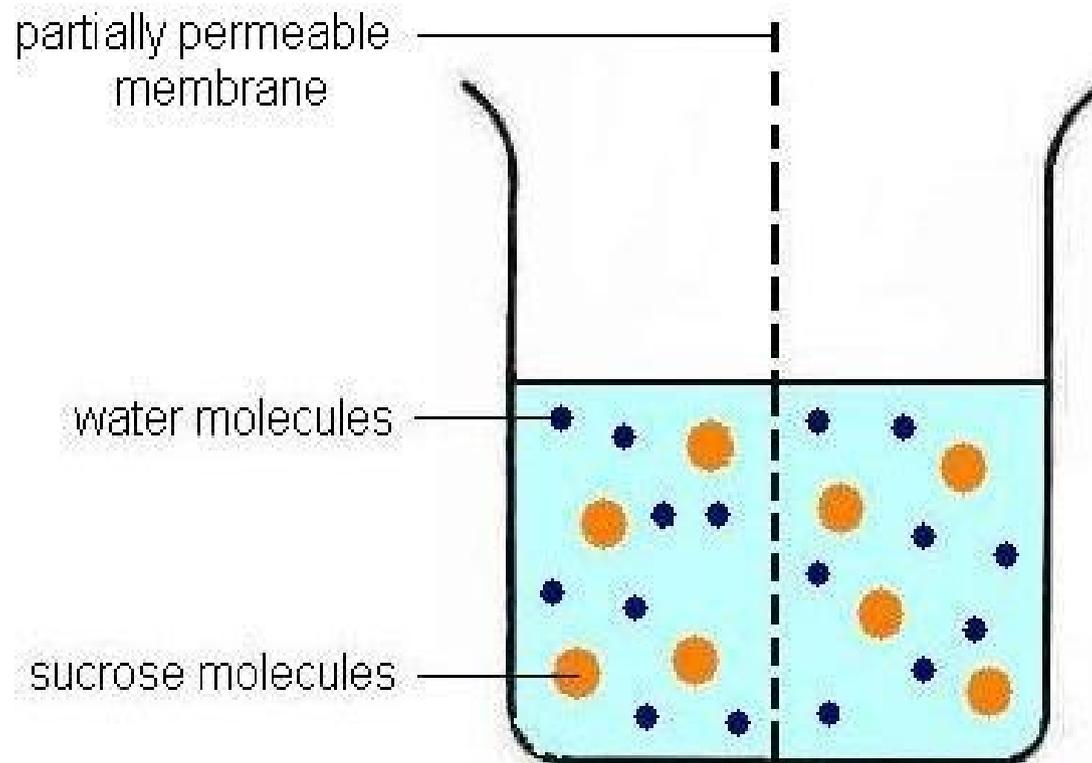


# Types of Solutions

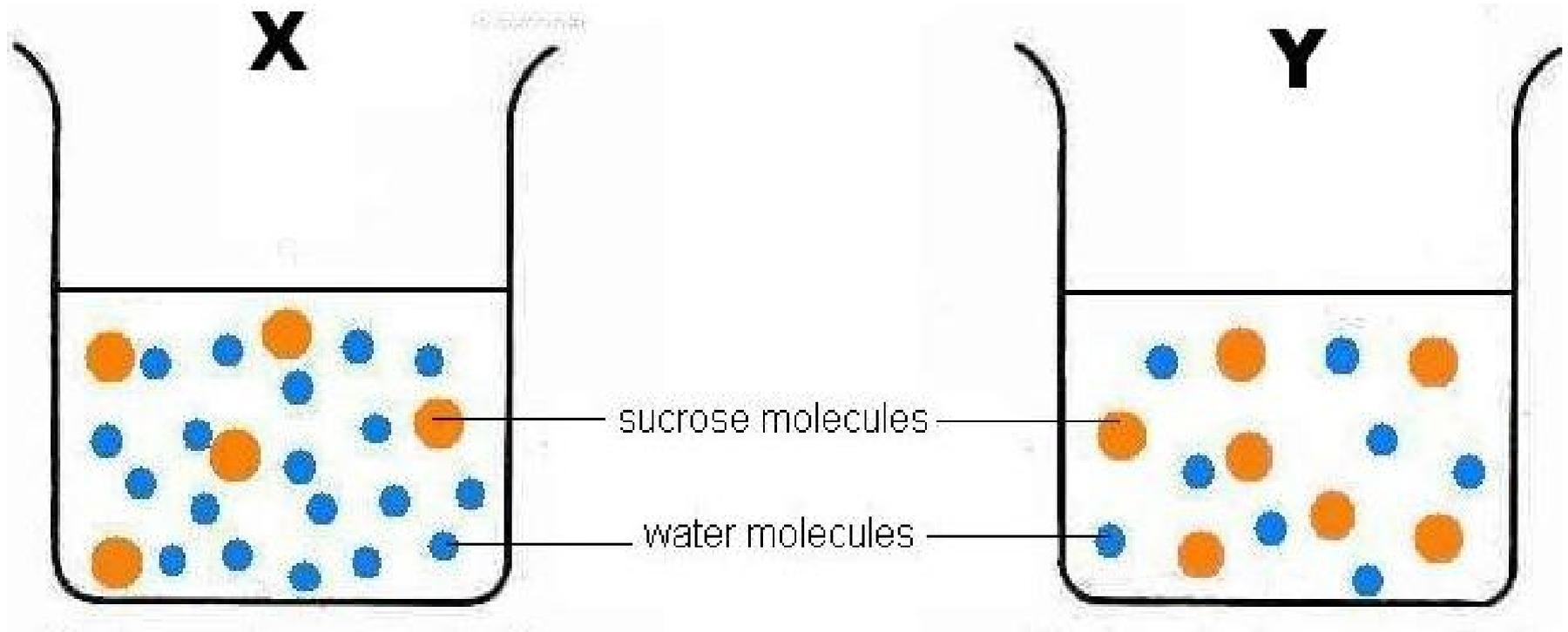
- Isotonic = a solution of equal concentration to a cell.
- Hypotonic = a solution of lower concentration than a cell (higher water potential)
- Hypertonic = a solution of higher concentration than a cell (lower water potential)

Note: Using these terms always involve comparison between 2 different solution!

Isotonic solutions are solutions of equal concentration.



# Hypotonic? Hypertonic?



X is \_\_\_\_\_ compared to Y

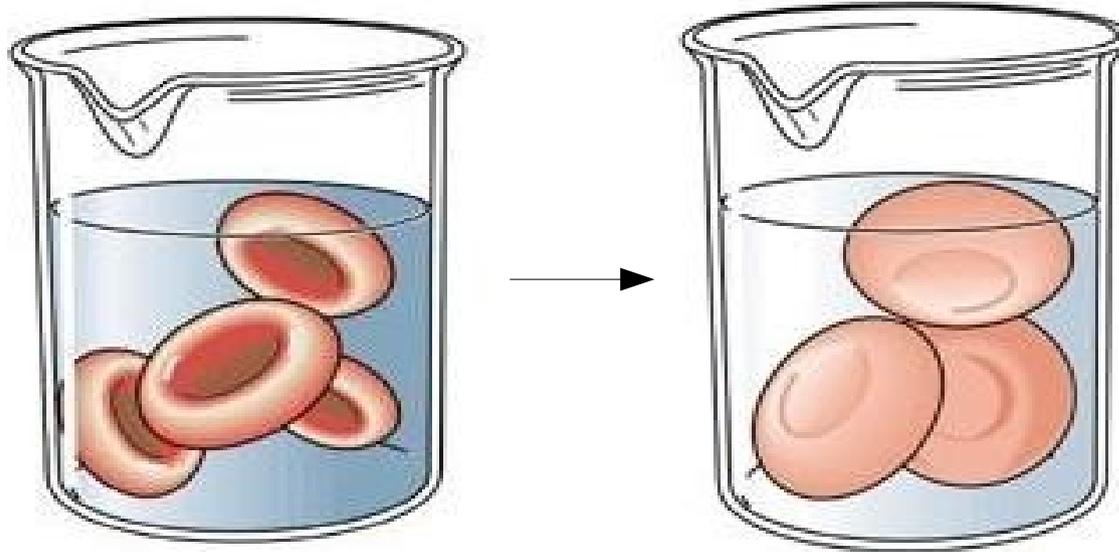
Y is \_\_\_\_\_ compared to X

# Osmosis in cells

Osmosis can occur in plant and animal cells.

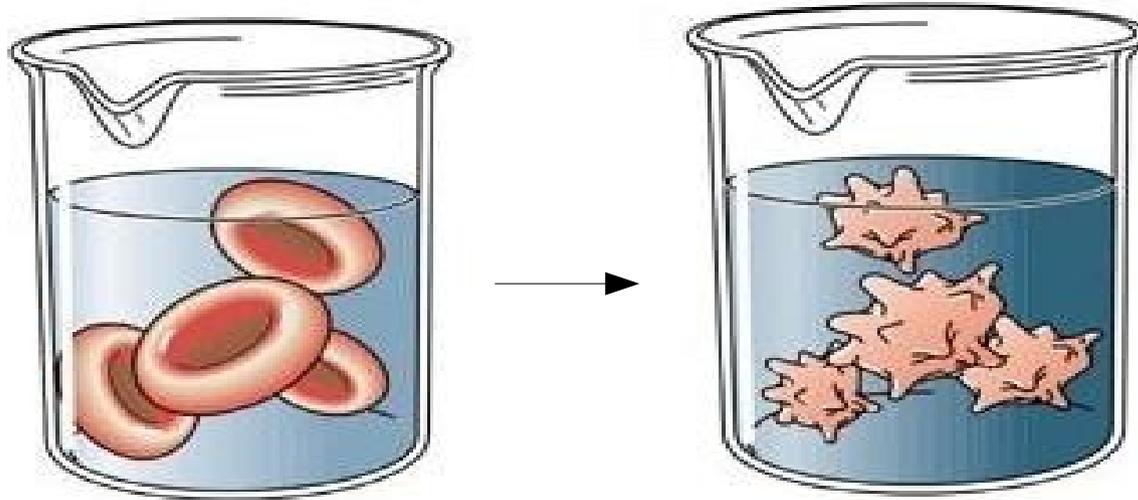
How do cells react in isotonic, hypertonic and hypotonic solutions?

# Animal cell in hypotonic solution



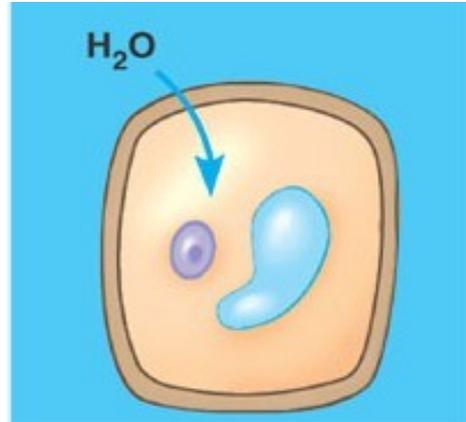
- There is high water potential in the solution than in the red blood cell.
- Therefore, water molecules move from the solution into the red blood cell by osmosis.
- This causes the red blood cell to swell. The cell may also burst due to absence of cell wall.

# Animal cell in hypertonic solution



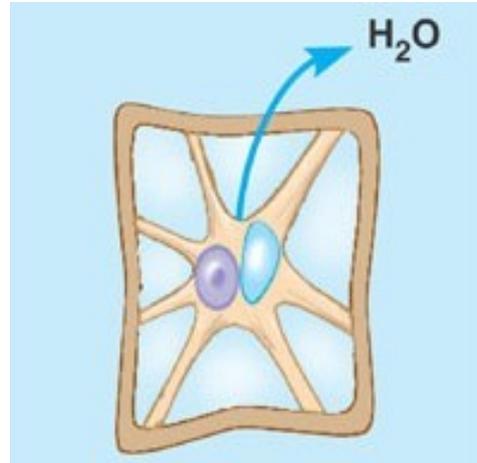
- There is high water potential in the red blood cell than in the solution.
- Therefore, water molecules move from the red blood cell into the solution by osmosis.
- This causes the red blood cell to shrink and become crenated.

# Plant cell in hypotonic solution



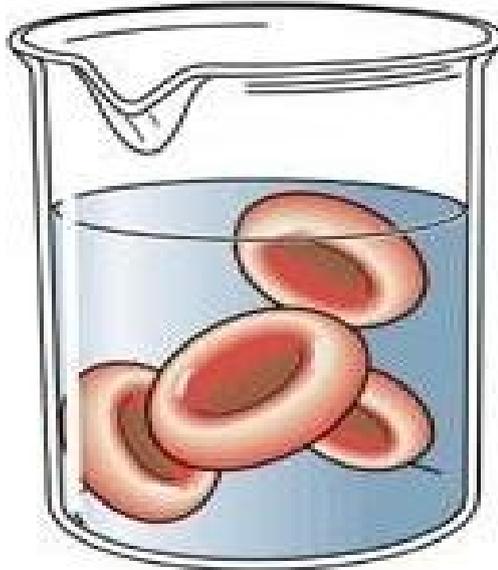
- There is high water potential in the solution than in the plant cell.
- Therefore, water molecules move from the solution into the plant cell by osmosis.
- This causes the plant cell to become turgid (firm). The cell wall prevents it from bursting.
- The turgidity of plant cells help support the cell.

# Plant cell in hypertonic solution



- There is high water potential in the plant cell than in the solution.
- Therefore, water molecules move from the plant cell into the solution by osmosis.
- This causes the plant cell to become flaccid and plasmolysed.

# What about isotonic solution?



- The water potential are equal in the red blood cell and the solution.
- Therefore, water molecules move in and out of the cell. There is no net movement of water molecules
- No change in size or shape of the cell.

# Definitions

Turgid – tight and firm

Flaccid – Floppy, losing firmness

Plasmolyse – A condition in plant cell where the vacuole and cytoplasm shrinks, pulling the cell membrane away from the cell wall

Crenation – Shrink with little spikes on the cell membrane

# Osmosis is important in plants

1. Water intake by root hair cell from the soil is by osmosis.
2. Turgidity provides support for non-woody plants
3. Changing the turgidity of guard cells help the stomatal pore to open or close.

When explaining osmosis in cell, remember the 3 important points:

1. Comparison between the water concentration/water potential inside and outside the cells.
2. Direction of movement of water (ALWAYS moving from high water potential to low water potential)
3. The effect of the movement of water on the cell.
  - Plant cell: Flaccid and plasmolysed / turgid
  - Animal cell: Shrink and crenated / swell and burst

# Past Year Question

What causes water to enter plant roots from the soil?

- A** Water potential in root hairs and the soil is equal.
- B** Water potential in root hairs and xylem is equal.
- C** Water potential in root hairs is higher than in the soil.
- D** Water potential in root hairs is lower than in the soil.

A human red blood cell is placed in a strong salt solution.

In which direction does water move and what is the effect on the cell?

	movement of water	effect on cell
<b>A</b>	into the cell	slight increase in size
<b>B</b>	into the cell	cell bursts
<b>C</b>	out of the cell	slight decrease in size
<b>D</b>	out of the cell	no change in cell volume

# Osmosis in cells

Describe osmosis and its effect on red blood cell in distilled water, concentrated salt solution and in blood plasma. (9)

Describe osmosis and its effect on plant cell in distilled water, concentrated salt solution and in cell sap. (9)

# Lesson 3

## Learning Objectives

1. Define active transport
2. Discuss its importance in the uptake of ions in plants.
3. State that energy from respiration is needed for active transport.

## Outline

- Active transport
  - Definition
  - Example

# Active Transport

The process in which energy is used to move the particles of a substance against a concentration gradient from a region of lower concentration to a region of higher concentration.

# Active Transport

- It only occurs in living things (because living things respire to obtain energy required in active transport).
- Involved in the absorption of
  - dissolved mineral salts by the root hair cells.
  - glucose and amino acids by cells in the small intestine of humans.

# Differences between diffusion and osmosis

## Diffusion

1. Flow of either solute or solvent molecules is in both directions.
2. No such membrane is required.
3. It is a **fast** process.
4. Occurs in liquids as well as gases
5. Movements are over large distances

## Osmosis

1. It involves flow of solvent molecules in one direction.
2. It requires partially permeable membrane.
3. It is a **slow** process .
4. Occurs only in liquids.
5. The movement is over a short distance

# Differences between diffusion, osmosis and active transport

Process	Movement of	Condition	Additional requirements
Diffusion	Molecules/ions	High conc. to low conc.	Down a conc. gradient
Osmosis	Water molecules	High water potential to low water potential	Across a partially permeable membrane
Active transport	Particles of substances	Low conc. to high conc.	Against a conc. Gradient; Energy required

# Past Year Question

Which is an example of active transport?

- A** movement of glucose into the cells of the villi
- B** movement of glucose molecules down a concentration gradient
- C** movement of ions in blood plasma
- D** movement of water in the transpiration stream