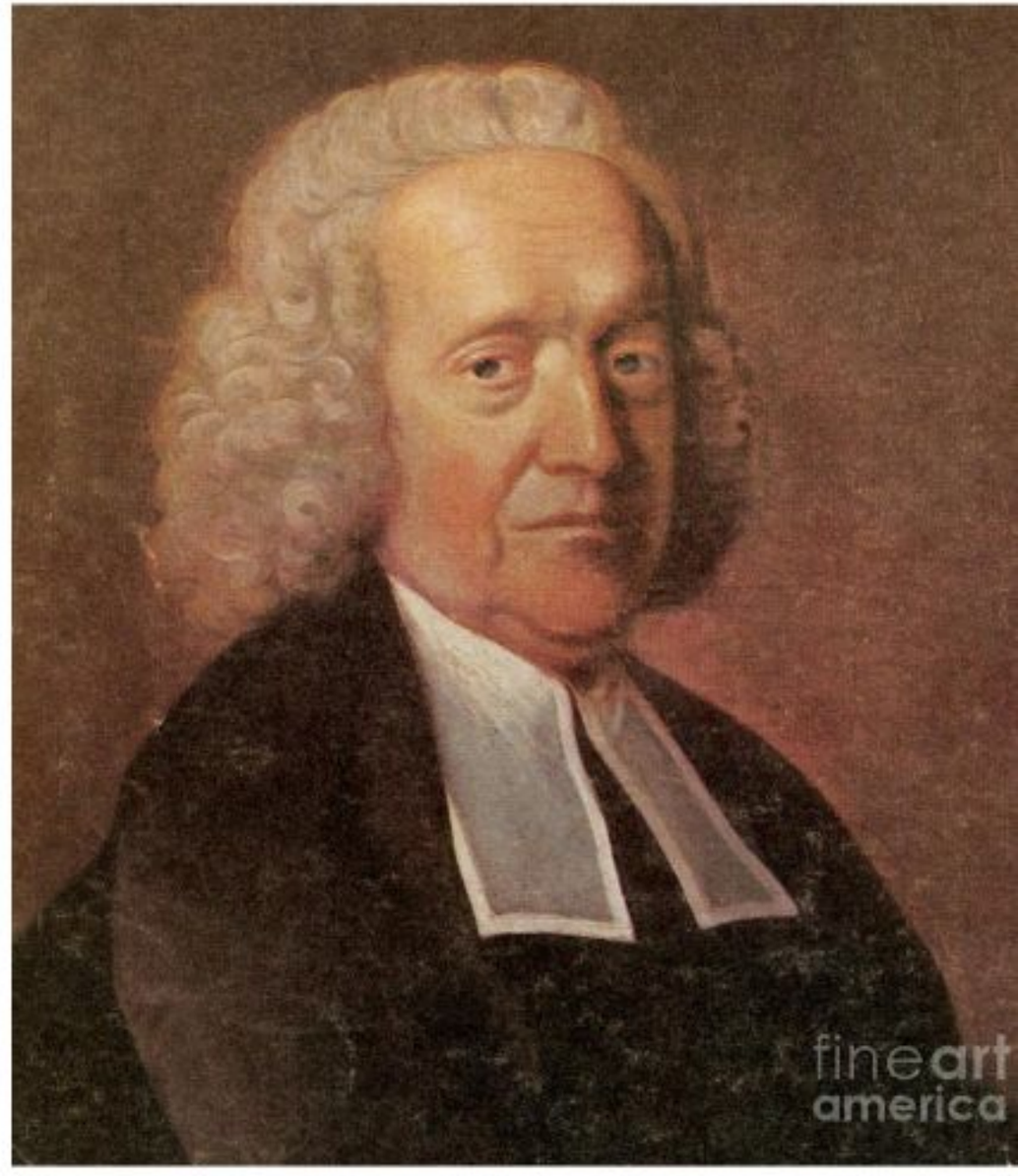
PLANT PHYSIOLOGY

- The branch of science which deals with the study of life processes, functions and response of plant in changing environmental condition is called plant physiology.

- Father of plant physiology: **Stephan Hales**



PLANT PHYSIOLOGY

Contents

- **Water relations** (INTRODUCTION & SIGNIFICANCE OF- Diffusion, Osmosis, Plasmolysis, Ascent of Sap, Transpiration, guttation)
- **Photosynthesis**
- **Respiration**
- **Plant Growth Hormones** (Auxin, Gibberellin, Cytokinin)
- **Plant growth & movements**

Plant- Water Relations

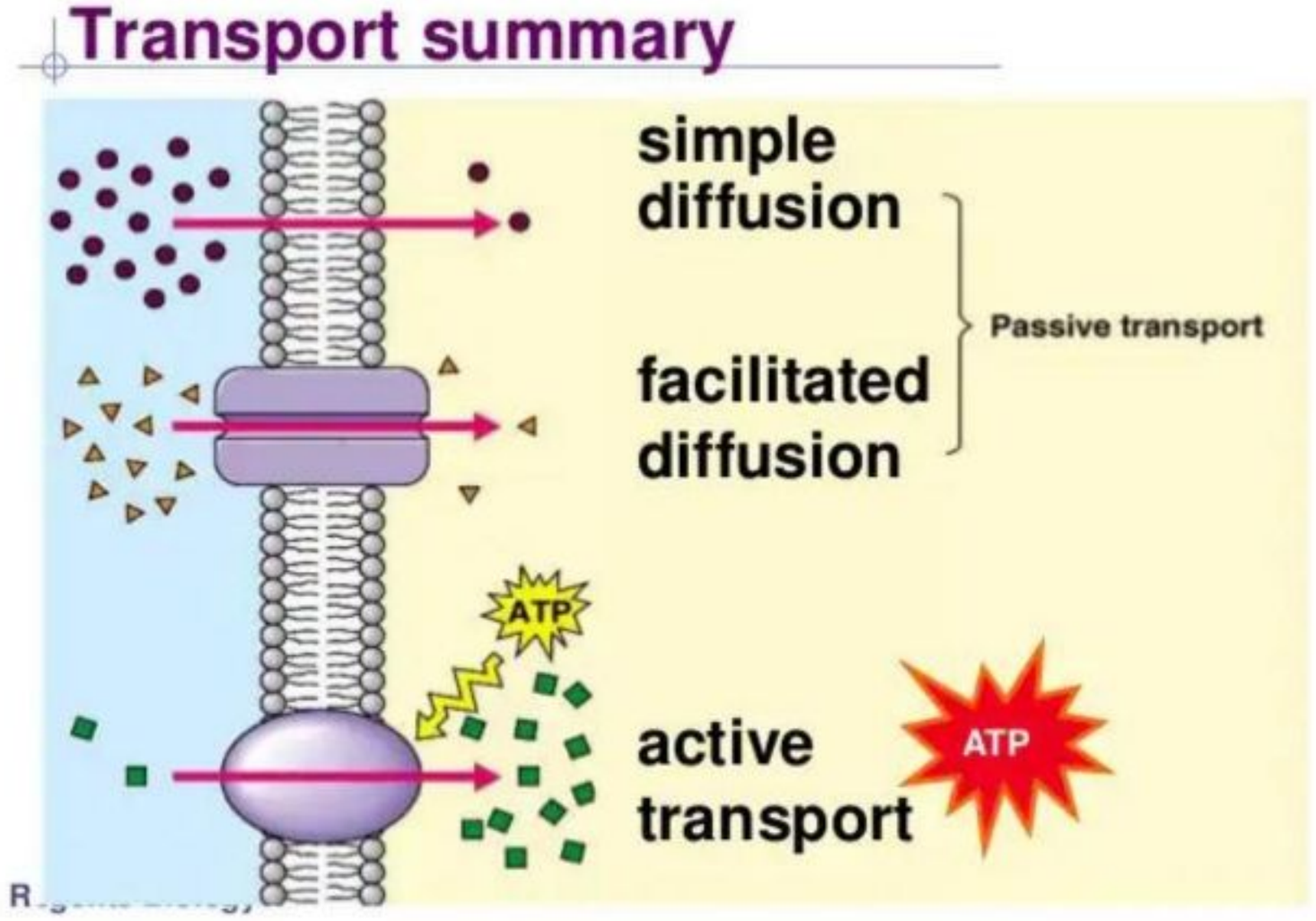
Importance of water

- Water constitute major portion of the protoplasm.
- Best known solvent.
- Transport nutrients throughout plant body.
- Water serves to regulate heat in plants.
- Mobility of gametes and dispersal of spores, fruits and seeds in certain cases.
- Maintains turgidity.
- Participates in many physiological process like photosynthesis, respiration, etc.

Transport in plant

short distance transport

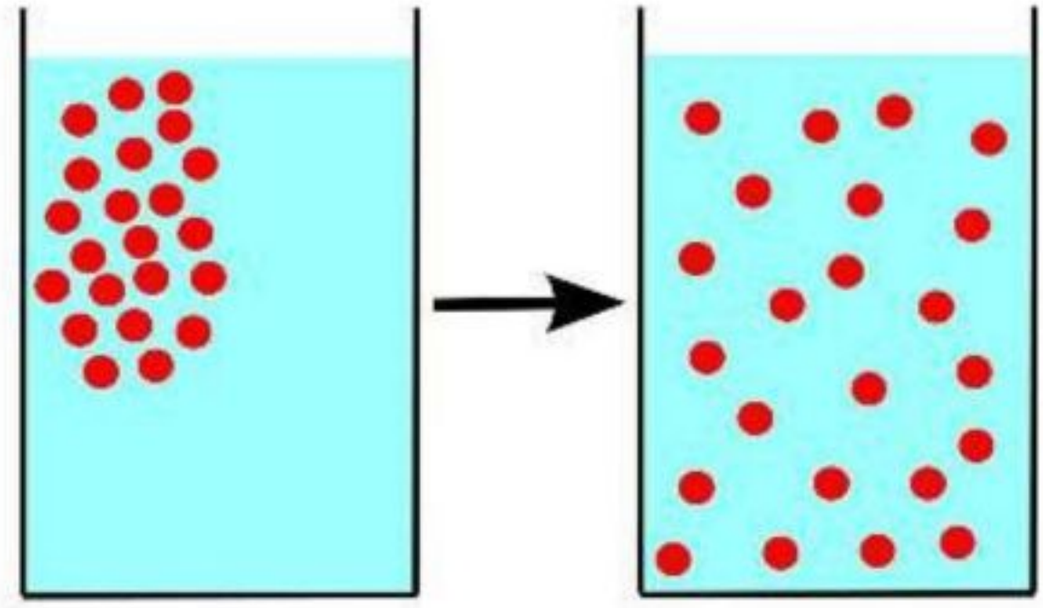
long distance transport-

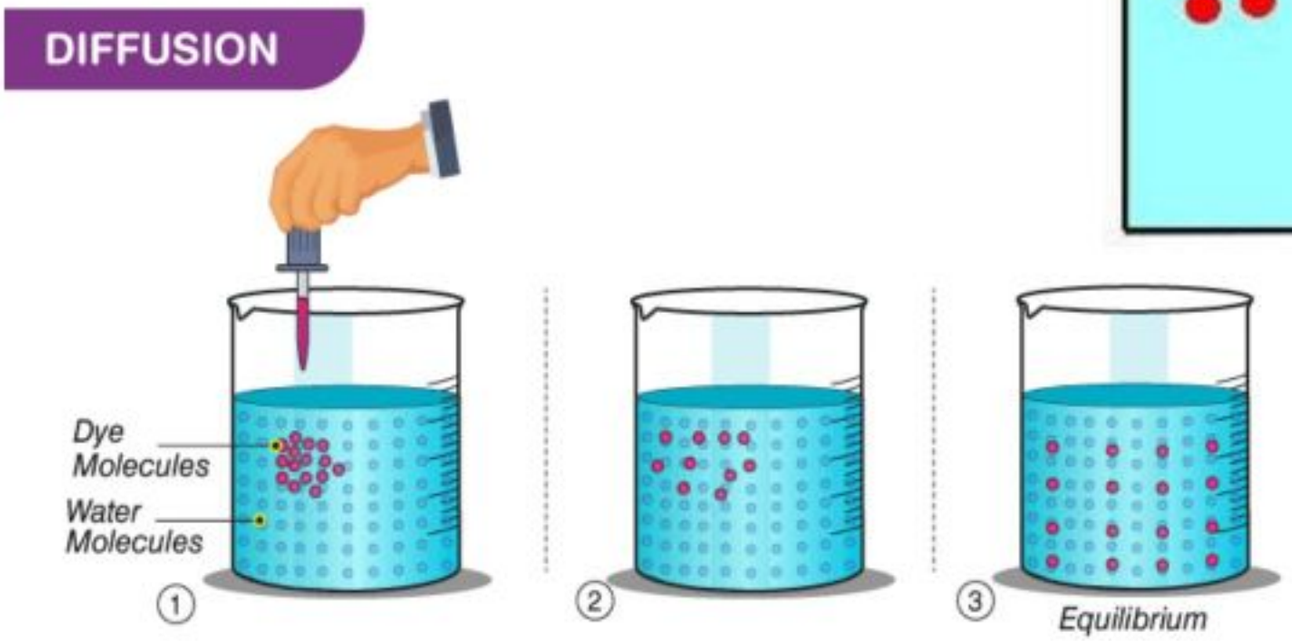


Plant- Water Relations

Diffusion

Diffusion





Diffusion

- The process of movement of ions, molecules or particles of a substance from the region of its higher concentration to the region of its lower concentration is called diffusion.
- It occurs along concentration gradient (Difference in conc of a substances between two area) till equilibrium is attained.
- Movement takes place due to kinetic energy of ions, or molecules.
- It requires **diffusing particles** (solid, liquid, gas) and **diffusion medium** (liquid or gas)
- The molecules of gas diffuse faster than that of solid and liquid.

Diffusion

Experiment of diffusion

- A small crystal of Potassium permaganet ($KMnO_4$) is placed into a beaker filled with water.
- Purple colour of $KMnO_4$ is spread and distributed evenly throughout the water until all the water becomes the same shade of purple colour.

Diffusion

Diffusion Pressure (DP):

- The pressure developed by the diffusing particles from the area of higher concentration to the area of lower concentration.

OR

- Potential ability of a substance to diffuse from its higher concentration to its lower concentration.
- Diffusion pressure is directly proportional to the number and concentration of diffusing particles. Therefore the diffusion takes place along the **diffusion pressure gradient**.
- Its value is always greater for a pure solvent than its solution.

Diffusion

Factors affecting Diffusion:

- **Temperature:** Rate of diffusion increases with increase in temperature.
- **Density of diffusing particles:** Rate of diffusion decreases with increase in density of diffusing particles.
- **Concentration of diffusing medium:** Higher concentration of diffusing medium lowers the rate of diffusion.
- **Diffusion pressure gradient:** Higher diffusion pressure gradient increases the rate of diffusion.

Diffusion

Importance of Diffusion:

- Transpiration takes place due to diffusion of water vapor from plant interior to dry atmosphere through stomata.
- Exchange of gases (O_2 and CO_2) during photosynthesis and respiration.
- During passive uptake of salts, ions are absorbed by the process of diffusion.
- Transport of substances within the cell or between the cell.
- Helps in pollination (insects are attracted to the flowers due to diffusion of aroma).

Diffusion

Diffusion Pressure Deficit (DPD)

- Pure water or solvent has high diffusion pressure. AS the solute is added the diffusion pressure of solution decreases.
- The amount by which the diffusion pressure of a solution is lower than its pure solvent is called **diffusion pressure deficit**.

Diffusion

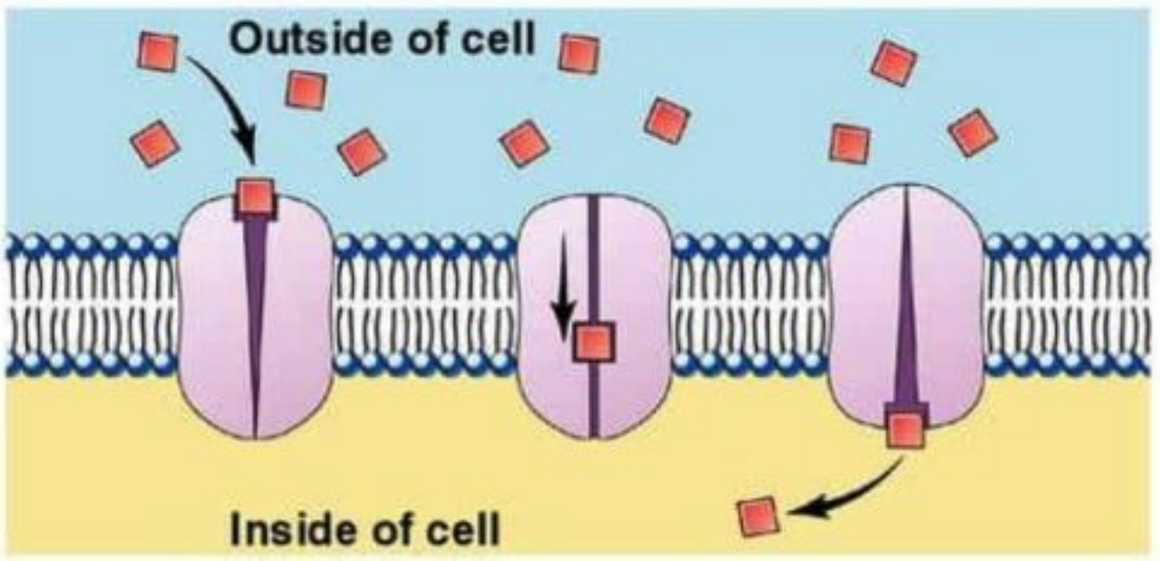
Independent Diffusion

- Simultaneous movement of two or more substance independently in a common medium. E.g. Gaseous exchange in respiration and photosynthesis.

Facilitated Diffusion

- Movement of dissolved substance through semi permeable membrane with the help of carrier protein without expending ATP. E.g. Transport of fructose, sucrose, etc.

Facilitated Diffusion



Osmosis

Types of membrane:

1. **Permeable membrane:** Which allows all solute and solvent to pass through them. (e.g. cellulosic cell wall)

2. **Impermeable membrane:** Which do not allow any solute or solvent to pass through them. (e.g. suberized cell wall)

3. **Semipermeable membrane:** Which allow all solvent but no solute to pass through them. (e.g. egg membrane, animal bladder)

4. **Selectively or differentially permeable membrane:** Which allow all solvent and few selected solutes to pass through them. (e.g. plasma membrane, tonoplast, subcellular membrane)

Osmosis

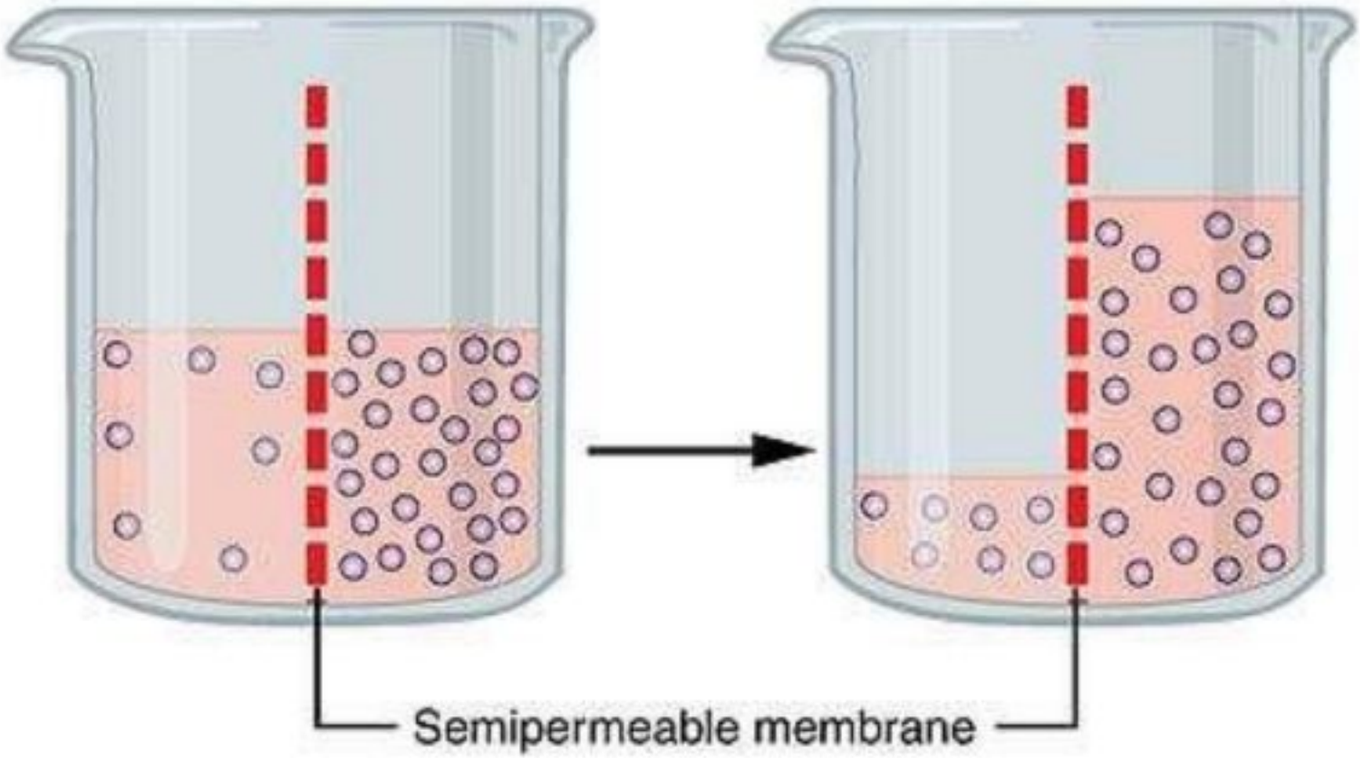
Types of solutions:

On the basis of relative concentration of water and solutes with respect to their concentration in the cell

3 types

1. **Isotonic solution:** When concentration of outer solution (in which cell is placed) is equal to concentration of cell sap, it is called isotonic solution.
2. **Hypotonic solution:** When concentration of outer solution (in which cell is placed) is lower than concentration of cell sap, it is called hypotonic solution.
3. **Hypertonic solution:** When concentration of outer solution (in which cell is placed) is higher than concentration of cell sap, it is called hypertonic solution.

Osmosis



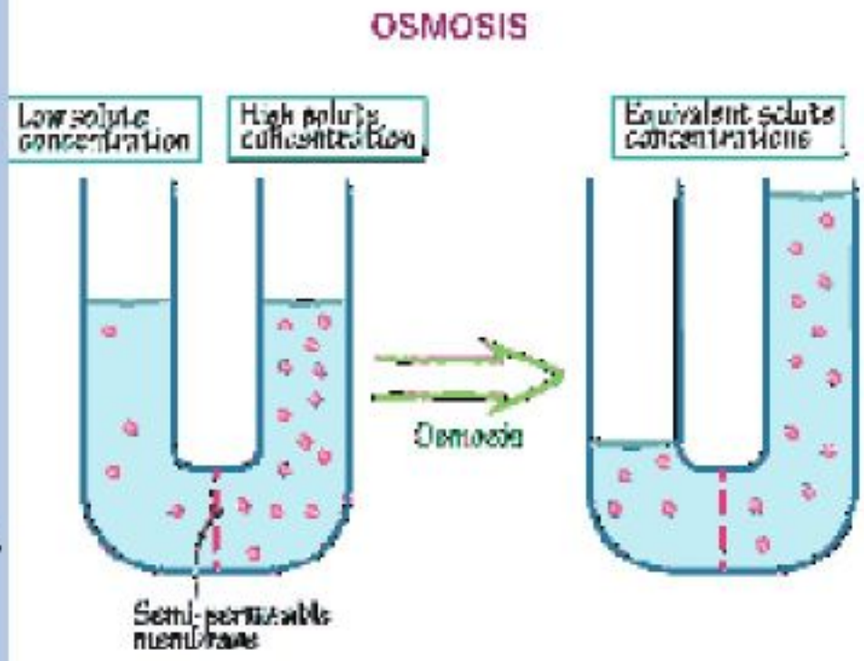
Osmosis

Definition:

- Movement of solvent (water)through a semipermeable membrane from an area where it is in high concentration to an area where it is in low concentration.

OR

- Movement of solvent through semi permeable membrane
  - From less concentrated solution to more concentrated solution.
  - From hypotonic solution to hypertonic solution.
  - From dilute solution to concentrated solution.
  - From low DPD to high DPD.



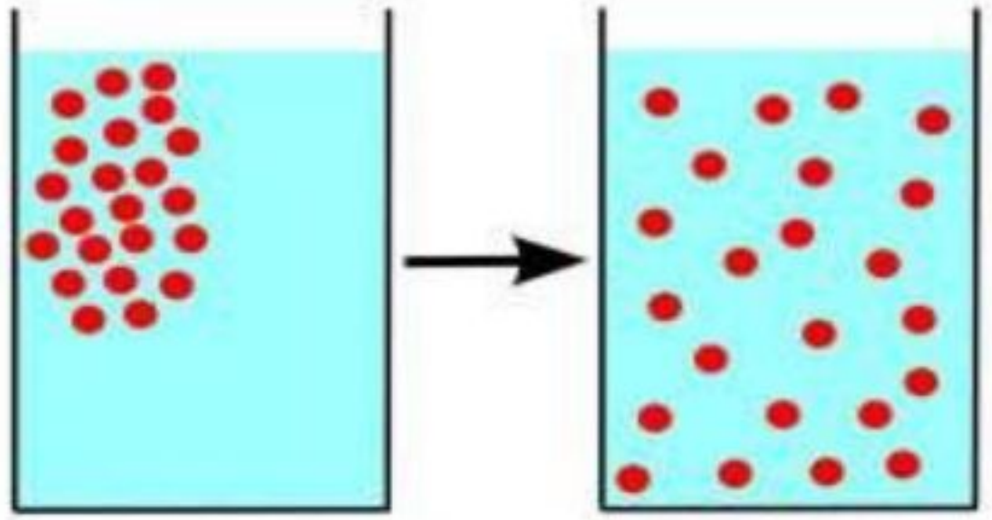
Osmosis

Osmosis is special type of diffusion. It is the diffusion of water through a semipermeable membrane.

Diffusion

Movement of molecules from high concentration to low concentration

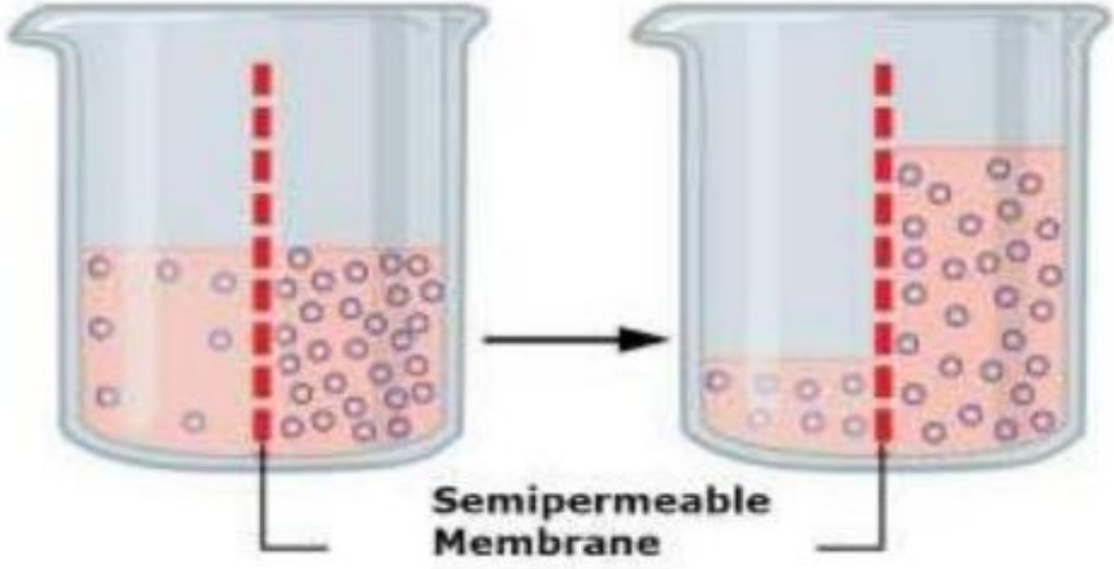
Both solute and solvent move



Osmosis

Movement of solvent (water) across a semipermeable membrane from high to low solvent concentration

Only solvent moves



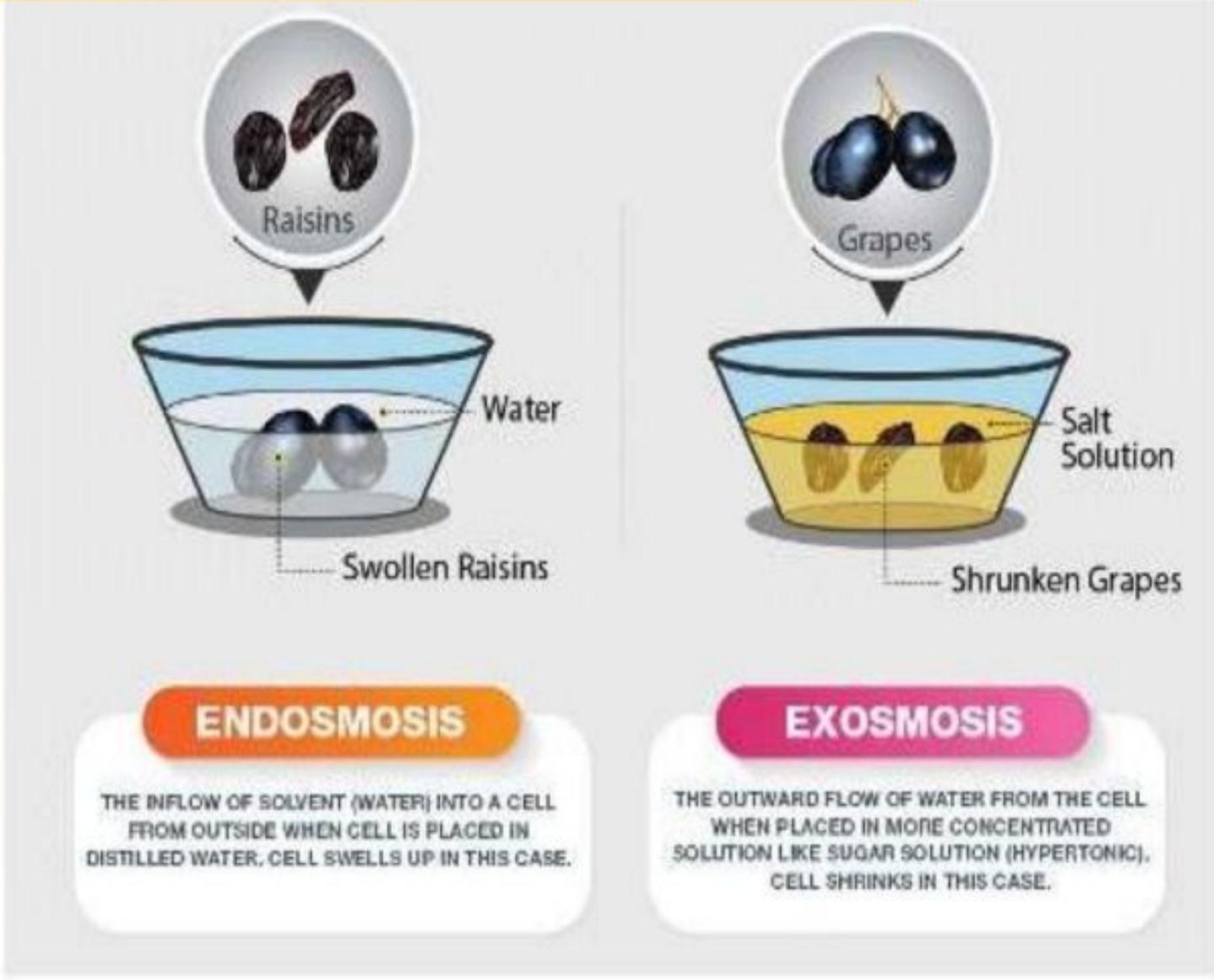
Osmosis

Types:

2 types:

a.Exosmosis:

b.Endosmosis:



Osmosis

Types:

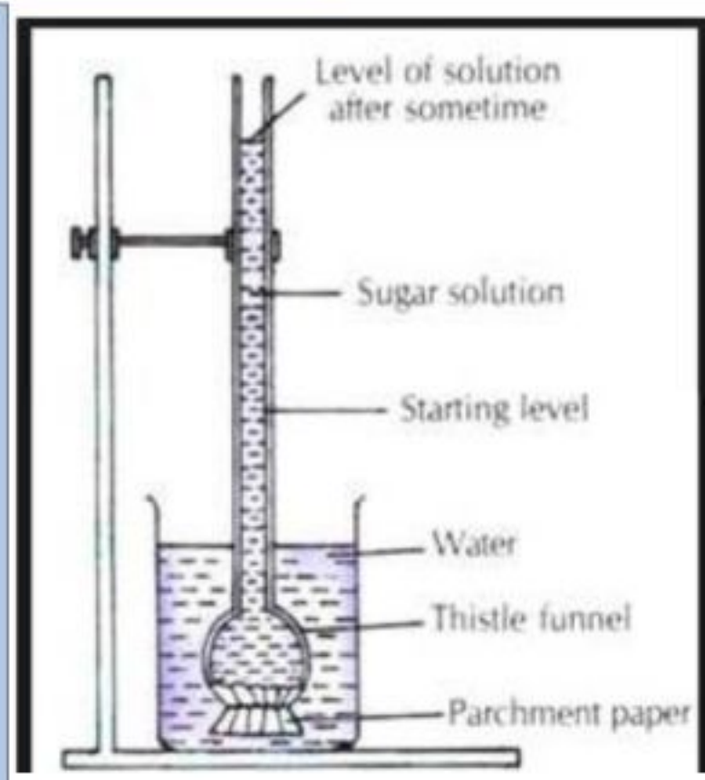
a.Exosmosis: It is the process of outward movement of water from a cell, when it is placed in hypertonic solution. It makes cell flaccid.

b.Endosmosis: It is the entry of water (solvent) into a cell when it is placed in hypotonic solution. It makes cell turgid.

Osmosis

Experiments

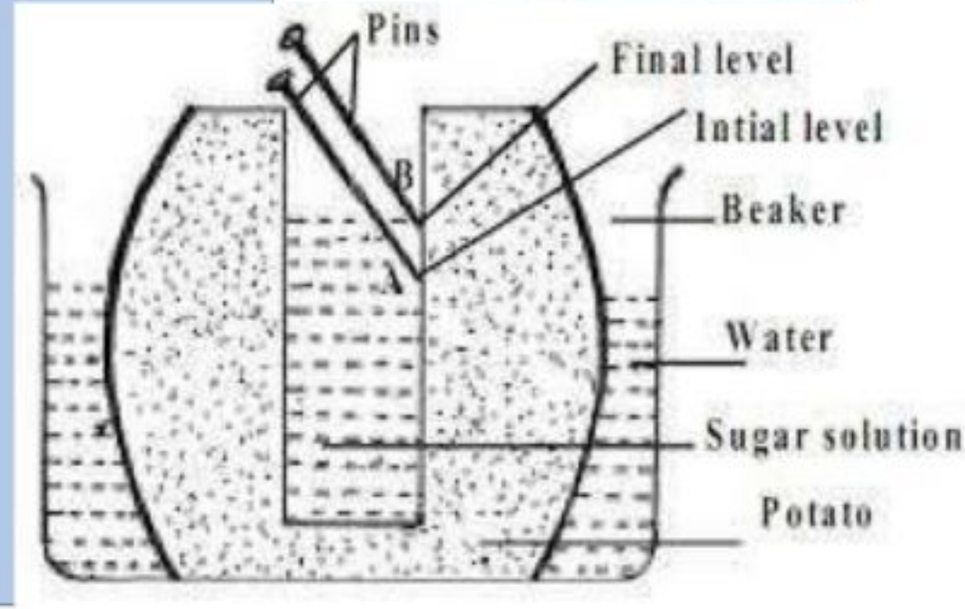
1. **DEMONSTRATION OF OSMOSIS BY EGG MEMBRANE:**
   - **Requirements**
   - **Theory**
   - **Procedure**
   - **Observation**
   - **Conclusion**
   - **Precautions**



Osmosis

Experiments

1. DEMONSTRATION OF OSMOSIS BY POTATO OSMOSCOPE
   - Requirements
   - Theory
   - Procedure
   - Observation
   - Conclusion
   - Precautions



Osmosis

Factors affecting osmosis

1. **Temperature:** On similar condition of pressure and concentration, if solution of different temperature is placed on either side of semipermeable membrane, the solvent moves from the side of higher temperature to the side of lower temperature.

2. **Pressure:** In constant temperature, water molecules will diffuse from the higher pressure side to low pressure side.

3. **Concentration gradient:** As the difference between concentrations of two solution increases the rate of osmosis also increased.

Osmosis

Significances of osmosis

1. Absorption of water by roots from the soil.
2. Cell to cell movement of water.
3. Opening and closing of stomata.
   - Turgid guard cell- opening of stomata
   - Flaccid guard cell- closing of stomata
4. Growth of plumule and radicle during seed germination
5. Growth of tissues
6. Shape and rigidity of plant organ is maintained due to turgidity caused by osmosis.

Osmosis

Osmotic Pressure (OP)

The pressure by which the solvent molecules move to the osmotically active solution through semi permeable membrane.

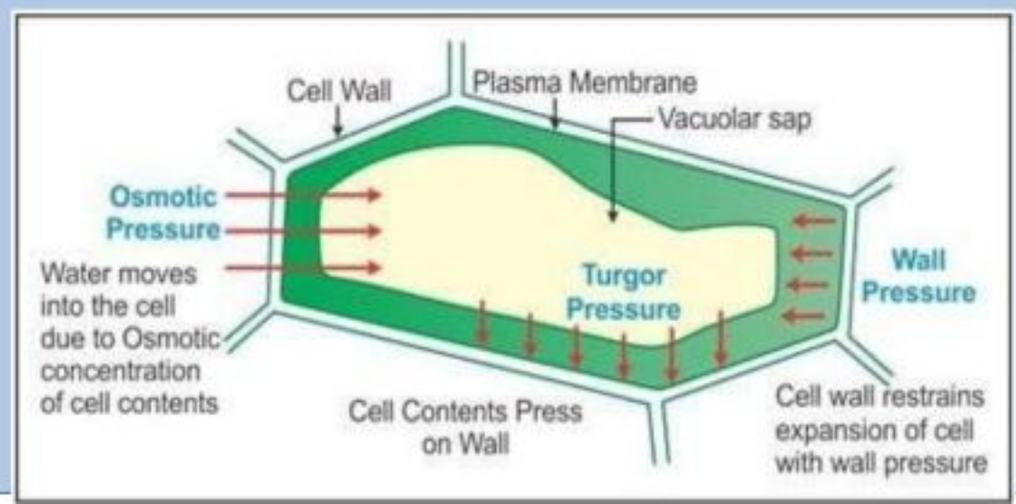
OR

Pressure required to prevent the net movement of water into the solution across the semi permeable membrane.

OR

- pressure develops in a solution when solution and water are separated by semipermeable membrane

- Osmotic pressure is directly proportional to the concentration of dissolved solutes in the solutions, so more concentrated solution has higher osmotic pressure.



Osmosis

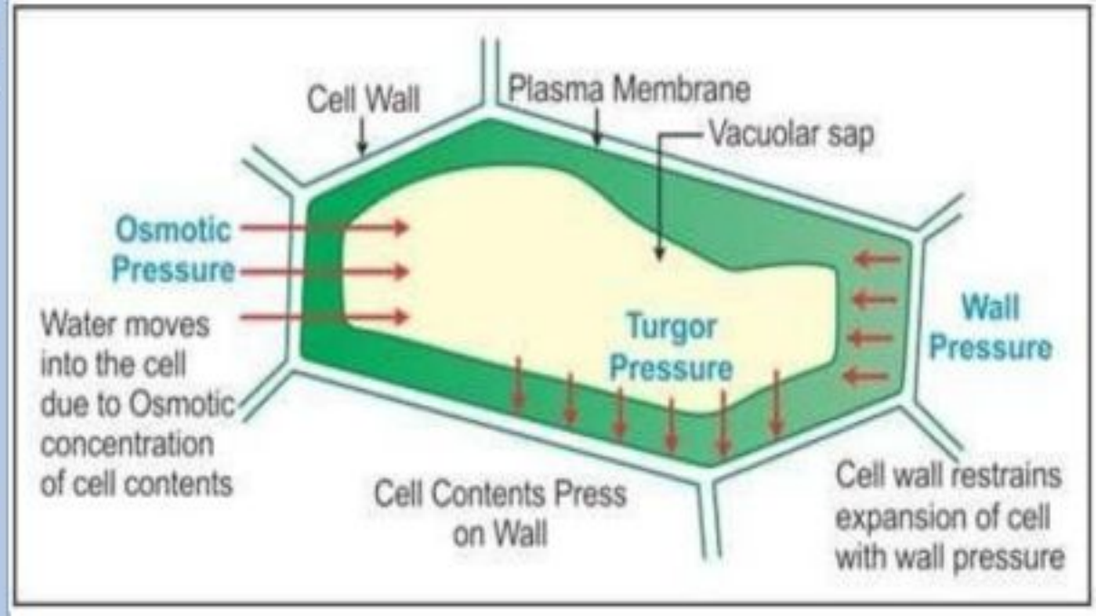
Turgor Pressure (TP)

- The pressure that develops in a cell due to the osmotic entry of water inside it against rigid cell wall.
- Also called **hydrostatic pressure**.

Wall Pressure (WP)

Pressure exerted by rigid cell wall against expanding protoplasm.

TP= WP



Osmosis

Diffusion pressure deficit (DPD):

- It is the difference in the diffusion pressure of solution and its pure solvent.
- DPD determine the direction of osmosis and it is the power of absorption of water from cells.
- DPD is the main force responsible for the absorption of water by plant roots, so also called **suction pressure (SP)**
- If DPD is zero, no absorption of water by cell (Turgid cell)
- DPD α Conc. Of solution

Osmosis

Relationship between DPD, OP and TP

- Normally osmotic pressure (OP) is greater than Turgor Pressure (TP). The difference in between OP and TP is called DPD.
- In normal cell, **DPD = OP-TP**

Or, DPD = OP-WP (TP=WP)

In fully turgid cell, DPD =0, (OP=TP)

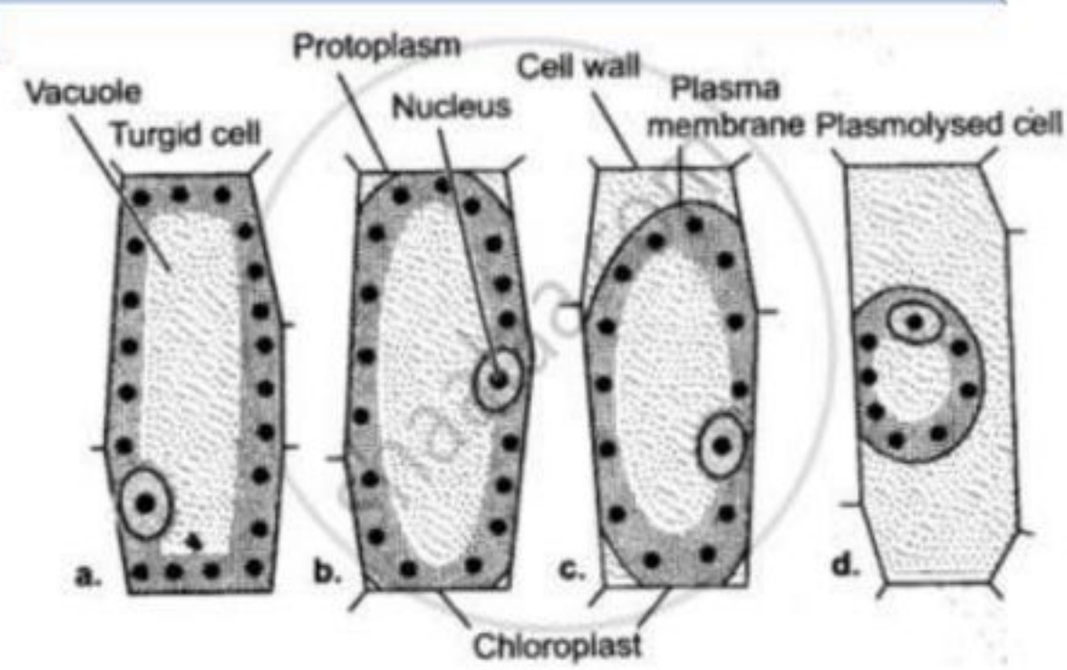
In case of plasmolyzed/ flaccid cell , DPD =OP (TP=0)

Plasmolysis

The shrinkage of protoplast when a cell is placed In hypertonic solution due to exosmosis is called **plasmolysis**.

Incipient plasmolysis: The stage at which the first sign of shrinkage of cell contents from the cell becomes detectable is called incipient plasmolysis.

Deplasmolysis: The process of regaining normal size by plasmolyzed cell when placed in hypotonic solution is called deplasmolysis.



Plasmolysis

Significance of plasmolysis:

- It indicates the semi permeable nature of plasma membrane and permeable nature of cell wall.
- It is used to determine the osmotic pressure of cell sap.
- Used to determine whether a cell is living or dead.
- Salting of pickles, meat and fish and sweetening of jams and jellies with sugar kill the spores of fungi and bacteria.

Imbibition

- The adsorption of water by the hydrophilic solids without forming solution so as to make them swell is called **imbibition.**
- The solvent which is adsorbed is **imbibate** and the material which adsorbs is **imbibant**.
- Only the solid substances containing hydrophilic colloids can adsorb water. E.g. Seed coat, cell wall, woody tissue (wood), etc.
- Swelling of dry seeds when placed in water is due to imbiition.
- During rainy season wooden doors swells due to imbibition which make difficulty in their opening and closing.
- Due to imbibition,
  - ✓ Volume of imbibant is increased.
  - ✓ Pressure is exerted
  - ✓ Heat is released (Exothermic)

Imbibition capacity

Agar- Agar> protein> Pectin> Starch> cellulose

Water Potential

- Potential ability of water molecules to do some work.
- Tendency of water molecules to move.
- It is represented by Ψ (psi).
- Water potential of pure water is maximum and considered to be zero.
- Water potential of solution is always negative.

"Osmosis is the movement of water molecules through semipermeable membrane from higher water potential to lower water potential."