ABSORPTION OF WATER

- Water is the essential and most abundant component of all living cells.
- It is even more important to plant cells because they have osmotic systems.
- The amount of water in the plant is dependent on the cell types, tissues, environmental conditions and physiological status of the plant.
- Non-woody parts of the plant have about **70%** of water by volume.
- Dry seeds have **5 – 10%** of water. It is not sufficient for the germination of seeds. They germinate when the water content of the seeds reach the optimum level.
- Plant water relations include the entry of water into the plant, its movement within the plant and its movement into the atmosphere from the plant.

SOIL WATER

It is of four types

1. Run-away water: water that drains away during heavy rain fall (not available to plants)
2. Gravitational water: earth's gravity influence some water in to the earths crust (not available to plants)
3. Hygroscopic water: a thin film of water is found around the soil particle (can't be utilized by plants)
4. Capillary water: water present in pore spaces of soil (available for plants)

Water Potential

- The amount of energy available in a substance to do a work is called as **free energy**.
- The **chemical potential** is the amount of free energy with which a substance does work or reacts.
- The term Water Potential was given by **Slatyer** and **Taylor**. It is the chemical potential of water. It is indicated with a symbol **Ψ** (psi).
- **Ψ** of pure water is zero. It is the difference between the chemical potential of pure water and chemical potential of water present in a system. It has negative value and measured in **Bars** or **Megapascals** (pressure units).
- Water always moves from a region of higher Ψ to a region of lower Ψ.

Components of Water potential

- Water potential has three components known as Osmotic potential, Pressure potential and Matric potential.

i. Osmotic Potential

- The decrease in the amount of water potential due to addition of water-soluble solute is called as Osmotic or Solute potential.
- Water-soluble substances acquire a **shell of hydration** and hence the free energy decreases.
- It has negative value and indicated with the symbol Π or **ΨΠ.**
- Water moves from a region of higher Π to lower Π.

ii. Pressure potential

- The outward pressure exerted by the protoplasm on the cell wall is called as **Turgor pressure**. It is due to the entry of water into the cell.
- The positive hydrostatic pressure developed due to the fluid contents of cell is called as **Pressure potential**. It increases the water potential. Hence it has positive value It is indicated with the symbol **P** or **Ψp**. In a plasmolysed cell, the P is zero.
- The pressure potential of an open system is negative. Ex: Hosepipe, Xylem vessel.

iii. Matric Potential:

- The quantum by which there is decrease in the water potential of water due to the presence of colloids and hydrophilic insoluble substances is called as **Matric potential**.
- It always has negative value and indicated with the symbol **Ψm** or **T** (Tau).
- Matric potential is the tendency of a matrix or solid to absorb water. It is as low as – 300 Mpa for filter paper, gelatin, wood and any dry colloid.
- The water potential of closed system is sum of π,P and T. It is **Ψ = Π + P + T**.
- The significance of matric potential for water potential of wet substances or solutions is negligible. It is significant only for dry matter. Hence **Ψ = Π + P.**

Diffusion

- The movement of ions or molecules or gases from a region of its higher concentration to a region of lower concentration is called as **Diffusion**. It is driven by concentration differences.
- Water of soil enters into the root cells by diffusion. Exchange of gases through stomata and loss of water through stomata are examples for diffusion.

Imbibition

- It is adsorption of water to hydrophilic colloids. In such substances matric potential contributes a lot to water potential
- Proteins have high, starch less and cellulose least imbibing capacity. Protein rich Pea seeds swell more than starchy wheat grains.
- Due to imbibition, the volume of the imbibiant increases and thereby the imbibitional pressure. The magnitude of imbibitional pressure can be understood by soaking the wooden piece inserted in the crevices that breaks the rock.
- Absorption of water by dry seeds, velamen roots, mosses and lichens are examples for imbibition.

Osmosis

- It is movement of water from a region of its higher chemical potential to a region of its lower chemical potential through semipermeable membrane.
- Semipermeable membranes allow the diffusion of solvent but not solute.
- The driving force for osmosis is energy difference of water between the two system under consideration separated by semipermeable membrane. The driving force is more appropriately water potential gradient.
- Osmosis is demonstrated in the laboratory by **thistle funnel** experiment.
- In this the broad end of thistle funnel is covered with a selectively permeable membrane such as egg membrane and tied.
- Sucrose solution is taken into the thistle funnel and its level is marked.
- The thistle funnel with sucrose solution is immersed in a beaker of distilled water or low concentrated solution.
- After sometime one can observe the increase in the level of sucrose solution. This indicates that water moved from a region of low concentrated solution to a region of high concentrated solution through semi-permeable membrane.
- The rate and direction of water flow depends on the water potential gradient between the two systems. This is continued till a balance is achieved between the two systems.
- The pressure developed in the thistle funnel due to osmotic entry of water is known as **Hydrostatic pressure**.
- The pressure or force required to prevent the entry of solvent (water) into the solution (Thistle funnel) is called as **Osmotic pressure**.
- Osmosis is involved in absorption of water by root cells from soil, movement of water from one cell to other cell in the plant, sleeping movements of leaves, opening and closing of stomata, opening and closing of flowers and maintaining the turgor of cells.

Plasmolysis

- If a cell is kept in a hypotonic solution, water of the solution enters into a cell by endosmosis. It results in building up of outward pressure in the protoplast on the cell wall. This pressure is known as **Turgor pressure**.
- The inward pressure exerted by cell wall on the protoplast to counter turgor pressure is called as **Wall pressure**. At this point the water potential of the cell becomes **zero** because the amount of osmotic potential is equal to pressure potential.
- Shrinkage of protoplast, when a cell is kept in hypertonic solution, due to exosmosis is called as **plasmolysis.** At this condition, the water potential of cell is equal to osmotic potential because the turgor pressure is zero. i.e. $\Psi = \pi + 0$ or $\Psi = \pi$.
- The first signs of plasmolysis in which the protoplast is showing the signs of detachment at cell corners is called as **incipient plasmolysis**.
- When a plasmolysed cell is kept in hypotonic solution, water enters into the cell and the cell regains its normal condition. This is known as **deplasmolysis**.
- Plasmolysis is not the usual phenomenon in plants. It can be experienced by the plant in extreme water stress conditions and grown in saline environment.
- The phenomenon of plasmolysis has practical applications in jams and pickle industry. Salting of pickles and adding sugars in jam making promotes plasmolysis in bacteria and fungal spores. This prevents the growth of microbes and spoilage of these foodstuffs.

Absorption of Water

- Roots of plants absorb water by both active and passive methods. Active absorption requires the expenditure of metabolic energy. There is no evidence of utilisation of energy for active absorption of water.
- Soil water has high water potential than the water potential of root. Hence water enters into the root. Greater is the water potential gradient; more is the rate of entry of water into the root. It shows that water is absorbed by plats mainly by **passive osmotic mechanism.**