

Diffusion:

It is the movement of particles from region of higher concentration to region of lower concentration through random motion. The movement of molecules of any substances is due to their kinetic energy and the process continues until the equilibrium mentioned.

The rate and direction of diffusion depends upon the concentration of diffusing particles and independent to the presence of other particles.

Factors affecting diffusion:

- 1. Diffusion Pressure gradient:** The pressure exerted by the diffusing particles is known as diffusion pressure. The minimum change in diffusion pressure along higher and lower concentration is known as diffusion pressure gradient. Diffusion of a particle is only possible when there is presence of diffusion pressure gradient. The rate of diffusion is proportional to the diffusion pressure gradient.
- 2. Size of substance:** The diffusion rate is high in case of small particles.
- 3. Density:** The rate of diffusion is inversely proportional to the density of diffusing particles.
- 4. Temperature:** With the increase in temperature, the free energy in the diffusion particle increases resulting the increase in diffusion.

Diffusion Pressure

It is defined as the ability of a substance to diffuse from an area of its greater concentration to the area of its lower concentration. It is directly proportional to the number of the diffusing particles.

Rate of diffusion

The rate of diffusion is inversely proportional to the square root of density of diffusing particles. Hence, diffusion increases when diffusion particles decreases and vice-versa.

Significance in diffusion:

1. It is an essential step in the exchange of gases during respiration and photosynthesis. It helps to diffuse in O_2 and diffuse out CO_2 during respiration; and diffuse in CO_2 and diffuse out O_2 during photosynthesis.
2. It helps in pollination by the diffusing of aromatic compounds that attracts insects.
3. It helps in transporting food, waste and other substances in and out of the cells.
4. It helps in transportation of glucose in liver cells and RBCs.
5. Diffusion is essential in the absorption of ions during passive salt uptake.

Osmosis:

It is defined as movement of solvent particles from higher concentration to lower concentration through semi-permeable membrane. Semi-permeable membrane is defined as partially permeable membrane through which solvent molecules easily pass but solute does not.

Osmosis is of two types.

1. **Exosmosis:** The water moves out from the cell when is placed in a hypertonic solution then is known as exosmosis.
2. **Endosmosis:** The water moves in the cell when is placed in a hypotonic solution, then is known as endosmosis.

Terminologies related to Osmosis:

Water Potential: It is the difference between free energy of pure water at atmospheric pressure. It can be taken as a measure of energy available for movement of water. At equilibrium, water potential will be the same as the system. The water potential of pure water is zero. The solutions have negative water potential.

Solute Potential: It is the energy that changes in water potential of a system due to presence of solute molecules.

Osmotic Pressure: When two solutions are separated by semi-permeable membrane, a pressure is developed in the solution due to the presence of dissolved solutes in it. This is called osmotic pressure (OP). The movement of solvent takes place due to the difference in osmotic pressure. So, the osmotic pressure can be defined as the force per unit area with which solvent molecules move to the osmotically active solution through semi-permeable membrane.

Diffusion Pressure Deficit (DPD): Diffusion pressure of pure water is maximum. When solute is added, the diffusion pressure of the solution is decrease. It is known as diffusion pressure deficit. In other words, DPD is the amount by which the diffusion pressure of a solution is lower than that of pure solvent. In a cell, if the DPD is greater, the cell will try to absorb greater amount of water.

Plasmolysis: When a cell placed in hypertonic solution, the exosmosis takes place where water molecules are diffuse out. Due to the loss of water by cells, the protoplasm is shrink by which it losses the contact with cell wall. This condition of cell is called flaccid cell.

The process of shrinkage of cell membrane due to loss of water when placed in hypertonic solution is known as plasmolysis.

Deplasmolysis: When the same plasmolysed cell placed in hypotonic solution, endosmosis occurred. Here the liquid re-entered into cell and cell becomes full. This condition of cell is known as turgid cell.

The process of expansion of cell membrane of plasmolysed cell when kept in hypotonic solution is known as deplasmolysis.

Factors affecting Osmosis:

- 1. Temperature:** When two solutions having different temperature are separated by semi-permeable membrane, the water molecule diffuses from higher temperature to the lower temperature.
- 2. Pressure:** When two solutions having different pressure are separated by semi-permeable membrane, the water molecule diffuses from higher pressure to lower pressure.
- 3. Concentration of solution:** When two different concentrated solutions are separated by semi-permeable membrane, the water molecule diffuse from lower concentrated solution to higher concentrated solution.

Significance of Osmosis:

1. The absorption of water by the root hairs from the soil and the movement of water from one cell to another within the plant are due to osmosis.
2. It helps to keep young stem and leaves erect and extended.
3. Opening and closing of stomata depends upon the turgidity of guard cells.
4. It maintains turgidity of the plant cells contributing in the growth of the plant.
5. High osmotic concentration of cells greatly increases the resistance to drought and frost.

Transpiration:

Plant absorbs large quantity of water from the soil through root. The absorb water is either utilized in the plant for various purposes or lost in the form of water vapour from aerial part of plants. Such loss of water in the form of water vapour from the aerial parts of the plant is called transpiration.

In other words, transpiration is also defined as loss of excess water from aerial part of plants in the form of water vapour. The amount of transpired water is greater than the utilized one. A plant utilized less than 2 percent of absorbed water in its various metabolic activities.

Mechanism of Transpiration:

Transpiration occurs due to turgor pressure. Turgor pressure is generated inside mesophyll cells of the leaf. This forces water outwards through the cell wall in the intercellular spaces. Water is collected in the intercellular spaces, which later diffuses out of the stomata into the atmosphere.

Types of Transpiration:

On the basis of occurrence of transpiration, it is of following types.

- 1. Stomatal transpiration:** The transpiration which occurs through stomata is called stomatal transpiration. About 90% of total transpiration takes place through stomata. The stomata are commonly found on leaves but are also present in young stem, flower etc.
- 2. Cuticular transpiration:** If the loss of water from cuticle or epidermal layer of plant parts, then is called cuticular transpiration. About 3 – 10% of total transpiration occurs through it.
- 3. Lenticular transpiration:** Lenticels are the opening on epidermal layer in woody stem (branches). The transpiration occurs through lenticels is called lenticular transpiration. About 0.5% of total transpiration occurs through it.
- 4. Bark transpiration:** Bark is corky covering of the stem. The transpiration occurs through it is called bark transpiration.

Basic Structure of Stomata:

Stomata are the small opening present on the epidermal layer of leaves. They are periodically opened and closed. Due to the opening and closing phenomenon, it controls the transpiration rate. It plays important role in photosynthesis and gaseous exchange.

It comprises two special cells named as guard cell. The opening and closing of stomata is due to the turgidity of guard cells. The guard cells are surrounded by other epidermal cells named as subsidiary cells.

The guard cell of dicot leaf is bean shaped whereas monocot leaf is dumbbell shaped.

Factors affecting Transpiration:

A. External Factors:

- 1. Relative humidity:** The rate of transpiration is inversely proportional to relative humidity of air.
- 2. Atmospheric pressure:** Low atmospheric pressure increases evaporation. It helps to increase the rate of transpiration.
- 3. Temperature:** High temperature of surrounding helps opening of stomata. It reduces the relative humidity and increase transpiration.
- 4. Movement of air:** The movement of air increases the rate of transpiration.
- 5. Light:** The rate of transpiration directly proportional to light. It helps in opening of stomata.
- 6. Availability of water:** Transpiration is equivalent with the rate of absorption. The different factors as soil temperature, soil water, soil air etc

influence the absorption of water which also influences the transpiration rate.

B. Internal Factors:

- 1. Leaf area:** Transpiration directly proportional to leaf area. Larger area of leaf contains more stomata that increase transpiration.
- 2. Leaf structure:** The different structures of leaf influence the transpiration rate. The factors as thick cuticle, reduced number of stomata, sunken stomata, compact mesophyll cells, modification of leaves into spine, scales etc reduce the transpiration rate.
- 3. Root/Shoot ratio:** High root/shoot ratio increase the rate of transpiration.
- 4. Plant age:** As the plant becomes mature, the rate of transpiration also increases.

Significance of Transpiration:

A. Advantages:

1. It exerts a suction force that helps in ascent of sap.
2. It helps to remove excess water that enables plants to absorb extra water.
3. It lowers the temperature of plants.
4. It helps in the development of mechanical tissue.
5. It helps to increase the concentration of mineral salts in plants.
6. It helps in hardening of tissue and makes plant resistant to drought.

B. Disadvantages:

1. If transpiration occurs excessively, wilting of leaves occurs that reduce photosynthesis and other metabolic activities.
2. It reduces water availability inside the plant.
3. It losses the energy used in absorption and conduction.

Guttation: The loss of water in liquid form. It takes place by special tissue named as hydathodes.

Differences between Transpiration and Guttation:

Transpiration	Guttation
1. The process where water losses from plants in the form of water vapour.	1. The process where water losses from plants in the form of water droplets.
2. It takes place through stomata, lenticels and cuticle.	2. It takes place through hydathodes.
3. It occurs through general surface of leaves.	3. It occurs through the margin and tip of the leaves.
4. The lose water is pure.	4.The lose water contains minerals as well as vitamins.

5. It occurs during day time.
6. It gives rise cooling effect.
7. It is common in all types of plants.

5. It occurs during night time.
6. It does not give rise such effect.
7. It is common in some herbaceous plants.