EXERCISE QUESTIONS

CHAPTER - 11 TRANSPORT IN PLANTS

11.1. What are the factors affecting the rate of diffusion?

Ans - The following variables impact the rate of diffusion:

• Density: According to Graham's Law, a substance's rate of diffusion is inversely related to the square root of its relative density.

• Medium permeability - Diffusion rate reduces with medium density.

• Temperature - With Q10 = 1.2 to 1.3, a rise in temperature accelerates the rate of diffusion. Because of this, sugar crystals dissolve more readily in warm water than they do in icy cold.

• Diffusion pressure gradient - The rate of diffusion is inversely proportional to the distance between two points in a system and directly proportional to the difference in diffusion pressure between them.

11.2. What are porins? What role do they play in diffusion?

Ans - The proteins known as porins create enormous openings in the outer membranes of some bacteria, mitochondria, and plastids that permit molecules as small as small proteins to pass through. As a result, they contribute significantly to aided diffusion.

11.3. Describe the role played by protein pumps during active transport in plants.

Ans - Molecules are pumped energetically against a concentration gradient during active transport. Membrane proteins are responsible for active transport. Therefore, several membrane proteins are crucial for both active and passive transport. Pumps are proteins that move materials across the cell membrane with the help of energy.

From a low concentration to a high concentration, this pump may move various chemicals.

When all of the protein transporters are in use or are saturated, the transport rate achieves its maximum. The carrier protein is extremely specialised in what it transports across the membrane, much like enzymes. When inhibitors interact with the side chains of proteins, these proteins become sensitive.

11.4. Explain why pure water has the maximum water potential.

Ans - Kinetic energy is present in water molecules. In their liquid and gaseous states, they move randomly in a swift and continuous manner. A system's kinetic energy, or "water potential," increases with the amount of water present. It follows that pure water will undoubtedly have the highest water potential.

The Greek letter Psi, which stands for "water potential," is used to represent it.

Pascals are a pressure unit used to express it (Pa). Conventionally, it is assumed that the water potential of pure water, which is not under any pressure and is at ordinary temperatures, is zero. When a solute is dissolved in pure water, less free water is present in the solution and the water concentration is lower, which lowers the solution's water potential. The water potential of all solutions is therefore lower than pure water.

11.5. Differentiate between the following:
(a) Diffusion and Osmosis
(b) Transpiration and Evaporation
(c) Osmotic Pressure and Osmotic Potential
(d) Imbibition and Diffusion
(e) Apoplast and Symplast pathways of movement of water in plants.
(f) Guttation and Transpiration.

Ans -

(a) The differences between diffusion and osmosis are as follows:

	Diffusion		Osmosis
1.	It is the movement of ions or molecules of any substance (liquid, solid or gas) from a region of its higher concentration to the region of its lower concentration.	1.	It is the movement of only solvent molecules from a region of its higher concentration to the region of its lower concentration through membrane.
2.	No membrane is requires.	2.	Movement occurs through semi-permeable membrane.
3.	It occurs in different medium, gas, liquid or solid.	3.	It occurs in liquid medium only.

(b) The differences between transpiration and evaporation are as follows:

	Transpiration		Evaporation
1	It is a physiological process.	1	It takes place at the surface of non-living objects.
2	It occurs at the exposed surface of plants.	2	It is a physical process.
3	It is influenced by the rate of water absorption, osmotic pressure of cell, thickness of cuticle, number, position and opening of	3	It is influenced by relative humidity and air current.
4	Transpiration is slow process.	4	Evaporation is comparatively faster.
5	Transpiration is affected by pH, CO_2 and hormones.	5	CO_2, pH and hormones have no effect on evaporation.

(c) The main differences between osmotic pressure and osmotic potential are as follows:

	Osmotic pressure		Osmotic potential
1.	It is the hydrostatic pressure required to stop the movement of water molecules through semipermeable membrane.	1.	It is decrease in water potential of pure water due to the presence of solutes.
2.	Expressed in bars with positive sign though numerically equal to osmotic potential.	2.	Expressed in bars with negative sign though numerically equal to osmotic pressure.
3.	The value of O. P. increase by increasing concentration of solute particles.	3.	More negative value of osmotic potential means greater the concentration of solute particles.
4.	It develops only in a confined system.	4.	Osmotic potential is present whether the solution occur in a confined system or an open system.

(d) The main differences between imbibition and diffusion are as follows:

	Imbibition		Diffusion
1.	Absorption of water by solid substance.	1.	It is flow of substance from higher concentration to lower concentration.
2.	Solid substance undergo swelling volume is increased.	2.	Total volume remains same.
3.	Pressure created is called imbibitional pressure.	3.	Takes place due to DPD.

(e) The main differences between apoplast and symplast pathways of movement of water in plants are as follows:

	Apoplast		Symplast
1.	Apoplast pathway is the movement of water through adjacent cell walls.	1.	In this pathway water moves from one cell to another through plasmodesmata.
2.	Movement through apoplast does not involve crossing the cell membrane.	2.	During symplast movement, the water travels through cells.
3.	Apoplast movement is fast.	3.	Symplast movement is relatively slower.
4.	The apoplast does not provide any barrier to water movement.	4.	In symplast water molecule are unable to penetrate casparian strip.

(f) The main differences between guttation and transpiration are as follows:

	Guttation		Transpiration
1.	It is loss or excretion of water in form of liquid droplet.	1.	It is loss of water in the form of vapour.
2.	Occurs through hydathodes.	2.	Occurs through stomata, lenticle or cuticle.
3.	Commonly occurs in night or early in the morning.	3.	Commonly occurs in day time.
4.	It is restricted to about 345 genera of herbaceous and some woody plants.	4.	It occurs in all higher terrestrial plants.
5.	It takes place due to root pressure.	5.	Root pressure is not involved.
6.	It has no relation with the temperature.	6.	Transpiration maintains the temperature of plants.

11.6. Briefly describe water potential. What are the factors affecting it?

Ans - Slatyer and Taylor were the first to use the term "water potential" (1960). The chemical potential of a specific chemical species is defined as its free energy per mole in a multicomponent system. The water potential (w) denotes the chemical potential of water. Since the free energy of water is reduced when solute particles are present, the water potential is decreased since the of pure water is zero (0). (negative value). As a result, the answer is either always less than zero or has a maximum value of zero.

The following are some factors that affect water potential:
(i) Adsorbent or colloidal particles that create a MATTERIAL potential (φm) (always negative and almost negligible).
(ii) Solute potential (φs) due to solute particle existence (decreases the water potential).
(iii) Pressure potential (φp) brought on by water entering or leaving (increases the water potential).

The three internal factors $\psi w = \psi m + \psi s + \psi p$ (where m is the matric potential, used to describe the surface, such as soil particles or cell walls, to which water molecules are absorbed, ψs is the solute potential, also known as osmotic potential, the amount by which water potential is reduced, and ψp is pressure potential, such as TP and WP) determine the water potential for solutions. Since ψm is ignored in the plant system, the equation can be expressed as follows:

$$\psi w = \psi s + \psi p$$

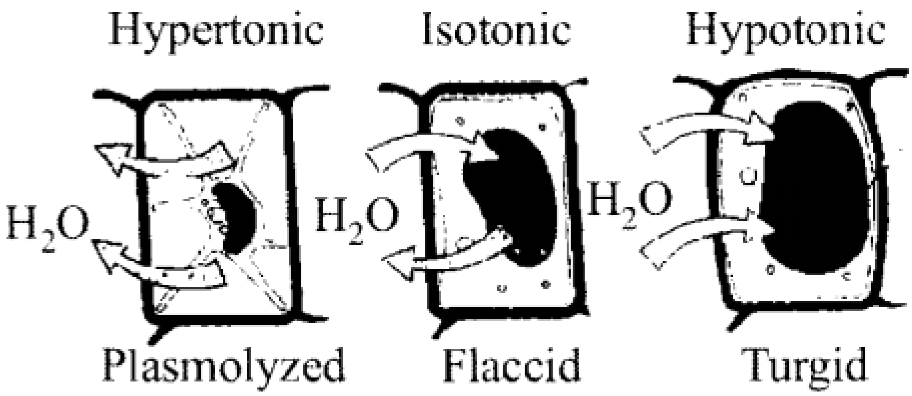
11.7. What happens when a pressure greater than the atmospheric pressure is applied to pure water or a solution?

Ans - Pure water or a solution's water potential increases when pressure greater than air pressure is applied. It is comparable to moving water by pump from one location to another. When water enters a plant cell through diffusion, pressure can build up on the cell wall, which causes the cell to become turgid.

11.8. (a) With the help of well-labelled diagrams, describe the process of plasmolysis in plants, giving appropriate examples.
(b) Explain what will happen to a plant cell if it is kept in a solution having higher water potential.

Ans - (a) Plasmolysis is the term used to describe the separation of a cell's protoplast from its cell wall when a hypertonic solution is present. Exosmosis, or the evacuation of water from the cytoplasm and central vacuole of the cell, is brought on by a hypertonic solution. Cytoplasm, the central vacuole, and the protoplast all shrink in size. Limiting plasmolysis is the name of the initial phase of plasmolysis. The pressure potential (p) is zero at limiting plasmolysis, and the osmotic concentration inside the cejl is barely equal to that of the exterior solution (isotonic). The flaccid cell is so named. The protoplast withdraws from the comer when pressure potential is negative. The term "incipient plasmolysis" refers to this phase. The cell wall does not provide any pressure to the cell contents during incipient plasmolysis (i.e. ψp is zero). Hence at this stage

$$\psi w = \psi s.$$



Plasmolysis

(b) Plasmolysis is typically a reversible process. Water diffuses into the cells when they are in a hypotonic solution (a solution with low concentration), causing the cytoplasm to expand. Deplasmolysis is the term used to describe the swell of a shrinking protoplast.

11.9. How is the mycorrhizal association helpful in absorption of water and minerals in plants?

Ans - Some plants also have structures attached to them that aid in the absorption of minerals and water. A fungus and a root system form a symbiotic relationship known as a mycorrhiza. Around the developing root, the fungus filaments weave a web or pierce the root cells. The hyphae collect water and mineral ions from a considerably bigger volume of soil than a root might be able to. This is due to their relatively huge surface area.

The roots receive water and minerals from the fungus, and the mycorrhizae receive sugars and N-containing chemicals from the roots. Certain plants are required to associate with mycorrhizae. For instance, mycorrhizae are necessary for the germination and establishment of Pinus seeds.

11.10. What role does root pressure play in water movement in plants?

Ans - Water circulates and raises pressure inside the xylem as different ions from the soil are actively carried into the vascular tissues of the roots. It is possible for water to be forced up to modest heights in the stem as a result of this positive pressure, which is known as root pressure.

When it comes to the whole operation of transporting water, root pressure can only offer a slight push. The main benefit is the restoration of the continuous water molecule chains in the xylem, which frequently break because to the extreme stresses produced by transpiration.

11.11. Describe transpiration pull model of water transport in plants. What are the factors influencing transpiration? How is it useful to plants?

Ans - Dixon and Joly first presented the transpiration pull or cohesion-tension hypothesis in 1894, and Dixon improved it in 1914. This idea states that a continuous

The plant's xylem canals contain a column of water. The cohesive force of water molecules keeps the water column continuous in the plant. Water is held to the walls of xylem vessels by another force of adhesion. Water is lost from the mesophyll cells to the outside during transpiration in plants in the form of water vapour through stomata. As a result, these cells' turgor pressure drops and their diffusion pressure deficit (DPD) widens. As a result, the turgor of the cells next to them drops as these cells now take water from them.

Water is eventually absorbed from the nearest xylem vessels of the leaf once this procedure is repeated. Since the xylem components contain a continuous water column, a tension or pull is communicated down and then to the root, causing the water to rise upward.

Both external and internal factors can have an impact on transpiration. environmental elements

(i) Relative humidity - The rate of transpiration is inversely correlated with relative humidity, meaning that it is higher when the relative humidity is lower and lower when it is higher.

(ii)Atmospheric temperature - Even in the dead of night, a high temperature causes stomata to open. In addition to heating the air, it also decreases relative humidity and raises vapour pressure inside the transpiring organ. As a result, transpiration rate rises.

(iii)Light - The rate of transpiration is quite high in light since the majority of it happens through stomata. In the dark, it significantly drops.

(iv)Air movements - Transpiration is less in still air as water vapours gather around the transpiring organs and lower the DPD of the air. By removing the saturated air from around the leaves, air movement accelerates transpiration.

(vi) Water availability - The rate of transpiration is influenced by the pace at which roots are able to absorb water from the soil. Additional soil variables like soil water, soil particles, soil temperature, soil air, etc. also have an impact on this.

Biological or internal factors:

(i) Leaf area (transpiring area) - A plant that has a lot of leaves will transpire more than a plant that has fewer leaves.

(ii)Leaf structure - Leaf structure has the following effects on transpiration:

(A) Cuticular transpiration reduces as the cuticle becomes thicker and the epidermal walls become cutinized.

(b) The quantity and location of the stomata, which account for the majority of transpiration, affect the rate of transpiration.

(iii)Root/shoot ratio: A low root/shoot ratio lowers transpiration rate, whereas a high ratio raises transpiration rate.

(iv)Mucilage and solutes - By tenaciously retaining water, they slow down the rate of transpiration.

Plants can benefit from transpiration in the following ways:

(i) Elimination of surplus water - It has long been believed that plants absorb significantly more water than they actually need. Transpiration thereby eliminates the surplus of water.

(ii) Root system: The growth of the root system, which is necessary for the support and absorption of mineral salts, is aided by transpiration.

(iv) Temperature control - Transpiration keeps leaves from overheating. Plants that thrive in places with little transpiration, however, do not exhibit overheating. Some succulents may withstand temperatures as high as 60°C without showing any obvious damage.

(v)Pole in sap ascent and turgidity - The primary cause of sap ascent is the pull of water transpiration. This pull is crucial for water absorption. Additionally, by keeping cells rigid, transpiration preserves the shape and structure of plant parts.

(vi) Mineral salts are primarily dispersed through a sap column that is rising.

(vii) Photosynthesis: Water for photosynthesis is obtained by transpiration.

11.12. Discuss the factors responsible for ascent of xylem sap in plants.

Ans - The following elements contribute to the rise of xylem sap.
(i) Root pressure (positive pressure that develops in the xylem sap of root).

(ii) Coherence (adhesion of water molecules due to hydrogen bonding).

(iii) Adhesion (force between tracheary wall and water molecule).

(iv) The principal factor for the ascent of xylem sap is transpiration pull, or tension that results from transpiration.

11.13. What essential role does the root endodermis play during mineral absorption in plants?

Ans - The plasma membrane of endodermal cells contains numerous transport proteins, which are present in all cells. Some solutes can pass through the membrane while others cannot. Plants can regulate the amount and types of solutes that reach the xylem at control sites such as the transport proteins of endodermal cells. The root endodermis can actively transport ions only in one direction because of the layer of suberin.

11.14. Explain why xylem transport is unidirectional and phloem transport bi-directional.

Ans - 1. The plant's leaf, which synthesises food, is referred to as the source, while the section that consumes or stores food is referred to as the sink.

2. Phloem in the vasculai tissue carries food, mostly sugar, from a source to a sink. But the source sink may be switched around according on the season or the needs of the plants.

3. In the early spring, when tree buds need energy for their growth and development and serve as sinks, sugar that has been stored in the roots may be mobilised and used as a food source.

4. The source-sink relationship is bidirection in the phloem, whereas it is unidirection in the xylem.

11.15. Explain pressure flow hypothesis of translocation of sugars in plants.

Ans - The pressure flow hypothesis is the recognised mechanism for the translocation of sugars from source to sink. As glucose is created at the source, which is in leaves, it is transformed into sucrose via photosynthesis (a dissacharide). The sugar is then actively transported in the form of sucrose into nearby partner cells, followed by the live phloem, or sieve tube cells. The phloem becomes hypertonic as a result of this loading process at the source. Osmosis causes water in the nearby xylem to flow into the phloem. The phloem sap will migrate to regions of lower pressure when osmotic pressure increases.Osmotic pressure needs to be decreased at the sink. Once more, active transport is required to remove the sucrose from the

Phloem sap then enters the cells, where the sugar is used to create starch, cellulose, or energy. As sugars are eliminated, the phloem's osmotic pressure drops and water begins to exit the phloem.

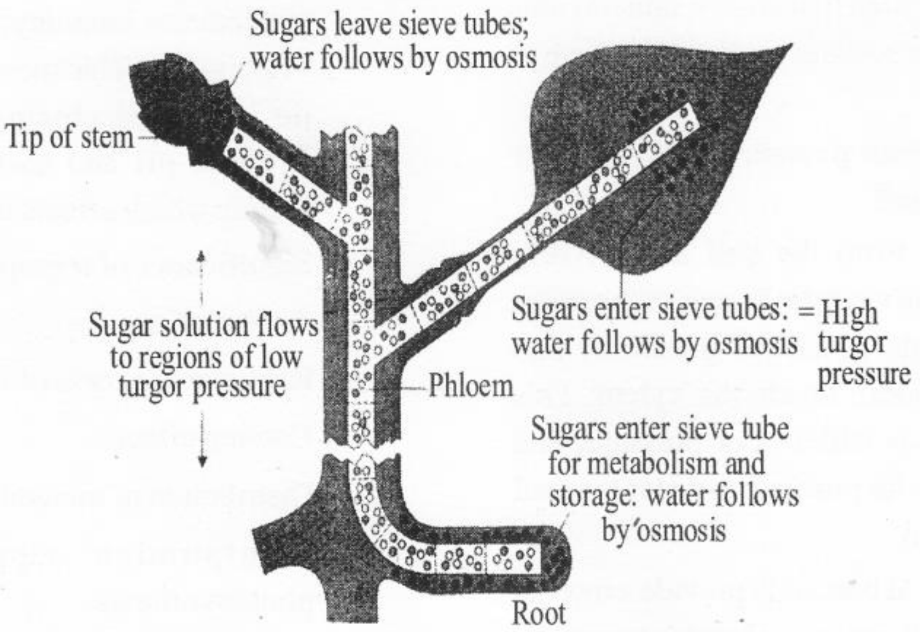


Fig. Diagrammatic presentation of mechanism of translocation

11.16. What causes the opening and closing of guard cells of stomata during transpiration?

Ans - The evaporative loss of water by plants is known as transpiration. Most of the time, it happens through the leaves' stomata. The guard cells' changing turgidity is the direct cause of the stomata's opening or closing. Each guard cell has a strong and elastic inner wall that faces the pore or stomatal aperture. The two guard cells that flank each stomatal aperture or pore have thin outer walls that protrude when turgidity rises, forcing the inner walls to curve into a crescent shape, which causes the stomata to open. The orientation of the microfibrils in the guard cells' cell walls helps the stoma open more easily.

1. The guard cells' turgid or flaccid state affects how the stomata open and close.

2. Guard cells have a thick inner wall that faces the pore and a weak outer wall that faces other epidermal cells.

3. The outer thinner wall of the guard cell is pushed out (toward the periphery) when the turgor pressure of the guard cells increases, pushing the inner thicker wall and causing the stomatal hole to open.

4. The outer, thinner wall of guard cells returns to its original position (moves toward pore) when the guard cells are in a flaccid state, releasing tension on the inner wall and closing the stomatal aperture.