# Chapter – 11

# Transport in Plants

## *NCERT Back Exercises:*

**Ques 1: What are the factors affecting the rate of diffusion?**

**Ans 1:** Diffusion is the passive movement of substances from a region of higher concentration to a region of lower concentration. Diffusion of substances plays an important role in cellular transport in plants. Rate of diffusion is affected by concentration gradient, membrane permeability, temperature, and pressure. Diffusion takes place as long as there is a difference between the concentrations of a substance across a barrier. However, diffusion stops, when the concentrations of the substance on either side of the barrier become equal. The permeability of a membrane affects the rate of diffusion. Diffusion rate increases as membrane permeability increases. Changes in temperature and pressure values also affect the diffusion of substances. Pressure plays an important role in the diffusion of gases as gases diffuse from a region of higher partial pressure to a region of lower partial pressure.

**Ques 2: What are porins? What role do they play in diffusion?**

**Ans 2:** Porins are types of proteins which form pores of large sizes in the outer membranes of plastids such as chloroplast, mitochondria and the membranes in bacteria. They help in facilitating the passive transport of small-sized protein molecules.

**Ques 3: Describe the role played by protein pumps during active transport in plants.**

**Ans 3:** In plant cells, active transport occurs against the concentration gradient, i.e., from a region of lower concentration to a region of higher concentration. The process of active transport involves specific protein pumps. The protein pumps are made up of specific proteins called trans-membrane proteins. These pumps first make a complex with the substance to be transported across the membrane, using the energy derived from ATP. The substance finally gets liberated into the cytoplasm as a result of the dissociation of the protein–substance complex.

## Ques 4: Explain why pure water has the maximum water potential.

**Ans 4:** Water potential quantifies the tendency of water to move from one part to the other during various cellular processes. It is denoted by the Greek letter Psi or Ψ. The water potential of pure water is always taken as zero at standard temperature and pressure. It can be explained in terms of the kinetic energy possessed by water molecules. When water is in liquid form, the movement of its molecules is rapid and constant. Pure water has the highest concentration of water molecules. Therefore, it has the highest water potential. When some solute is dissolved in water, the water potential of pure water decreases.

## Ques 5: Differentiate between the following:

**(i) Diffusion and Osmosis**

**(ii) Transpiration and Evaporation**

**(iii) Osmotic Pressure and Osmotic Potential**

**(iv) Imbibition and Diffusion**

**(v) Apoplast and Symplast pathways of movement of water in plants.**

**(vi) Guttation and Transpiration.**

**Ans 5:**

(i) Diffusion and osmosis

| Diffusion | | Osmosis | |
|---|---|---|---|
| **1.** | Diffusion is the passive movement of particles, ions, and molecules along the concentration gradient. | **1.** | Osmosis is the process in which the diffusion of a solvent (water) occurs across a semi-permeable membrane. |
| **2.** | It can occur in solids, liquids, and gases. | **2.** | It occurs in the liquid medium. |
| **3.** | It does not require | **3.** | It requires a semi-permeable membrane. |

(ii) Transpiration and evaporation

| Transpiration | | Evaporation | |
|---|---|---|---|
| **1.** | It occurs in plants. | **1.** | It occurs from any free surface and involves living and non-living surfaces. |
| **2.** | It is a physiological process. | **2.** | It is a physical process. |
| **3.** | It occurs mainly through the stomatal pores on plant leaves. | **3.** | It is occurs through any free surface. |
| **4.** | It is controlled by environmental factors as well as physiological factors of plants such as root-shoot ratio and number of stomata. | **4.** | It is entirely driven by environmental factors. |

(iii) Osmotic pressure and osmotic potential

| Osmotic pressure | | Osmotic potential | |
|---|---|---|---|
| **1.** | It is expressed in bars with a positive sign. | **1.** | It is expressed in bars with a negative sign. |
| **2.** | It is a positive pressure. | **2.** | It is a negative pressure. |
| **3.** | Its value increases with a solute particles. | **3.** | Its value decreases with an increase in the concentration of solute particles. |

(iv) Imbibition and diffusion

| Imbibition | | Diffusion | |
|---|---|---|---|
| **1.** | Imbibition is a special type of diffusion. In this process, water is absorbed by solids and colloids, causing an enormous increase in volume. | **1.** | Diffusion is the passive movement of particles, ions, and molecules along the concentration gradient. |
| **2.** | It usually involves water. | **2.** | It involves solids, liquids, and gases. |

(v) Apoplast and symplast pathways of movement of water in plants

| Apoplast pathway | | Symplast pathway | |
|---|---|---|---|
| **1.** | The apoplast pathway involves the movement of water through the adjacent cell walls of the epidermis and cortex. The movement of water is restricted at the casparian strips of the root endodermis. | **1.** | The symplast pathway involves the movement of water through the interconnected protoplasts of the epidermis, cortex, endodermis, and root pericycle. |
| **2.** | It is a faster process of water movement and water moves through mass flow. | **2.** | It is a slower process of water movement. |

(vi) Guttation and transpiration

| Guttation | | Transpiration | |
|---|---|---|---|
| **1.** | It occurs usually at night. | **1.** | It occurs usually during the day. |
| **2.** | Water is lost from the leaves in the form of liquid droplets. | **2.** | Water is lost from the leaves in the form of water vapour. |
| **3.** | It occurs through the vein endings of leaves. | **3.** | It occurs through the stomata. |
| **4.** | It is an uncontrolled process. | **4.** | It is a controlled process. |

**Ques 6: Briefly describe water potential. What are the factors affecting it?**

**Ans 6:** Water potential is the tendency of the water to move from one area to other due to osmosis, gravity and mechanical pressure. In other words, it is the difference in the free energy or chemical potential per unit molal volume of water in a system and that of pure water, at the same pressure and temperature. It can be estimated in units of pressure. At a standard temperature and pressure, pure water is defined as possessing a 0 water potential. When solutes are added to water, potential lowers and increase in pressure, increases potential.

Factors affecting water potential:

(i) Solute potential
(ii) Pressure potential
(iii) Matric potential
(iv) Pressure
(v) Temperature
(vi) Gain/loss of water

**Ques 7: What happens when a pressure greater than the atmospheric pressure is applied to pure water or a solution?**

**Ans 7:** The water potential of pure water or a solution increases on the application of pressure values more than atmospheric pressure. For example: when water diffuses into a plant cell, it causes pressure to build up against the cell wall. This makes the cell wall turgid. This pressure is termed as pressure potential and has a positive value.

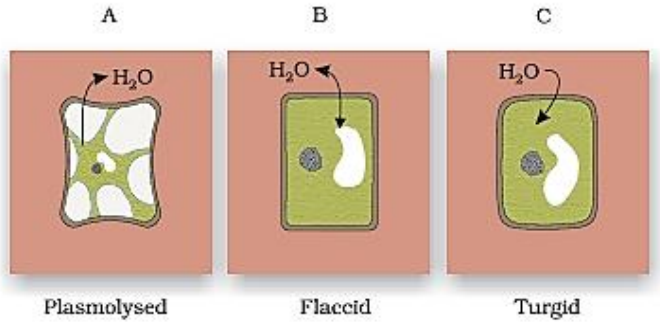
**Ques 8:**

**(i) With the help of well-labelled diagrams, describe the process of plasmolysis in plants, giving appropriate examples.**

**(ii) Explain what will happen to a plant cell if it is kept in a solution having higher water potential.**

**Ans 8:**

(i) Plasmolysis can be defined as the shrinkage of the cytoplasm of a plant cell, away from its cell wall and toward the centre. It occurs because of the movement of water from the intracellular space to the outer-cellular space. This happens when the plant cell is placed in a hypertonic solution (i.e., a solution having more solute concentration than the cell cytoplasm). This causes the water to move out of the cell and toward the solution. The cytoplasm of the cell shrinks and the cell is said to be plasmolysed. This process can be observed in an onion peel kept in a highly concentrated salt solution.




(ii) When a plant cell is placed in a hypertonic solution or a solution having higher water potential, the water diffuses into the cell (i.e., movement is observed from higher to lower water pressure region). The entry of water in the plant cell exerts pressure on the rigid cell wall. This is called turgor pressure. As a result of its rigid cell wall, the plant cell does not burst.

**Ques 9: How is the mycorrhizal association helpful in absorption of water and minerals in plants?**

**Ans 9:** Mycorrhiza is a symbiotic association of fungi with the root systems of some plants. The fungal hyphae either form a dense network around the young roots or they penetrate the cells of the roots. The large surface area of the fungal hyphae is helpful in increasing the absorption of water and minerals from the soil. In return, they get sugar and nitrogenous compounds from the host plants. The mycorrhizal association is obligate in some plants. For example, *Pinus* seeds do not germinate and establish in the absence of mycorrhizal.

**Ques 10: What role does root pressure play in water movement in plants?**

**Ans 10:** Root pressure is the positive pressure that develops in the roots of plants by the active absorption of nutrients from the soil. When the nutrients are actively absorbed by root hairs, water (along with minerals) increases the pressure in the xylem. This pressure pushes the water up to small heights. Root pressure can be observed experimentally by cutting the stem of a well-watered plant on a humid day. When the stem is cut, the solution oozes from the cut end.
Root pressure is also linked to the phenomenon of guttation, i.e., the loss of water in the form of liquid droplets from the vein endings of certain herbaceous plants.
Root pressure is only able to transport water up to small heights. However, it helps in re-establishing the continuous chains of water molecules in the xylem.
Transpirational pull maintains the flow of water molecules from the roots to the shoots.

**Ques 11: Describe transpiration pull model of water transport in plants. What are the factors influencing transpiration? How is it useful to plants?**

Ans 11: Transpiration pull helps water rise in tall trees which is created by loss of water or the process of transpiration from the pores of stomata of leaves which is known as cohesion-tension model of water transport. The water that is lost during day time through the process of transpiration results in the epidermal cells and guard cells to turn flaccid. In turn, these take water from the xylem creating a negative pressure or tension in the xylem vessels from the surface of the leaves to root tips, through the stem. Subsequently, water in the xylem gets pulled as a single column from the stem. The adhesion and cohesion forces of the water molecules and cell walls of the xylem vessels restrict the splitting of the water column.

Factors affecting transpiration pull are:

(i) Temperature
(ii) Relative humidity
(iii) Light
(iv) Wind
(v) Plant factors – number and distribution of stomata, canopy structure, water status of plants, number of open stomata

Importance of transpiration pull

(i) It has a cooling effect on plants
(ii) Transpiration pull exerts ascent of sap which helps in the distribution of mineral salts.
(iii) It helps in retaining shape and structure by keeping the cells turgid.
(iv) Transpiration helps in the removal of excess water absorbed by the plants.
(v) Provides water for photosynthesis

**Ques 12: Discuss the factors responsible for ascent of xylem sap in plants.**

**Ans 12:** Transpirational pull is responsible for the ascent of water in the xylem. This ascent of water is dependent on the following physical factors:

(i) Cohesion – Mutual attraction between water molecules

(ii) Surface tension – Responsible for the greater attraction between water molecules in liquid phase than in gaseous phase

(iii) Adhesion – Attraction of water molecules to polar surfaces

(iv) Capillarity –Ability of water to rise in thin tubes

These physical properties of water allow it to move against gravity in the xylem.

**Ques 13: What essential role does the root endodermis play during mineral absorption in plants?**

**Ans 13:** In plants, nutrients are absorbed through the active and passive transports. The endodermal cells of the roots containing suberin allow only selected minerals to pass through them. The transport proteins present in the membranes of these cells act as check points for the various solutes reaching the xylem.

**Ques 14: Explain why xylem transport is unidirectional and phloem transport bi-directional.**

**Ans 14:** During the growth of a plant, its leaves act as the source of food as they carry out photosynthesis. The phloem conducts the food from the source to the sink (the part of the plant requiring or storing food). During spring, this process is reversed as the food stored in the sink is mobilised toward the growing buds of the plant, through the phloem. Thus, the movement of food in the phloem is bidirectional (i.e., upward and downward). The transport of water in the xylem takes place only from the roots to the leaves.
Therefore, the movement of water and nutrients in the xylem is unidirectional.

**Ques 15: Explain pressure flow hypothesis of translocation of sugars in plants.**

**Ans 15:** According to the pressure flow hypothesis, food is prepared in the plant leaves in the form of glucose. Before moving into the source cells present in the phloem, the prepared food is converted into sucrose. Water moves from the xylem vessels into the adjacent phloem, thereby increasing the hydrostatic pressure in the phloem. Consequently, the sucrose moves through the sieve cells of the phloem. The sucrose already present in the sink region is converted into starch or cellulose, thereby reducing the hydrostatic pressure in the sink cells. Hence, the pressure difference created between the source and the sink cells allows sugars to be translocated from the former to the latter. This starch or cellulose is finally removed from the sink cells through active transport.

**Ques 16: What causes the opening and closing of guard cells of stomata during transpiration?**

**Ans 16:** The tiny pores present on the surfaces of leaves, called stomata, help in the exchange of gases. Each stoma consists of bean-shaped or dumbbell-shaped guard cells. The epidermal cells surrounding the guard cells are modified to form subsidiary cells. The opening and closing of the guard cells is caused by a change in their turgidity. The inner walls of the guard cells are thick and elastic, while the outer walls are thin. The numerous microfibrils present in the guard cells facilitate the opening and closing of the guard cells. At the time of the opening of the stomata, the turgidity of the guard cells increases. As a result, the outer walls bulge and the inner walls become crescent-shaped. The stomatal opening is facilitated by the radial arrangement of the microfibrils.

At the time of the closing of the stomata, the guard cells lose their turgidity, the outer and inner walls retain their original shapes, and the microfibrils get arranged longitudinally.