Chapter 11
Transport in Plants

Question 1:
What are the factors affecting the rate of diffusion?

Solution 1:
Various factors affecting the rate of diffusion are:
(i) **Gradient of concentration:** Rate of diffusion increases with the increase in concentration gradient across the barrier. Diffusion stops, when the concentration of the substance on either side of the barrier becomes equal.
(ii) **Permeability of membrane:** Rate of diffusion increases with the increased permeability of the membrane separating the two substances to be diffused.
(iii) **Temperature:** Rate of diffusion increases with an increase in temperature.
(iv) **Pressure:** 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.

Question 2:
What are porins? What role do the play in diffusion?

Solution 2:
Porins are a kind of proteins that form pores of large sizes in the outer membranes of chloroplast, mitochondria and some bacteria, allowing the passive transport of small-sized protein molecules. Thus, porins facilitate diffusion.

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

Solution 3:
In plant cells, protein pumps are used to transport the substances against the concentration gradient, i.e., from a region of lower concentration to a region of higher concentration. Each protein pump is very specific in what substance it carries across the membrane. The protein pumps are made up of specific proteins called trans-membrane proteins. These specific proteins make a complex with the substance to be transported across the membrane, using the energy derived from ATP. One entering the cytoplasm, this protein substance complex gets dissociated to liberate the substance.

Question 4:

Explain why pure water has the maximum water potential.

Solution 4:

Water potential denoted by Psi (Ψ), refers to the tendency of water molecules to move from one part to the other during various cellular processes. It can be explained in terms of the kinetic energy possessed by water molecules. Greater the concentration of water in a system, the greater is its kinetic energy, hence greater is the water potential. Since pure water has the highest concentration of water molecules, therefore, it has the highest water potential.

Question 5:

Differentiate between the following:

(a) Diffusion 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.

Solution 5:

(a) Difference between diffusion and osmosis:

S. No	Diffusion	Osmosis
1.	It is a movement of particles, ions, and molecules from their region of high concentration to their region of low concentration.	It is a special type of diffusion in which a solvent like water moves from its region of high concentration to its region of low concentration.
2.	Movement occurs along the general concentration gradient,	Movement occurs against the general (solute) concentration gradient.
3.	It does not require any semi-permeable membrane.	It requires a semi-permeable membrane.

(b) Differences between transpiration and evaporation are:

S. No	Transpiration	Evaporation
1.	It is the process of loss of water through the aerial part of plants.	It is the process of loss of water from any free surface.
2.	It is a both physical and	It is only a physical process.

	physiological process.	
3.	It occurs only in living tissues.	It can occur in non-living tissues.

(c) Differences between osmotic pressure and osmotic potential are:

S. No	Osmotic pressure	Osmotic potential
1.	It is the pressure required to stop the inward movement of water molecules through a semipermeable membrane.	It is the ability of a solution to suck water from across a semipermeable membrane.
2.	Its value increase with an increase in the concentration of solute particles.	It value decreases with an increase in the concentration of solute particles.
3.	It is a positive pressure.	It is a negative pressure.

(d) Differences between imbibition and diffusion are:

S. No	Imbibition	Diffusion
1.	It is special type of diffusion in which water is absorbed by solids and colloids, causing an enormous increase in their volumes. For example, water absorbed by the dry seeds.	It involves the movement of particles, ions, and molecules along the concentration gradient.
2.	It usually involves the movement of water molecules.	It involves the movement solid, liquid as well as gaseous molecules.

(e) Differences between Apoplast and Symplast pathways of movement of water in plant are:

S. No	Apoplast pathway	Symplast pathways
1.	The apoplast pathway involves the movement of water through the adjacent cell walls of the epidermis and cortex.	The symplast pathway involves the movement of water through the interconnected protoplasts of the epidermis, cortex, endodermis, and root pericycle.
2.	Water movement does not involve crossing the cell membrane in apoplast pathway	Water has to move into the cell through the cell membrane.
3.	It is a faster process of water	It is a slower process of water

	movement.	movement.

(f) Differences between guttation and transpiration are:

S. No	Guttation	Transpiration
1.	It involves the loss of water from the leaves in the form of liquid droplets.	It involves the loss of water from the leaves in the form of water vapour.
2.	It occurs at the vein endings of leaves.	It occurs on general surface, stomata and lenticels.
3.	It occurs usually at night.	It occurs usually during the day.
4.	It does not occur in water deficient conditions and never leads to wilting.	It can occur in water deficient conditions, leading to wilting.

Question 6:

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

Solution 6:

Water potential quantifies the tendency of water to move from one area to the other due to osmosis, gravity, mechanical pressure, etc. It is denoted by the Greek letter Ψ (Psi) and is expressed in Pascals (Pa). Pure water has the highest water potential. Solution have lower water potential than pure water. Water potential (Ψ w) is expressed as the sum of the solute potential (Ψ s) and pressure potential (Ψ p).

$\Psi w = \Psi s + \Psi p$

Thus, Solute potential and pressure potential are the two factors which affect water potential.

Question 7:

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

Solution 7:

When a pressure greater than the atmospheric pressure is applied to pure water or a solution then its water potential increases. This happens due to the increased pressure potential on increasing pressure. Pressure can be built up in a plant cell against the cell wall, when water diffuses into it. This makes the cell wall turgid. This pressure is termed as pressure potential and has a positive value.

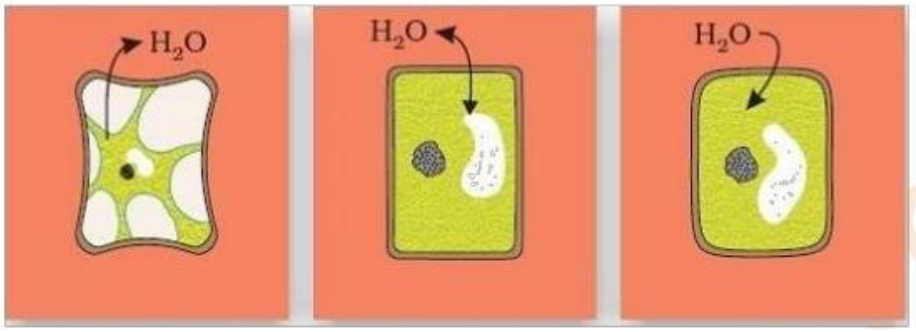
Question 8:

(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.

Solution 8:

(a) **Plasmolysis:** It is a process in which water moves out of the cell resulting in the shrinkage of the cytoplasm of the cell, away from its cell wall. This occurs when the plant cell is placed in a hypertonic solution (i.e., a solution having more solute concentration than that inside the cell cytoplasm). This causes the water to move out of the cell and towards the solution. This causes the cytoplasm of the cell to shrink. In this situation the cell is said to be plasmolysed. This process can be observed in an onion peel placed in a highly concentrated salt solution.



Plasmolysed cell **Turgid cell**

Fig. Diagram showing the process of plasmolysis

(b) When a plant cell is kept in a solution having higher water potential (hypotonic solution or dilute solution), the water diffuses into the cell causing the cytoplasm to build up a pressure against the cell wall. This is called turgor pressure. This pressure causes the enlargement of the cell. But the rigidity of the cell wall prevents the cell from bursting.

Question 9:

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

Solution 9:

Mycorrhiza is a symbiotic association of fungi with the root systems of some plants. The

fungal hyphae from a network around young roots and thus, increase the surface area. This increased surface area of the fungal hyphae is helpful in increasing the absorption of water and minerals from the soil. In return, the roots provide sugar and nitrogenous compounds to the mycorrhizae.

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

Solution 10:
Root pressure is the positive pressure developed in the roots of plants by the active absorption of nutrients from the soil. This pressure can only provide a modest push to water.
However, it contributes towards the re-establishment of continuous chains of water molecules in the xylem, which often break under enormous tensions created by transpiration pull. Transpiration pull maintains the flow of water molecules from the roots to the shoots.

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

Solution 11:
Transpiration is the process of loss of water through aerial part of the plant especially through the leaves. It creates a suction force inside the xylem. It is this suction force known as transpirational pull which causes the overall circulation of water through the xylem vessels. This is called the cohesion-tension model of water transport.
Various factors influencing the transpiration are: Temperature, wind speed, humidity, light, number and distribution of stomata, water status of the plant, canopy structure, etc.
Importance of transpiration in plants: it helps in the absorption and transport of essential minerals and liquids from soil to the various parts of plant. It also helps to maintain the temperature inside the plants. It helps to keep the cells turgid thereby maintain the plant shape and structure.

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

Solution 12:

Various factors responsible for ascent of xylem sap in plants are:

(i) **Cohesion** – The mutual attraction between water molecules is called cohesion.

(ii) **Surface tension** – The property by the virtue of which every liquid tends to occupy the least possible surface area is known as the surface tension. It is responsible for the greater attraction between water molecules in liquid phase than in gaseous phase.

(iii)**Adhesion** – Attraction of water molecules to polar surfaces is called adhesion.

All these physical properties impart high tensile strength to water, which enables the water to resist a pulling force and high capillarity (ability to rise in thin tubes). The ability to rise in tubes is called capillarity. The thin tubes of xylem work like capillary tubes.

Question 13:

We essential role does the root endodermis play during mineral absorption in plants?

Solution 13:

The root endodermis have many transport proteins embedded in their plasma membrane, that control the quantity and types of various solutes reaching the xylem. Minerals need to be actively absorbed by the epidermal cells. The root endodermis has a layer of suberin which has the ability to actively transport ions in one direction only.

Question 14:

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

Solution 14:

Xylem tissues mainly transport water and minerals roots to other parts of plant. These water and minerals are utilized by the leaves in the process of photosynthesis. Also most of the water is lost through transpiration. This creates a further demand for water and minerals which are once again supplied through the same channel. Hence, transport through xylem is unidirectional.

Phloem tissues transport the food in plants from source (part of the plant that produces food) to sink (part of the plant that needs or stores food). During the growth of a plant, its leaves act as the source of food as they carry out the process of photosynthesis. The phloem transports the food from the leaves to the sink. But during early spring when new buds emerge out, the storage organ becomes a source. In that case, a reverse flow a food is required. Thus, the movement of food in the phloem is bidirectional.

Chapter 11
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Question 15:

Explain pressure flow hypothesis of translocation of sugars in plants.

Solution 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.

Question 16:

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

Solution 16:

The tiny pores present on the surfaces of leaves, called stomata, help in the exchange of gases. Each stoma consists of bean-shaped guard cells. The inner walls of the guard cells are thick and elastic, while the outer walls are thin. The opening and closing of the stomata, is caused by a change in the turgidity of the guard cells. When the turgidity of the guard cells increases, the outer walls bulge out and the inner walls become bend inwards. Then the radial arrangement of the micro fibrils causes the opening of the stomatal pores. Whereas, at the time of the closing of the stomata, the guard cells lose their turgidity, causing the outer and inner walls to retain their original shapes which makes the micro fibrils to get arranged longitudinally.