Chapter: Transport in Plants

Exercise Question

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

Answer: Diffusion is the passive movement of substances from a location of higher concentration to a region of lower concentration. The rate of diffusion is influenced by a number of factors such as concentration gradients, membrane permeability, temperature, and pressure.

Diffusion will stop when the chemical concentrations on both sides of the barrier are equal. The membrane permeability affects the rate of diffusion. As the permeability of the membrane increases, so the rate of diffusion also increases. Temperature and pressure have a great impact on chemical diffusion. Pressure is very important for diffusion of gases as they move from a higher partial pressure area to a lower partial pressure area.

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

Answer: Porins are protein types that generate huge pores in the outer membranes of plastids such as chloroplasts, mitochondria, and bacterial membranes. They aid in the movement of tiny protein molecules passively.

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

Answer: In plant cells, active transport occurs against the concentration gradient, that is, from a lower to a higher concentration zone. In the active transport process, certain protein pumps are involved. Trans-membrane proteins, which are specialised proteins, make up protein pumps. These pumps first build a compound with the substance to be transported over the membrane using the energy provided by ATP.

The substance is finally released into the cytoplasm as a result of the dissociation of the protein–substance combination.

Question 4: Explain why pure water has the maximum water potential.

Answer: During numerous cellular activities, water potential measures the tendency of water to migrate from one place to another. The Greek letter Psi (or) is used to represent it. At standard temperature and pressure, pure water's water potential is always assumed to be zero. The kinetic energy of water molecules can be used to explain this phenomenon. When water is in a liquid state, its molecules flow quickly and continuously. The largest concentration of water molecules is seen in pure water. As a result, it has the most water potential. The water potential of pure water falls when a solute is dissolved in it.

Question 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.

Answer:

(a) Diffusion and osmosis

	Diffusion		Osmosis
1.	Diffusion is defined as the passive movement of particles, ions, and molecules down a concentration gradient.	1.	Osmosis is a diffusion process in which a solvent (water) diffuses over a semi-permeable membrane.
2.	Solids, liquids, and gases all contain it.	2.	It takes place in a liquid medium.
3.	The usage of a semipermeable membrane is not required.	3.	It necessitates the use of a semi-permeable membrane.

(b) Transpiration and evaporation

	Transpiration		Evaporation
1.	It can be found in plants.	1.	It can happen on any free surface, including living and non-living ones.
2.	It's a physiological process, after all.	2.	It is a bodily function.
3.	It is primarily accomplished through the stomatal pores on plant leaves.	3.	It can happen on any free surface.
4.	It is influenced by both environmental and physiological elements in plants, such as the root-shoot ratio and the number of stomata.	4.	It is fully influenced by external forces.

(c) Osmotic pressure and osmotic potential

	Osmotic pressure		Osmotic potential
1.	It is written with a positive sign in bars.	1.	It is written with a negative sign in bars.
2.	The pressure is positive.	2.	It's a negative pressure situation.
3.	As the concentration of solute particles rises, its value rises as well.	3.	As the concentration of solute particles increases, its value drops.

(d) Imbibition and diffusion

	Imbibition		Diffusion
1.	Imbibition is a sort of diffusion that is unique. Water is absorbed by solids and colloids in this process, resulting in a massive volume rise.	1.	Diffusion is the movement of particles, ions, and molecules down a concentration gradient in which they are not actively moving.
2.	It frequently entails the use of water.	2.	Solids, liquids, and gases are all involved.

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

	Apoplast pathway		Symplast pathway

1.	The apoplast route involves the passage of water via the epidermis and cortex's neighbouring cell walls. At the Casparian strips of the root endodermis, water circulation is impeded.	1.	Water moves through the linked protoplasts of the epidermis, cortex, endodermis, and root pericycle in the symplast pathway.
2.	Water moves through mass flow, which is a faster mode of water transportation.	2.	It is a slower water movement method.

(f) Guttation and transpiration

	Guttation		Transpiration
1.	It frequently happens at night.	1.	It generally happens throughout the day.
2.	Water is lost in the form of liquid droplets from the leaves.	2.	Water is lost via the leaves in the form of water vapour.
3.	It happens as a result of leaf vein ends.	3.	It happens via the stomata.
4.	It is a procedure that is uncontrollable.	4.	It's a well-managed procedure.

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

Answer: Water potential is a measurement of the tendency of water to transfer from one part to another via cellular processes like diffusion and osmosis. The Greek letter Psi or is used to represent it, and it is measured in Pascals (Pa). At standard temperature and pressure, pure water's water potential is always assumed to be zero.

The sum of solute potential (s) and pressure potential (p) equals the water potential (w).

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

The water potential of pure waterfalls when a solute is dissolved in it. Solute potential (s), which is always negative, is the word for this. w = s for a solution at atmospheric pressure.

The water potential of pure water or a solution increases more than air pressure when pressure values are applied. Pressure potential is what it's called. Although the xylem has a negative pressure potential, it is indicated by p and has a positive value. The ascent of water via the stem is aided by this pressure potential.

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

Answer: The water potential of pure water or a solution increases more than air pressure when pressure values are applied. Water, for example, causes pressure to build upon the cell wall when it diffuses into a plant cell. The cell wall becomes turgid as a result of this. Pressure potential is the name given to this pressure, which 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.

Answer:

a. Plasmolysis is the process of a plant cell's cytoplasm shrinking away from the cell wall and toward the centre. Water moves from the intracellular to the extracellular space, causing this phenomenon.

When a plant cell is placed in a hypertonic solution, this occurs (i.e., a solution having more solute concentration than the cell cytoplasm). Water moves out of the cell and into the solution as a result of this. When a cell's cytoplasm shrinks, the cell is said to be plasmolyzed. An onion peel held in a very concentrated salt solution can demonstrate this process.

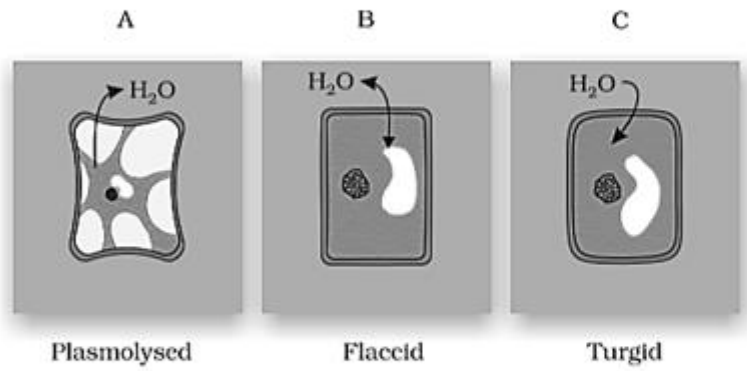

Fig. Process of Plasmolysis

b. Water diffuses into a plant cell when it is placed in a hypertonic solution or a solution with a higher water potential (i.e., migration from a higher to a lower water pressure zone). Water pressure is exerted on the stiff cell wall as it enters the plant cell. This is referred to as turgor pressure. The plant cell does not explode because of its stiff cell wall.

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

Answer: Mycorrhiza is a symbiotic relationship between fungi and plant root systems. The hyphae of the fungus may create a dense network around the young roots or penetrate the roots' cells. The enormous surface area of the fungal hyphae aids in enhancing water and mineral absorption from the soil. They acquire sugar and nitrogenous substances from the host plants in exchange. In some plants, the mycorrhizal connection is required. Pinus seeds, for example, do not germinate and grow in the absence of water mycorrhizal.

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

Answer: The positive pressure that develops in the roots of plants as a result of active nutrient absorption from the soil is known as root pressure. Water (together with minerals) increases the pressure in the xylem when nutrients are actively absorbed by root hairs. The water is pushed up to modest heights by this pressure. Cutting the stem of a well-watered plant on a humid day can be used to test root pressure. The solution flows out the cut end of the stem when it is sliced.

Guttation, or the loss of water in the form of liquid droplets from the vein ends of certain herbaceous plants, is similarly linked to root pressure.

Root pressure can only convey water up to a certain height. It does, however, aid in the re-establishment of continuous water molecule chains in the xylem. The movement of water molecules from the roots to the shoots is maintained by transpirational pull.

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

Answer: The transpirational pull caused by transpiration or loss of water from the stomatal holes of leaves causes water to rise in tall plants. The cohesion-tension model of water transportation is what it's called. The guard cells and other epidermal cells become flaccid during the day as a result of the water lost through transpiration (by the leaves to the surroundings). Water is taken from the xylem by them. From the surfaces of the leaves to the tips of the roots, through the stem, a negative pressure or tension is created in the xylem vessels. As a result, the water in the xylem is drawn from the stem in a single column. The water molecules' cohesion and adhesion forces.

The xylem vessels' cell walls prevent the water column from separating. Several environmental and physiological factors influence plant transpiration. Wind, speed, light, humidity, and temperature are all extrinsic elements that influence transpiration. The number and distribution of stomata, the water status of plants, and the number of open stomata are all plant characteristics that influence transpiration. Although transpiration causes water loss, the transpirational pull aids in the increase of water in plant stems. This aids in mineral absorption and transfer from the soil to various plant sections. Plants benefit from the cooling action of transpiration. It aids in the maintenance of the plant's form.

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

Answer: Transpirational pull causes the ascent of water in the xylem. The following physical factors have an impact on water level rise:

- Cohesion - The attraction of water molecules to one another.
- Surface tension - The attraction between water molecules in the liquid phase is stronger than in the gaseous phase.
- Adhesion - Water molecules cling to polar surfaces.
- Capillarity — Water's ability to rise through tiny tubes.

Water's physical qualities allow it to travel in the xylem against gravity.

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

Answer: Nutrients are absorbed in plants via active and passive transportation. Only some minerals can get through the endodermal cells of suberin-containing roots. The transport proteins in these cells' membranes operate as checkpoints for the numerous solutes that reach the xylem.

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

Answer: By producing photosynthesis, a plant's leaves serve as a food source during its growth. From the source to the sink, food is conveyed (the part of the plant that requires or stores food). In the spring, when the food stored in the sink is mobilised toward the plant's developing buds via the phloem, the process is reversed.

As a result, food movement is bidirectional in the phloem (i.e., upward and downward). The xylem is the only way for water to go from the roots to the leaves. As a result, water and nutrient transport in the xylem is unidirectional.During a plant's growth, its leaves serve as a food supply by performing photosynthesis. Food is transported from the source to the sink (the part of the plant that requires or stores food). This process is reversed in the spring, when the food stored in the sink is mobilised toward the plant's budding buds via the phloem.

As a result, food flow in the phloem is bidirectional (i.e., upward and downward). Water is only transported from the roots to the leaves through the xylem. As a result, the xylem's water and nutrient transport is unidirectional.

Question 15: Explain the pressure-flow hypothesis of the pressure-low translocation of sugars in plants.

Answer: Food is prepared in the form of glucose in the plant leaves, according to the pressure-flow hypothesis. The prepared meal is transformed to sucrose before entering the source cells in the phloem. The hydrostatic pressure in the phloem is increased as water travels from the xylem vessels into the nearby phloem. As a result, sucrose passes past the phloem's sieve cells. The sucrose in the sink region is transformed into starch or cellulose, which lowers the hydrostatic pressure in the sink cells. As a result of the pressure difference between the source and sink cells, sugars can be translocated from one to the other.

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

Answer: Stomata, which are microscopic pores on the surface of leaves, aid in the exchange of gases. Each stoma is made up of guard cells that are either bean-shaped or dumbbell-shaped. The epidermal cells that surround the guard cells are transformed into subsidiary cells. A change in the turgidity of the guard cells causes them to open and close. The guard cells' inner walls are robust and elastic, but their outer walls are flimsy. The presence of many microfibrils in the guard cells aids in the opening and closing of the guard cells.

The turgidity of the guard cells rises when the stomata expand. The outside walls swell and the inner walls become crescent-shaped as a result. The radial orientation of the microfibrils facilitates stomatal opening.

The guard cells lose their turgidity as the stomata close, the outer and inner walls preserve their original forms, and the microfibrils are oriented longitudinally.