CHAPTER – 4

ABSORPTION BY ROOTS

P. 42 Check Your Progress 1

A. Answer these questions.

1. Three major functions of roots:

- Absorption of water and inorganic nutrients
- Anchoring of the plant body to the ground
- Storage of food and nutrients

2. Nitrogen, Phosphorus and Potassium are three minerals in plants.

- Nitrogen (N) is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis. It helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops as it forms part of nucleic acids and proteins.
- Phosphorus (P) is an essential part of the process of photosynthesis. It is involved in the cell division.
- Potassium (K) is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium. It helps in the building of protein, photosynthesis and activating the enzymes.

3. Main characteristics of root hair that help them in absorption of water:

- Roots contain root hair that provide enormous surface area for absorption of water.
- The epidermis of root hair is permeable to water. Most of the absorption of water and minerals occurs near root tips.
- Root hair contain cell sap, which is at a higher concentration of minerals than the surrounding water.

4. Root hair have large vacuoles to absorb water quickly and transport it to the next cells. The vacuoles have salts, which speed up water absorption from soil water.

5. a. Water is one of the most essential parts of photosynthesis. Water provides electrons to replace those removed from chlorophyll in photosystem II. Also, water produces oxygen as well as reduces NADP to NADPH. Roots absorb water from soil and supply this to the leaves for photosynthesis.

b. The presence of water in a plant body gives it a shape and mechanical support. Loss of water from the plant body makes it wilt. and the plant will not have the mechanical support to stand straight.

P. 46 Check Your Progress 2

A. Differentiate between diffusion and osmosis with respect to the following features.

	Feature	Diffusion	Osmosis
1.	Medium	Solid, liquid, gas	Liquid
2.	Type of membrane	Not required	Semi-permeable membrane
3.	Speed	Rapid process in gases and slow process in liquids	Slow process

B. State whether the following statements are True (T) or False (F).

1. F **2.** T **3.** F **4.** T

5. F

C. 1. An isotonic solution contains the same concentration of solute as in a cell. If plant cells are kept in isotonic solution then cells will not swell or shrink. Hence, there will not be any change in cells.

2. If the plant cell is placed in a hypotonic solution, it takes up water by endosmosis and begins to swell. The rigid cell wall in plants prevents the cell from bursting. The plant cell is said to have become turgid.

3. If plant cells are placed in the hypertonic medium, it will lose water due to the process of exosmosis. Such a cell is called as plasmolysed cell.

P. 50 Check Your Progress 3

A. Name the following.

1. Imbibition **2.** Active Transport

3. Turgid **4.** Flaccidity

5. Plasmolysis **6.** Deplasmolysis

7. Root pressure

P. 53 Check Your Progress 4

A. Answer the following.

1. Xylem

2. The twig wilts because water was not transported

from the roots to the leaves due to absence of xylem. The experiment proves that water rises through the xylem vessels.

3. In the centre of the stem, the xylem vessels appear red due to conduction of eosine stain dye. This shows that coloured water of the beaker is conducted through xylem tissue.

P. 54 Exercises

I. Multiple-Choice Questions

A. Choose the most appropriate answer.

1. b	2. d	3. d	4. b
5. c	6. a	7. b	8. b
9. a	10. b		

II. Assertion–Reason Type Questions

A. 1. c 2. c 3. c 4. b

III. Very Short Answer Type Questions

A. Name the following.

1. Endosmosis	2. Plasmolysed
3. Turgid	4. Turgor pressure
5. Osmosis	6. Endosmosis
7. Xylem	8. Flaccidity
9. Diffusion	10. Imbibition

B. Complete the following paragraph by filling in the blanks (1) to (6) with appropriate words.

1. Osmosis	2. diffusion
3. stomata	4. transpiration
5. plasmolysis	6. deplasmolysis

C. Mention if the following statements are True (T) or False (F). Rewrite the false statements correctly.

1. True
2. False

   Cells that have lost their water contents are said to be plasmolysed.
3. False

   Diffusion and osmosis are the same process in which the molecules move from its higher concentration to lower concentration.
4. False

   A plant cell kept in a hypertonic solution gets plasmolysed.
5. True

D. Write the following in a logical sequence.

1. Soil water, root hair, cortical cells, endodermis, xylem
2. Soil water, root hair, cortex, endodermis, xylem

IV. Short Answer Type Questions

A. Differentiate between the following.

1. The diffusion of water molecules through a semi-permeable membrane from a region of its higher concentration (more dilute solution) to its lower concentration (less dilute solution) is called osmosis.

   The movement of molecules of a substance from a region of their higher concentration to a region of their lower concentration is called diffusion.
2. The shrinkage of the cytoplasm (cell content) of a cell from a cell wall when placed in a hypertonic solution is called plasmolysis. If we place a living turgid cell in a hypertonic solution, outer movement of water (exosmosis) occurs from the central region of the cell. As a result the size of the protoplasm becomes reduced and the plasma membrane is withdrawn from the cell wall. This is called plasmolysis and the cell is a plasmolysed cell.

   If a plasmolysed cell is placed in water, its shrunk cytoplasm swells up against the cell wall. This happens due to endosmosis. The swelling up of a plasmolysed cell under influence of hypotonic solution or water is called deplasmolysis.
3. A condition in which a cell reaches a state when it cannot accommodate any more water is called turgidity. The pressure of the cell contents against the cell wall is called turgor pressure.

   Flaccidity is the reverse of turgidity. If a fully-distended or turgid cell is placed in a hypertonic solution, the water moves out of the cell due to exosmosis, cytoplasm will shrink and the plasma membrane will withdraw from the cell wall. The cell is called flaccid and the condition is called flaccidity.
4. Imbibition is the process by which plant cells (living or dead) absorb water by surface attraction. Imbibition results in swelling of tissues for germination of seeds. Swelling of wooden doors during the rainy season is due to imbibition.

   The passage of salt or ions of a substance from its lower concentration to higher concentration utilizing the energy from the cell through a living membrane is known as active transport.

5. A hypertonic solution has higher solute concentration than the cell cytoplasm. Thus water molecules from inside the cell move to the outside.

   A hypotonic solution is less concentrated than the cell cytoplasm. Thus water molecules move from the solution into the cell cytoplasm.

6. The primary difference between the targor pressure and wall pressure is that wall pressure is applied by the cell wall on the cell's contents. Turgor pressure is the pressure which is exerted by the cytoplasm on the cell wall.

B. Give reasons for the following.

1. When a layer of a high-salt or high-sugar substance is used to preserve food, the food is protected from microbial invasions due to plasmolysis. This is a more sophisticated way to preserve food than the oldest method – simply letting it dry out.
2. Absorption of mineral elements by the root from the soil takes place by active transport. The water film along with the soil particles also contains a low concentration of mineral elements. These mineral elements move from soil into the root cells against the concentration gradient. Energy in the form of ATP is required by the cell for the absorption of minerals.
3. A very strong sugar solution is a hypertonic solution. If we place soft-skinned grapes in the sugar solution, the water content will come out through the soft skin and the grapes will shrink.
4. The potato strips appear soft and shrivelled as there is no water in them. This is because the concentration of water is lower in the sugar solution than inside the potato. As a result water moves out of the potato to the sugar solution due to exosmosis and the potato strips become flaccid.
5. The solution containing fertilizers is hypertonic to the root hair. This causes exosmosis from root hair cell, thus resulting in flaccid root hair.
6. Leaves of wilted lettuce leaves are plasmolysed and when put in cold water get deplasmolysed and become turgid and hence become crisp.

V. Long Answer Type Questions

A. Answer these questions.

1. The absorption of water occurs through root hairs. Root hairs are thin-walled extensions of the outer layer of the root. The roots are surrounded by a thin film of water and soil particles.

   The adaptation of roots to absorb water are as follows:

   The root hair contains cell sap which has a higher concentration of salts than the outside soil water. This causes osmosis and the water from outside diffuses into the cells of root hair. This causes root pressure to develop.

   The root hairs have a large surface area over which absorption of minerals and water can occur faster.

   Roots and root hair are long in shape for faster and easier transport.

2. The root hair of plants are permeable to water. The cell sap inside the vacuole contains salts and sugars and is highly concentrated. If this cell is surrounded by water, osmosis of water will cause water to enter the cell sap. As a result, the vacuole would expand, pushing the cell cytoplasm against the cell wall. Such a cell cannot accommodate any more water and is called turgid and the condition is called turgidity.

   In the plant *Mimosa pudica*, turgor pressure keeps the leaves fully-expanded and oriented towards light.

   In case of loss of turgidity, the leaves of *Mimosa pudica* wilt and the shoots droop down. The condition of the shoots and leaves are said to be flaccid.

3. During photosynthesis, glucose is synthesised from CO_2 and H_2O. This causes an increase in the osmotic pressure of the contents of guard cells. As a result, the guard cells absorb more water from the neighbouring cells, thus becoming turgid. The high turgor pressure causes the guard cells to swell and bulge out and the stomata open. At night since no photosynthesis takes place, there is a shortage of water in the leaf, and the guard cells become flaccid and shrink and their inner walls become straight and the stomata are closed.
4. Concentration of mineral elements is higher inside the root hair. Absorption of mineral elements by the root from the soil takes place by active transport. The water film along with the soil particles also contains a low concentration of mineral elements. These mineral elements move from soil into the root cells against the concentration gradient. Energy in the form of ATP is required by the cell for the absorption of minerals.
5. The seed coat is selectively permeable to water. The majority of a seed is made up of

two cotyledons which require water in order to trigger certain hormones within the seed and get it to start growing. The water on the outside of the seed will diffuse into the seed by way of osmosis because inside is an area with a very low concentration of water. The cotyledons are basically like sponges which inflate as water enters them and the seed begins to grow and ultimately the seedcoat bursts.

6. Water is pulled from the soil up to the leaves by the adhesive-cohesive force. There is a loss of water during transpiration. This leads to the generation of tension (negative pressure) in the leaf due to the unique physical property of water. The thin film of water vapour present in the mesophyll cells replaces the water vapour which is lost from the leaf stomata by transpiration. During this process water is pulled on by the adhesive and cohesive forces between the molecules of two different substances. This tension is the pulling force or suction force which draws water from the leaf xylem through the mesophyll cells toward stomata. The water lost via transpiration is replaced by the water that is pulled out of the leaf xylem.

The transpiration pull on water extends from the leaves up to the root tip and even into the soil solution. This cohesion of water is due to hydrogen bonding between water molecules. Each water molecule is attached (adhered) to adjacent water molecule and this pull is relayed from molecule to molecule down the entire column of water in the xylem.

7. The relative concentration of a solution which determines the direction and extent of diffusion is called tonicity.

An isotonic solution has the same concentration as the cell cytoplasm. Thus, no net movement of water molecules across the cell membrane occurs.

A hypertonic solution has higher solute concentration than the cell cytoplasm. Thus, water molecules move from inside the cell to the outside.

A hypotonic solution is less concentrated than the cell cytoplasm. Thus, water molecules move from the solution into the cell cytoplasm.

8. A plant cell placed in a hypertonic solution shrinks due to exosmosis, i.e., water comes out of the plant cell as the surrounding hypertonic solution is more concentrated. As a result, the size of the cytoplasm reduces and the plasma membrane is withdrawn from the cell wall.

9. The inward diffusion of water through a semi-permeable membrane when the surrounding solution is less concentrated is called endosmosis (endo=inward). Endosmosis leads to swelling up of cells.

The outward diffusion of water through a semi-permeable membrane when the surrounding solution is more concentrated is called exosmosis (exo=outward). Exosmosis leads to shrinking of cells.

10. Xylem vessels are largely pulled upwards by transpiration pull (cohesion-tension mechanism).

Refer to the answer 6.

11. The absorption of water occurs through root hair. Root hair are thin-walled extensions from the cells of the outer layer of a root. The root hair contains cell sap which has a higher concentration of salts than the outside soil water. This causes osmosis and the water from outside diffuses into the cells of root hair. This is due to root pressure. As water enters the vacuole of cell, it dilutes the concentration of sugar and salts in its cell sap. Another cell (assume cell B) next to cell A has a higher concentration of cell sap (salts and sugars). As a result water from cell A moves to cell B. The water entering cell B makes its cell sap dilute and then moves to cell C. This way water moves from one cell to another by cell to cell osmosis. The water ultimately passes into the xylem vessels at the centre of root and is conducted up the root and stem into the leaves.

12. The various causative forces are root pressure, capillary nature of xylem vessels and pulling of xylem sap (cohesion-tension mechanism).

VI. Structured/ Application/ Skill Type Questions

A. 1. Root Pressure

2. Root pressure is the pressure developed in roots due to continuous inflow of water by cell-to-cell osmosis.

3. We observe that water starts coming out of the cut end of the plant and exerts pressure and raises the level of mercury in the connected manometer. This upward movement of water is due to heavy root pressure.

4. The upward movement of water is due to heavy root pressure. This helps in the ascent of sap upward through the stem.

B. **1.** Turgor pressure in plant cell.

2. The pressure of the cell contents against the cell wall is called turgor pressure.

3. **i.** Salts and sugars in the cell sap make it concentrated inside.

ii. Water enters the cell by osmosis.

iii. The cell sap volume increases, pushing the cell wall outward making it turgid.

4. As water enters the cell sap by osmosis, the vacuole will expand in size, pushing the cell cytoplasm against the cell wall.

C. **1.** **i.** Root hair **ii.** Soil particles

iii. Cortical cells **iv.** Xylem vessel

2. Unicellular

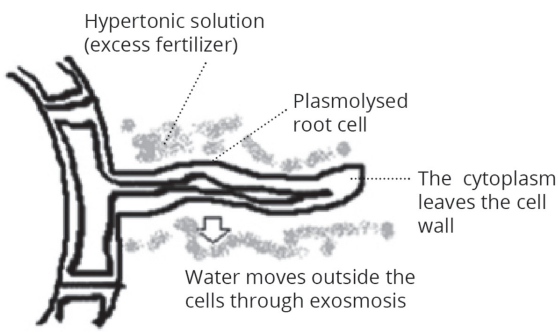
3. Cell-to-cell osmosis

4. Root pressure

5. The root hair contains cell sap which has a higher concentration of salts than the outside soil water. This causes osmosis and the water from outside diffuses into the cells of root hairs. Therefore, a root pressure is built-up.

6. Guttation

7.



D. **1.** Plasmolysed state of the cell is shown.

2. Cell membrane

3. The cell would have become turgid and there would be no sugar solution between cell membrane and protoplasm.

E. **1.** Osmosis

2. The diffusion of water molecules through a semi-permeable membrane from a region of its higher concentration (more dilute solution) to its lower concentration (less dilute solution) is called osmosis.

3. The level of sugar solution rises in the thistle funnel and the level of water drops in the beaker.

4. In the control experiment, instead of sugar solution, water should be taken in the thistle funnel.

5. **a.** Cell sap of root hair **b.** Semi-permeable cell membrane **c.** Water in the surrounding soil.

6. Cellophane paper

7. The two advantages of this process are :

- Entry of water from soil into roots.
- Cell-to-cell movement of water.

F. **1.** Conduction of ascent of sap by xylem

2. The upward movement of water from roots to aerial parts against gravitational force.

3. Water rises through xylem vessels, but in **ii** water has not risen because xylem vessels have been removed.

4. From this experiment, we conclude that xylem is the path of ascent of sap.

G. **1.** **a.** Flaccid

b. Plasmolysed

2. **a.** Water

b. Strong sugar solution

3. **a.** Cell A

4. Osmotic pressure is responsible for the movement of water from the root hairs to the cortical cells and then finally to the xylem vessels. It is the force required to resist the movement of water through a semi-permeable membrane down the concentration gradient.

5. The pressure with which water is pushed into the xylem tubes of the root is called root pressure. The water moving upwards forms a column, which is maintained up to a certain height due to root pressure.

H. **1.** Solutions in beaker 1: Hypotonic solution

Beaker 2: Hypertonic solution

Beaker 3: Isotonic solution

2. An isotonic solution contains the same concentration of solute as in a cell. If plant cells are kept in isotonic solution then cells will not swell or shrink. Hence, there will not be any change in cells. Therefore, no change occurred in potato cube in beaker 3.

3. Cell sap of root hair is hypertonic to the surrounding soil water, so, water from soil enter within the root hair by osmosis.

4. Refer to solution E. 2, Structured/Application/ Skill Type Questions

5. Cell wall in permeable and cell membrane is semipermeable or selectively permeable in nature.