Absorption by roots - The process involved

Plant physiology is the branch of botany which deals with the study of metabolic activities or life processes of plants.

Absorption by roots.

i) Water - for photosynthesis, transpiration, transportation and mechanical stiffness.

ii) Mineral Nutrients: constituents of cell and cell organelles, synthesis of enzyme etc.

Characteristics of roots for absorbing water.

Surface Area	Large surface area provided by rootlets and root hairs. Eg. Balsam plant.
Cell sap	Cell sap of root hair is of high concentration as compared to surrounding water for the occurrence of osmosis.
Thin walls of root hairs	The cell wall is thin and permeable while the cell membrane is very thin and semi-permeable. This is the main characteristic of root for water absorption.

The processes in absorption and conduction of water and minerals.

(A) **Imbibition**: It is a phenomenon in which living or dead cells of plants in their dry or semi-dry state absorb water by surface tension. It results in an increase in volume, liberation of heat and development of pressure.

- It is the passive absorption of water by substances such as cellulose and starch.

(B) **Diffusion**: The movement of molecules of a substance (gas, liquid or solid) from the region of higher concentration

to the region of lower concentration when are in direct contact (as shown in diagram).

Diffusion pressure (DP) is directly proportional to the number of diffusing particles.

It is important for gaseous exchange of plants with atmosphere through stomata and lenticels.

(c) Osmosis and osmotic pressure.

Osmosis is the movement of water from the region of higher chemical potential (dilute solution) to the region of its lower chemical (concentrated solution) when diffusion of solute is prevented by a semipermeable membrane.

Endosmosis: is the osmotic entry of water into a cell or system, when placed in pure water or hypotonic solution It makes the cell swell up.

Exosmosis: is the osmotic withdrawal of water from a cell or system, when placed in hypertonic solution. It makes the cell shrink.

Osmotic Pressure: is the minimum pressure that must be exerted to prevent the passage of pure solvent in to the solution when the two are separated by a semi-perme-

-able membrane.

Experiment to show osmosis by thistle funnel containing sugar.

Conclusion: Some water has passed through cellophane paper to enter the funnel A and sugar from thistle funnel A has not passed to the beaker.

b. The cellophane paper acts as semi-permeable membrane that allows only water to pass, not sugar because of concentration difference.

Experiment to show osmotic pressure by thistle funnel and air tight piston.

Conclusion: Osmotic pressure applied by piston did not ~~show~~ allow water to pass through i.e no osmosis take place.

Tonicity - It is the relative concentration of the solutions that determines the direction and extent of diffusion.

Isotonic Solution	Hypotonic Solution	Hypertonic Solution
If the external solution has a similar solute or solvent concentration as the cell. Cell shape and size remains unchanged.	If the external solution has low solute (or high solvent) concentration than the cell. Cell slightly enlarges or even bursts.	If the external solution has a high solute (or low solvent) concentration than the cell. Cell shrinks in size and loses shape.

Active transport

- The passage of a substance (salts or ions) from its lower to higher concentration using energy (ATP) from the cell, through a living cell membrane (opposite of diffusion).
- Passive transport doesn't require energy. Eg transpiration and diffusion.

E) Turgidity and flaccidity.

- Turgidity is a condition of being fully distended due to endosmosis. Healthy plants cells are turgid.
- The pressure of cell contents on the cell wall is known as turgor pressure and the pressure of cell wall on the cell contents is known as wall pressure.
- Flaccidity is a condition of absence of turgidity in which cell loses water from its cytoplasm due to exosmosis. Such cell is known as a flaccid cell eg wilting property of leaves when the plant is exposed to the sun.
- Plasmolysis is the shrinkage of protoplast from the cell wall due to exosmosis caused by hypertonic solution. Permanent plasmolysis cause death.
- Deplasmolysis is when a plasmolysed cell is kept in water or hypotonic solution. Water enters the cell

due to endosmosis and the cell becomes turgid again.

Uses of turgidity.

1. It provides rigidity to soft tissues like leaves.
2. Turgor pressure helps to push through the hard grounds eg. mushrooms and seedlings.
3. Turgor in the opening and closing of stomata.
4. Turgor movements in Mimosa pudica plants.

Root pressure

The pressure developed in the roots due to the inflow of water, brought about due to the alternate turgidity and flaccidity of the cells of the cortex and the root hair cell, which helps in pushing the plants sap upwards It is the maximum during spring in tropical regions and minimum in summer.

Experiments:

1. Cut off part of shoot shows water droplets.
2. Water droplets along the margins of leaves due to excess root pressure (guttation). Eg tomato, grass, banana, ferns. etc

Experiment to show absorption and conduction of water in plants.

(A) To show the root absorbs water.

Conclusion: The level of water in test tube A falls but not in test tube B, proving that water lost in test tube A was absorbed by roots.

B) To show that water is conducted upwards through the xylem

Conclusion: Water and salt travel upwards mainly in the xylem (stained part) and food substance travel up and down in the phloem.

(C) To show conduction of water through xylem.

Conclusion: In balsam plant, ringing experiment or girdling, the leaves in the 1st twig remain turgid and stand almost normally but in the second twig get wilted and droop down.

(D) To show that food from the leaves is conducted downwards through the phloem in the stem.

Conclusion: In girdling, the stem above the ring has grown in diameter and the stem below the girdle has stopped growing and may even die. It proves that leaves continue to get a supply of water through the deeper located xylem.

Forces contributing to Ascent of sap.

- Upward transport of water to aerial parts along with the dissolved mineral salts from roots to the aerial parts against the downward pull of gravity is called ascent of sap.
- Ascent of sap take place through xylem
- Mechanism: Vital force theory, Root-pressure theory, Capillary force theory and Cohesive force theory.

(A) Root pressure: build up sufficient force to push the sap. In the xylem vessels up to a certain height and may be enough for herbaceous plants.

B) Capillarity (narrow diameter) of xylem vessels causes the water from a lower level to rise to fill up the vaccum created by the loss of water due to transpiration from the leaves by capillary force.

C) Transpiration pull - More water molecule are pulled up due to the tendency of water molecules to remain joined (cohesion) and produce a continous column of water through the stem.

D) Adhesion - causes the water to stick to the surface of cells thus drawing more water molecules from below when the leaf cells lose water during transpiration. Eg Pines (tall trees).

- Downward movement of sap mainly because of the force of gravity.