

Unit-1

Plant Physiology

Lecture 1B

PLANT WATER RELATION

Water absorption in plants

Slides for UG students prepared by **Dr. D. Barman, Asst. professor, Goalpara College, Goalpara**

Declaration

The source of Data/Text used in the preparation of power point presentation were Google, E-Books, Books and Journals. It is used for teaching purpose only.

ABSORPTION OF WATER

- ✓ Uptake of water by plant is called **absorption** of water.
- Plant **absorb** water from the soil through the **root hairs**.
- Water is said to be the liquid gold of life.
- Plant are capable of absorbing water from soil solution.
- Mainly absorb capillary water.
- Plant also absorb dissolved nutrients along with water.



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Site of Water Absorption

- ✓ Water is mainly absorption of root hairs.
- ✓ Located in a group just above the root cap.
- ✓ This area rich in root hairs is called **root hair zone**.

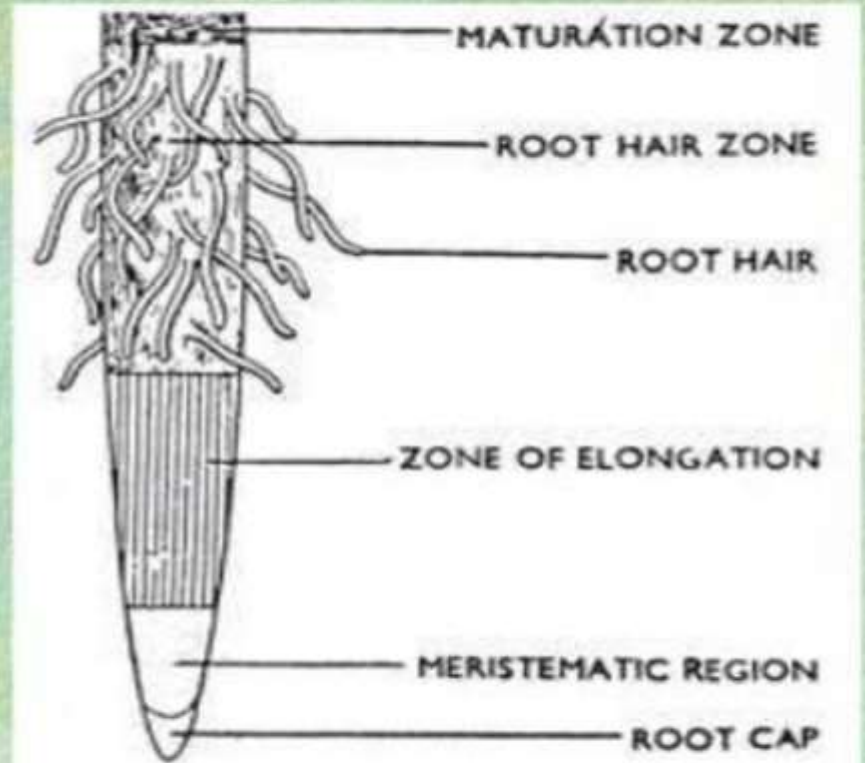
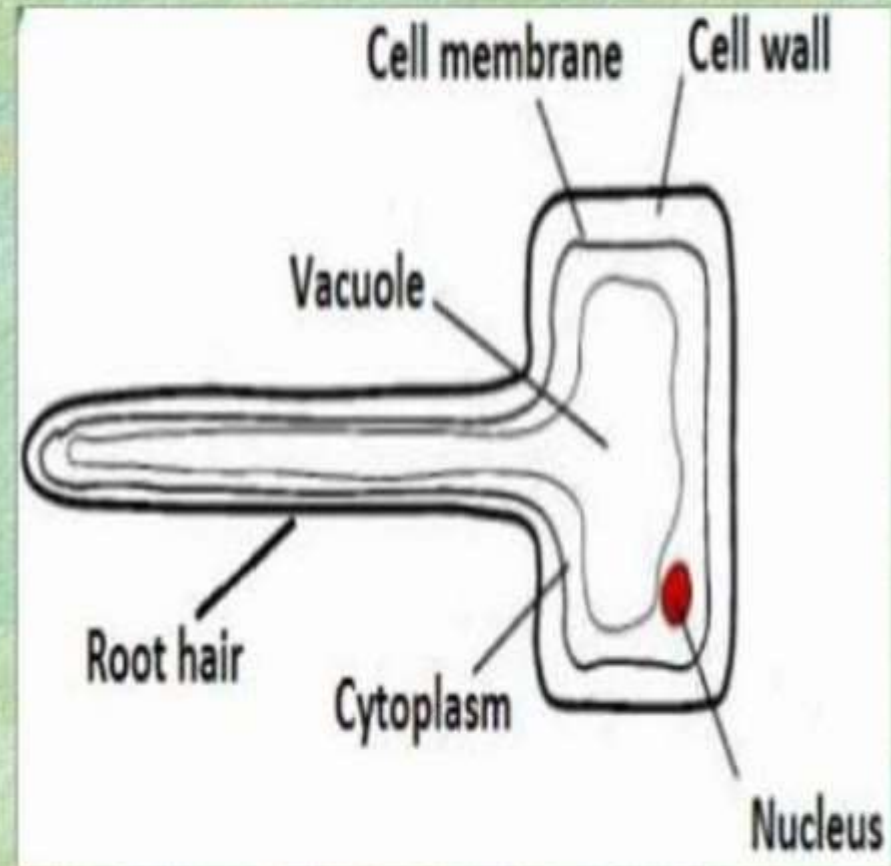


Fig. 4.1. Diagrammatic representation of a root tip showing root hair zone.

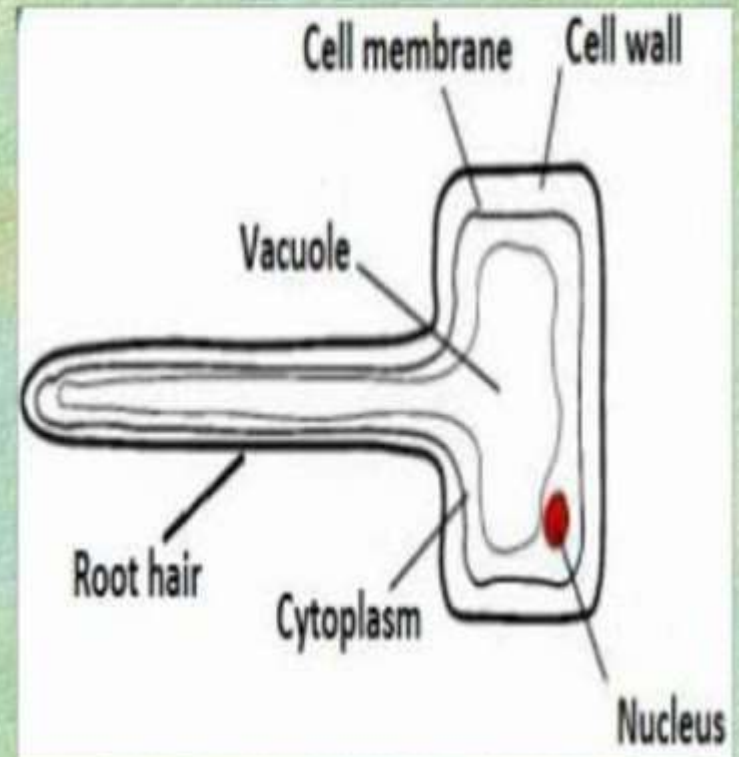
Typical Root Hair

- Billions of root hairs in the root system of a plant.
- Root hairs are tubular hair like projections of the epidermal cells.
- Each root hair is single cell.
- Root hairs are 0.5 to 1.0 cm in length and 10 μ m in diameter.



Water Absorption in plants

- Root hair is modified epidermal cell
- The wall of the root is permeable to water it is made up of cellulose and pectic substances which are strongly hydrophilic (water loving in nature)
- Next cell wall there is plasma membrane enclosing cytoplasm, nucleus and vacuole.
- Vacuole is filled with cell sap whose water potential is more negative than the soil solution.

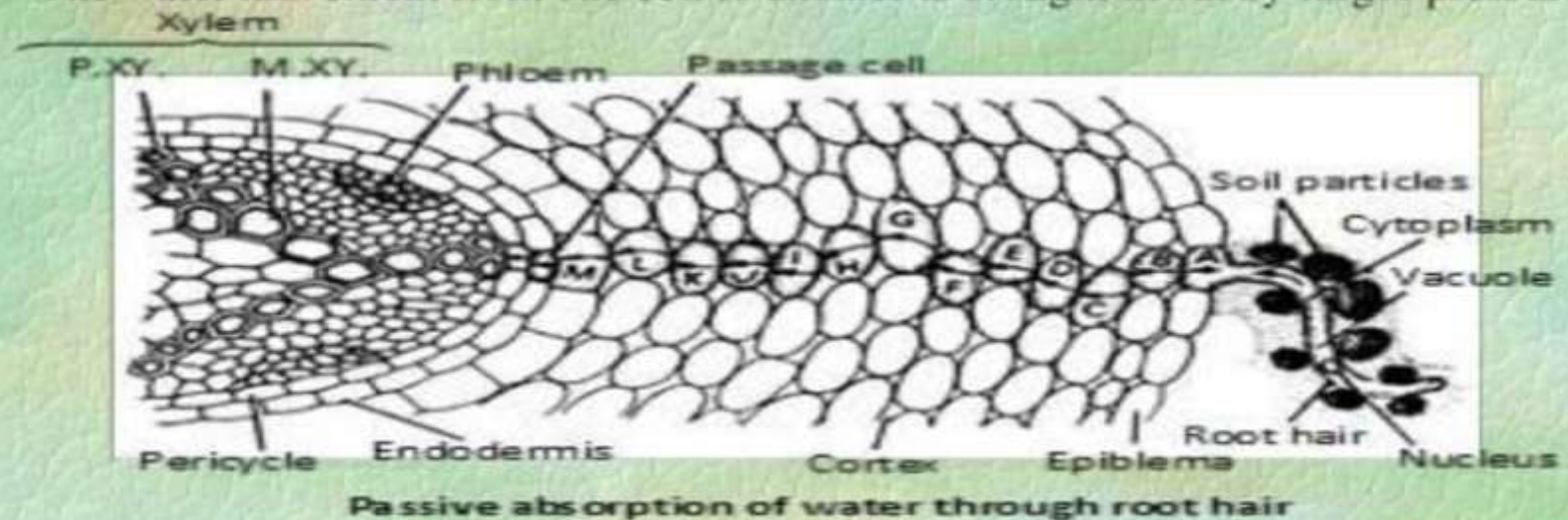


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Water Absorption in plants

PATH OF ABSORBED WATER

- ✓ It move into the cortical cells.
- ✓ After crossing the cortical cells the reaches the epidermis.
- ✓ The endodermal cells lying opposite to root hairs are especially modified to transport the absorbed water. These endodermal cells are called passage cells. The passage cells are permeable to water because they lack of casparian thickening in their wall.
- ✓ Other indodermal cells are provided with casparian thickening are impermeable to water.
- ✓ The water passege cells pass into the pericycle cells. from the pericycle cells ,the water passage into xylem. through the xylem tube ,the water move up through stem to reach the leaves.
- ✓ The water movement from one cell to another is brought about by turgor pressure.



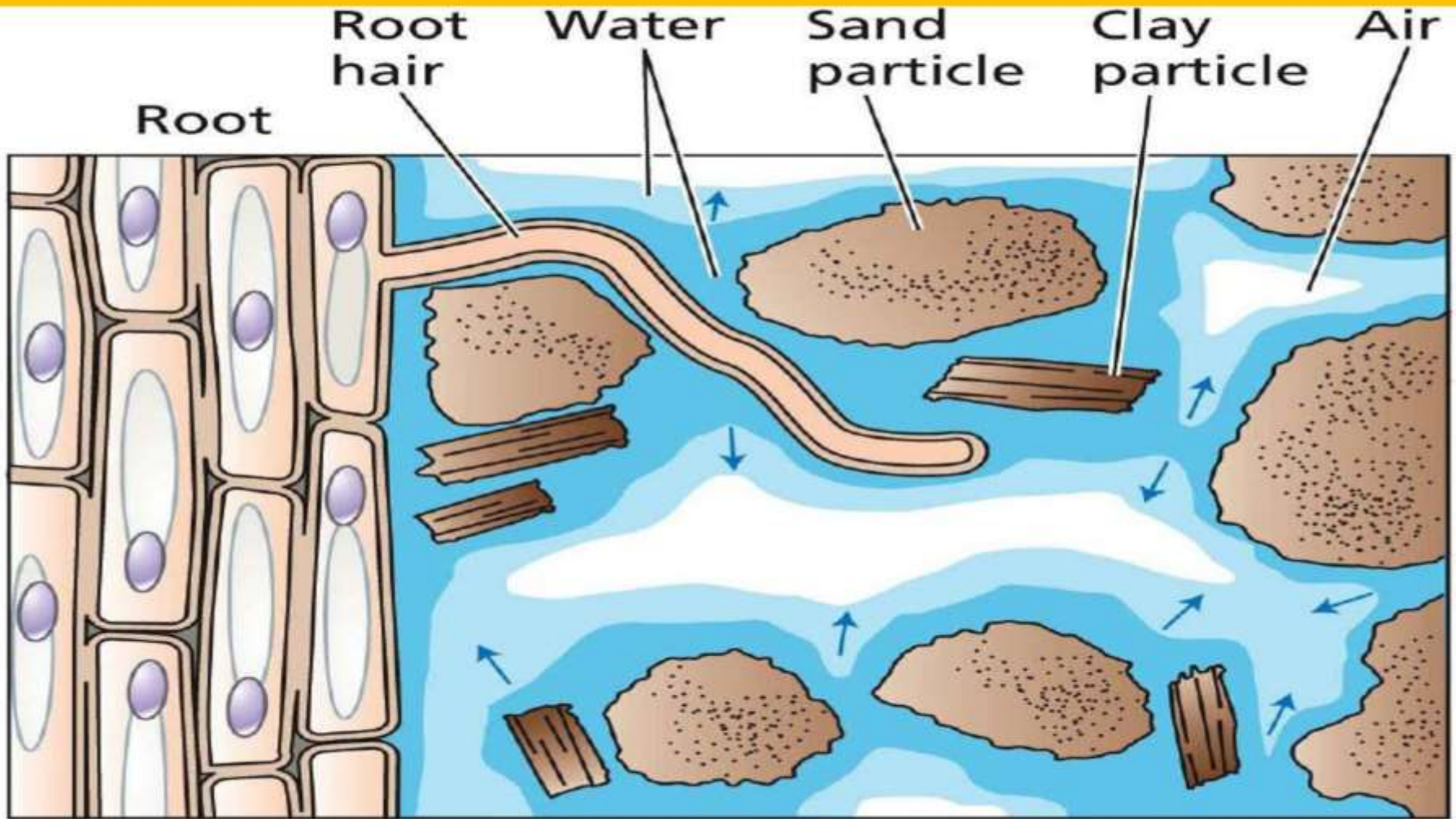
Water Absorption in plants

Absorption of Water

Proposed by **Atkins (1916)**, **PRIESTLY** and **Arnold(1952)** **ANDERSON** and **house(1967)**, **Levitte (1969)**

- The soil water molecules are absorbed into the cell wall of root hair cells by imbibitions.
- The protoplast of root hair cell is **hypertonic** and the soil is **hypotonic** and the soil water is **hypotonic**.
- OP of the cell sap of root hair cell is higher than the OP of the soil water.
- OP of cell sap is usually between 3 to 8 atmosphere while that of reach watered soil is less than 1 atm.
- As the root hair cell contains less water it has less turgor pressure.
- High OP and less TP of root hair cell result in increased diffusion pressure deficit.
- This leads to the increase in the suction pressure of root hairs.
- The cell of endodermis facing xylem are thin walled and lack casparian thickening. they are called passage cells.

Water Absorption in plants

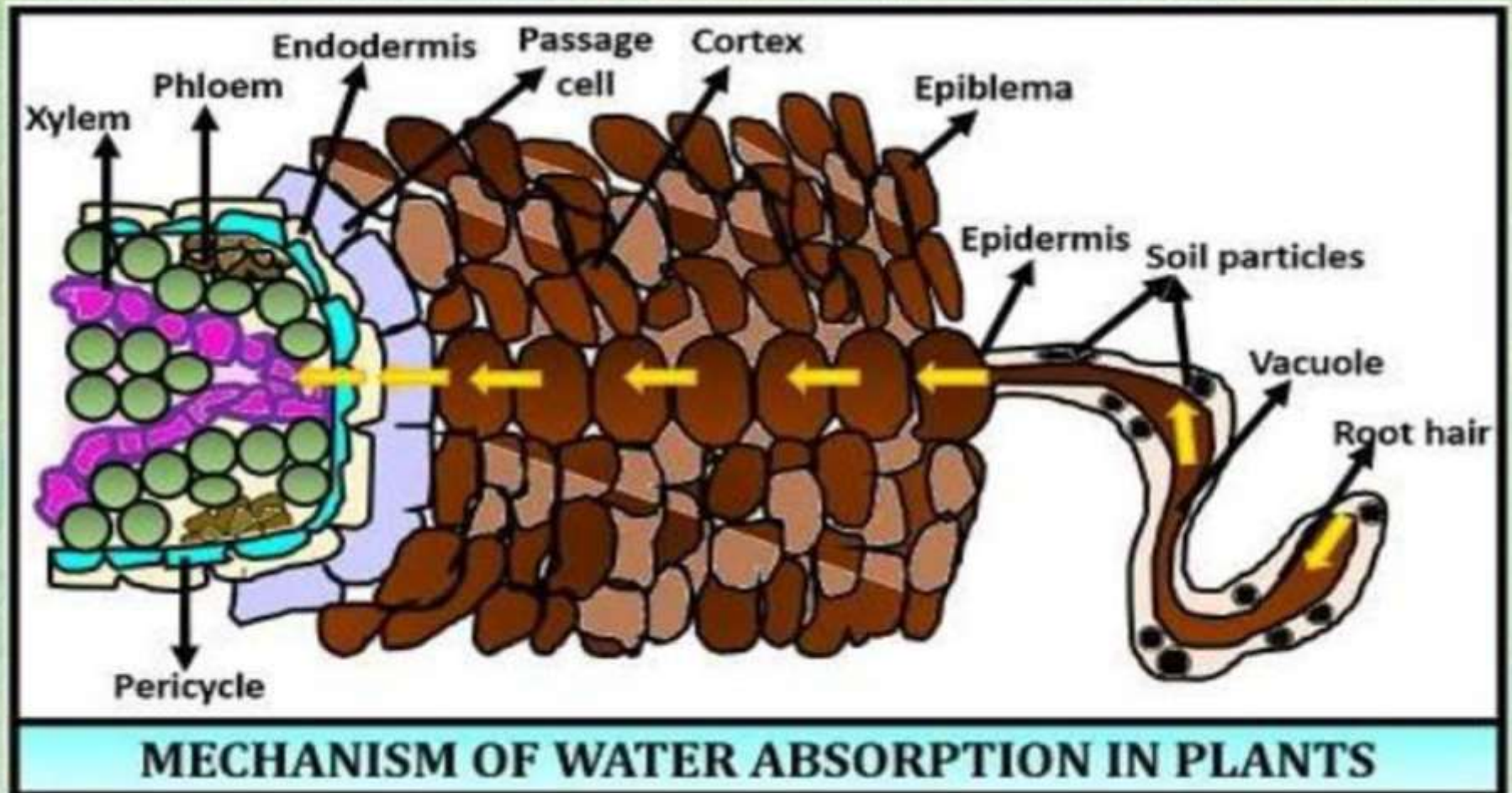


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Water Absorption in plants

Mechanism of water absorption

Kramer (1949) proposed that water is absorbed by to mechanism.



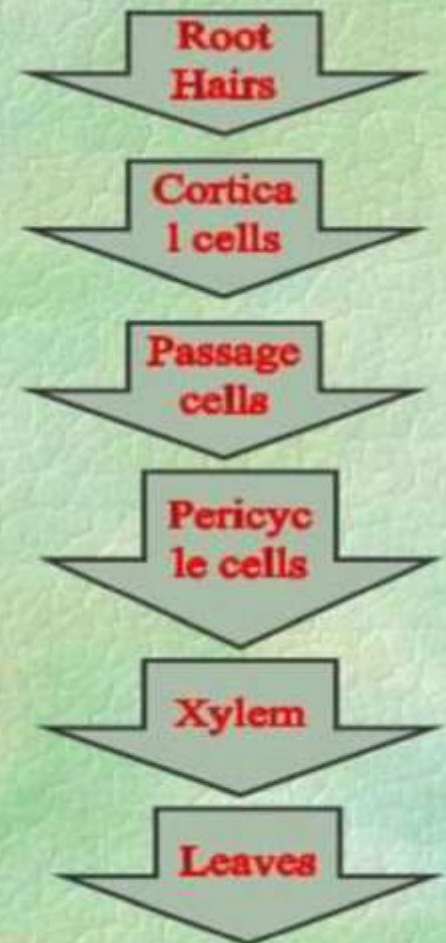
Water Absorption in plants

1. Active absorption

- Active osmotic absorption.
- Active non osmotic absorption.

Proposed by Atkins (1916) & Priestly (1922)

- Active absorption** – the absorption of water by the plant with the use of energy is known as **active absorption**. in this process, the root cell play active role in the **absorption** of water.
- Intake of water by the plants with the use of energy is called **active absorption**.
- The water is absorbed by the activity of root hair cells.
- The water is absorbed by the operation of osmotic forces by the use of energy.
- In osmotic active absorption, the water move from hypotonic solution to hypertonic solution.



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Water Absorption in plants

I. Active Osmotic Absorption

- The intake of water by the root hairs by the operation of osmotic forces is called **osmotic active absorption**.
- Water is absorbed by the activity of root cells.
- Osmotic pressure, root pressure, turgor pressure and DPD play the main role.
- The water move from hypotonic solution to hypertonic solution.
- The root hair cells suck the soil water and the xylem vessel pumps the water upwards.

Water Absorption in plants

Active non osmotic absorption of water

This concept was proposed by Kramer(1959). Poisons retard this absorption.

- This intake of water without the involvement of osmotic forces and with the use of energy is called **non osmotic active absorption**.
- The water moves against concentration gradient.
- Respiratory energy is used.
- It is correlated with respiration.
- The water molecules move through symplast pathway transmembrane pathway.
- Plant hormone like auxins stimulate non osmotic active absorption.

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Water Absorption in plants

Passive absorption

- The intake of water by plants due to transpiration pull is called passive absorption.
- The water is absorbed due to transpiration activity in the top of the plants.
- The root hair cell has no role in absorption. It function as an absorptive surface.
- Water is absorbed through roots.
- Transpiration increase the concentration of cell sap and DPD in the leaves.
- As result water from the xylem vessels move into the mesophyll cells of leaves.
- The water in the xylem vessels is in the form of a column.
- Hence there is pulling up of water column.
- This result in a tension in the root hair cells.
- The water moves through **apoplastic pathway**, **symplast pathway** and transmembrane pathway.
- It is now largely greatest amount of water is pulled up by passive absorption.

Water Absorption in plants

Difference between active and passive absorption

s.no.	Active absorption	Passive absorption
1	Energy is required.	Energy is not required.
2	The forces are created by osmotic concentration.	Created by transpiration pull
3	Absorption is due to activity of root hair cell.	Absorption is due to the activity of the leaves.
4	root hair cells have high DPD, compared to soil solution.	The mesophyll cell have high DPD compared to xylem vessels.
5	Rate of absorption depend on DPD.	Rate of absorption depend on transpiration.
6	Absorbed through symplast pathway and transmembrane pathway.	Water passes through apoplast pathway, symplast pathway and transmembrane pathway.
7	It is correlated with respiration for energy.	It is correlated with transpiration.
8	The rate of absorbtion is slow.	The rate of absorbtion is high.

WATER ABSORPTION IN PLANTS

Water Transport in the Root

- ❑ Water is taken in to the root hair.
- ❑ move into and within the plant root in a variety of routes.
 - Apoplast
 - Symplast

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WATER ABSORPTION IN PLANTS

A. Apoplastic path way

- movement of water through intercellular spaces and cell wall.
- continuum formed between the continuous matrix of cell walls.
- Water and solute move without entering a cell.
- involves the non-living vascular tissue.

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WATER ABSORPTION IN PLANTS

- **blocked by the casparian strip at Endodermis.**
- **Impermeable band of suberin inside walls of endodermal cells.**
- **regulates the quantity and type of minerals and ions reach the xylem.**

WATER ABSORPTION IN PLANTS

B. Syplastic path way

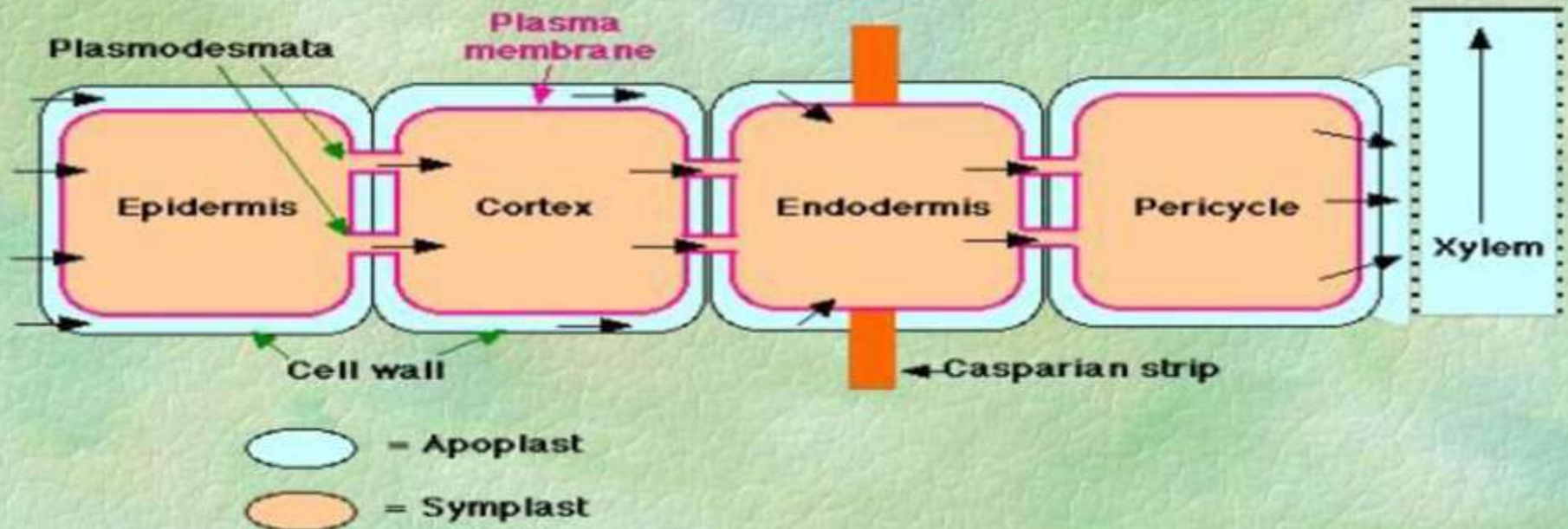
- the continuum of cytoplasm within a plant tissue
- formed by the plasmodesmata which pass through pores in the cell walls.
- responsible in order water and minerals to reach the xylem.
- This path way involves the living part of the cell
- water moves by osmosis.

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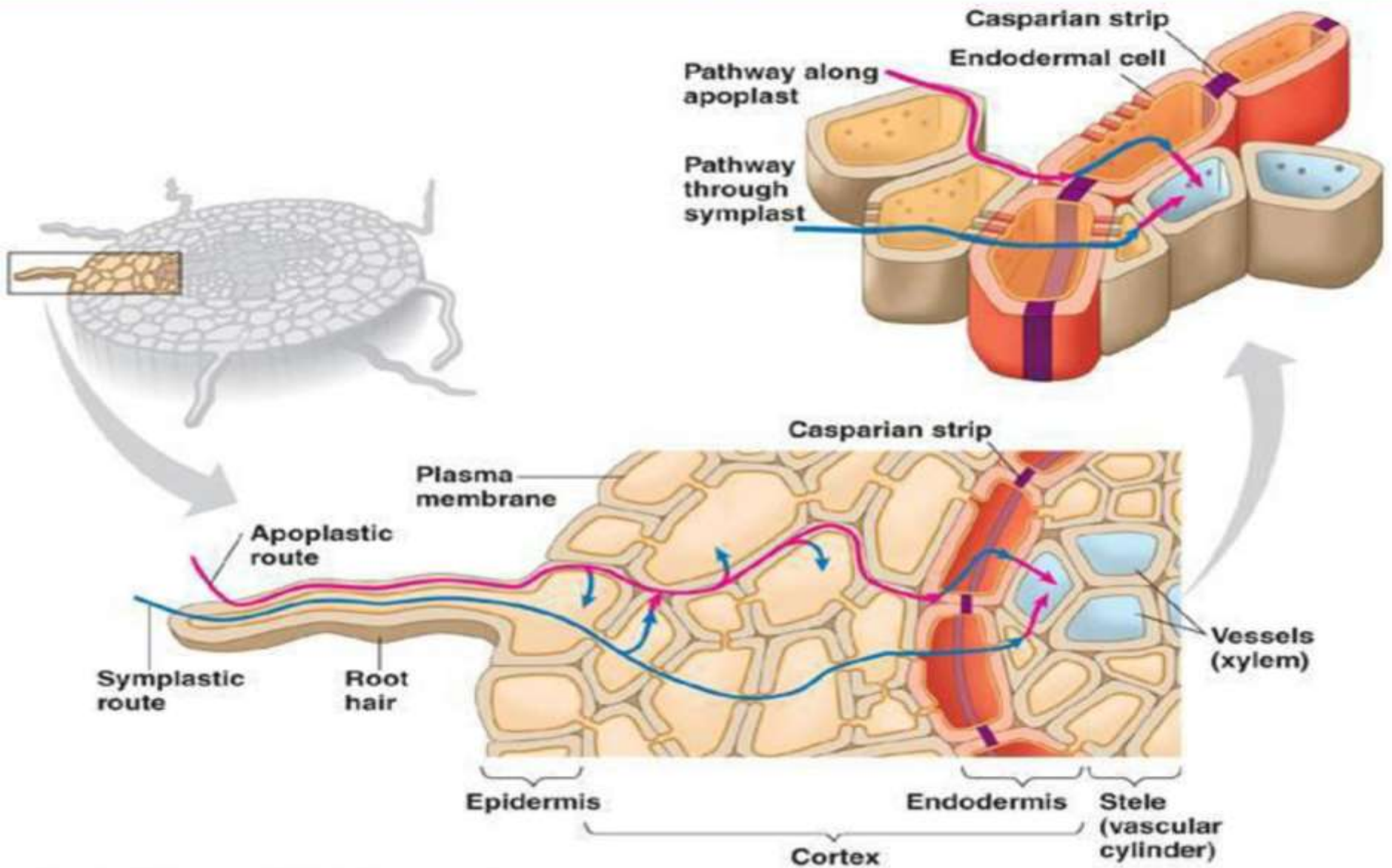
Water Absorption in plants

Apoplast and Symplast

- ❑ The water move through **apoplastic pathway** (Through intercellular pathway).
- ❑ Symplast pathway through **plasmadesmata**.
- ❑ Transmembrane pathway through **aquaporins**.



WATER ABSORPTION IN PLANTS



Water Absorption in plants

Factors affecting water absorption

1. External factors:

i. Available soil water:- Dry soil decreases the rate of absorption. Decreases in soil water reduces the rate of absorption.

ii. Concentration of solution: Soil much more concentration than the cell sap OP high of cell sap of root cells.

iii. Soil temperature: Max. absorption of water 20°C to 30°C.

If temperature ↑ absorption ↓.

If 20°C ↓ together absorption ↓.

If 0°C physiologically dry.

iv. Soil aeration: Oxygen is essential for water absorption by roots.

- In water logged soils, aeration is very poor and this poor aeration decreases the permeability of root cells to water.
- They are not good absorption of water. Therefore, such water logged soils are to be physiologically dry.

Water Absorption in plants

Internal factors

i. **Transpiration:**

- Rate of absorption of water is directly proportional to that of transpiration.
- High rate of transpiration increase the rate of absorption due to transpiration pull transmitted to roots.
- Transpiration creates a favorable condition for the entrance of water into roots.

ii. **Root hairs:**

- The efficiency of water absorption depends upon the characteristics of the absorbing system(root system).
- The presence of more number of root hairs accounts for the high rate of absorption.

iii. **Metabolism:**

- The metabolism and absorption are closely related.
- The factors inhibiting the rate of respiration such as poor aeration and KCN reduce the water absorption rate.

THANKS