TRANSPORT IN PLANTS.

⊙ Translocation: Long distance transport proceeds through Vascular System [Xylem and phloem].

→ Transport in xylem [water and minerals] is unidirectional.

→ Transport in phloem [Nutrients] is multidirectional.

MEANS OF TRANSPORT

- Diffusion
- Facilitated Diffusion
- Active Transport.

1. Diffusion: Movement is passive and short distances.

→ No Energy expenditure.

→ Movement is from region of high Concentration to low Concentration.

→ Slow process.

→ It is the only mean for gaseous movement.

→ Obvious in gases and liquids.

→ Diffusion rate are affected by gradient of Concentration, permeability of membrane separating them, Temperature and pressure.

2. Facilitated Diffusion:

- Lipid soluble particle easily pass through cell membrane but hydrophilic solute movement is facilitated.
- Membrane protein provide site at which such molecule cross the membrane
- Without expenditure of ATP energy.

⊙ Water ~~Canal~~ Channels: Made up of 8 different type of Aquaporins [membrane protein]

→ Extracellular molecule bind to transport protein. Then, transport protein rotate and release molecule inside the cell.

⊙ Porins: protein that form huge pore in outer membrane of plastid mitochondria etc.

⊙ Symport
In Symport both molecule cross the membrane in same direction.

⊙ Antiport: both molecule move in opposite direction.

⊙ Uniport: When a molecule move across a membrane independent of other molecule, the process is called Uniport.

⊙ Active Transport:

- Uses energy to pump molecules against the Concentration gradient.
- Movable Carrier protein are called pumps.
- Transport substance from low Concentration to high Concentration

⊙ The Carrier protein are Very Specific in what it Carries across the membrane.

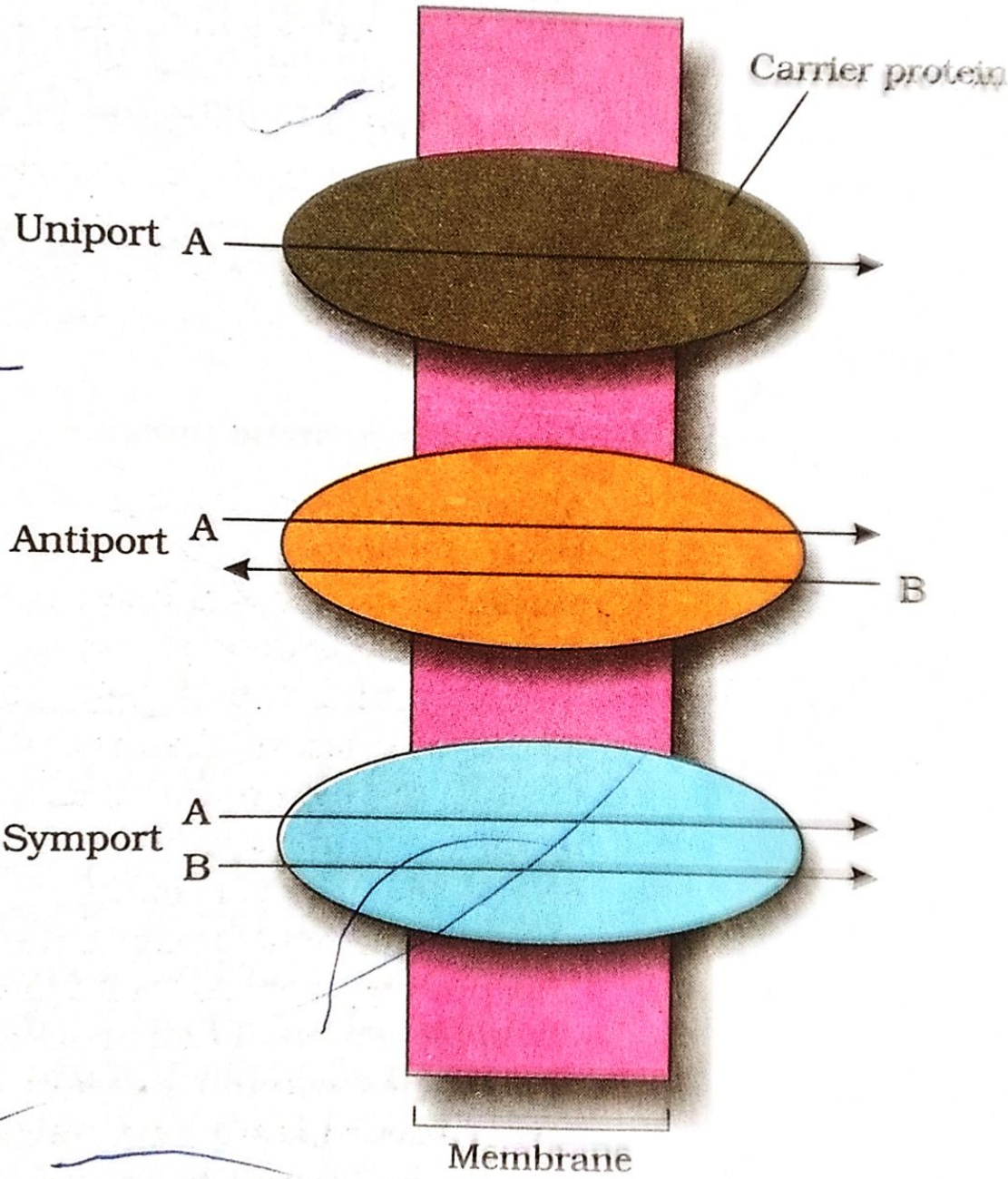

Figure 11.2 Facilitated diffusion

* PLANT WATER RELATIONSHIP

- Water is essential for all physiological activities of plant along with all living organism.
- Protoplasm of cell contain water in which different molecules are dissolve and suspended.
- Terrestial plant take lot of water and release most of in form of water vapour by the process of Transpiration.
- Water is the limiting factor for plant growth and productivity in both agricultural and natural enviroments.

* Water Potential :

- Water molecules posses kinetic Energy. The greater the concentration of water in a system, the greater is it's kinetic Energy or water potential.
- Denoted by Psi or ψ.
- Expressed in Pascals [Pa]

⊙ Pure water will have greatest water potential.
at standard temperature is taken to be zero.

⊙ Solute potential and ~~water~~ Pressure potential are Component that determine water potential.

⊙ Solute potential: The magnitude of lowering water potential due to ~~solution~~ dissolution of Solute is Called Solute potential [ψ_s]

→ ψ_s is always negative.

→ for a solution at atmospheric pressure
$\psi_s = \psi_w$

→ The more the Solute molecule, the lower [more negative] is ψ_s.

⊙ Pressure potential:

When a water enters a plant cell due to diffusion Cause a pressure built up against cell wall. It makes the Cell turgid. and increase pressure potential.

→ Denoted by ψ_p
→ usually positive.

NOTE: $\psi_w = \psi_s + \psi_p$

⊙ pressure greater than atmospheric pressure is applied to pure water or a solution than it's water potential increase.

* OSMOSIS:

⊙ Term used to refer diffusion of water through a differentially or semi permeable membrane.

⊙ Net direction and rate of Osmosis is depend on Pressure gradient and Concentration gradient.

⊙ Water move from high potential to low Chemical potential. Until equilibrium is reached.

⊙ Osmotic potential: Pressure required to prevent water from diffusing.

→ More the solute Concentration greater will be pressure required to prevent from diffusing it.

⊙ Numerically Osmotic pressure is equal to Osmotic potential but sign is Opposite.

⊙ Osmotic pressure = Negative
Osmotic potential = Positive.

⊙ Isotonic solution : If external solution balanced the Osmotic pressure of Cytoplasm. It is said to be Isotonic

→ No net flow of water towards inside or Outside.
→ The Cell are said to be Flaccid.

⊙ Hypotonic solution : If external solution is more dillute than the Cytoplasm. It is said to be hypotonic.
→ Cell swell in hypotonic solution.

→ Water diffuse into the Cell causing Cytoplasm to build pressure against Cell wall. this is Called turgour pressure.

→ The pressure exerted by protoplast due to entry of water against rigid wall is Called Pressure potential. [ψ_p]
→ Turgor pressure is responsible for enlargement and extension of growth Cell.

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(*) Hypertonic: If external solution is more Concentrate than the Cytoplasm. It is said to be Hypertonic.

- Cell shrink in hypertonic solution.
- water move outside the cell.
- plasmolysis: Occur when water moves out of cell and Cell membrane of a plant cell shrinks away from it's cell wall.
- The Cell is said to be plasmolysed.

* IMBITION:

⊙ It is a special type of diffusion. when water is absorb by solid Cause them to enormously increase in Volume.

⊙ Ex: Absorption of water by seeds and dry woods.

⊙ It is also diffusion because water movement is along a Concentration gradiet.

* Long Distance Transport Of Water.

⊙ For long distance transport and at ~~must~~ much faster rate.
Water and minerals, and food are ~~moved~~ moved by mass or bulk flow System.

⊙ Mass flow: It is the movement of substance in bulk or en mass from one point to Another due to pressure difference b/w two point.

⊙ Bulk flow can be acheieved either through positive hydrostatic pressure gradient [eg: garden hose] or a Negative hydrostatic pressure gradient [eg: Suction through a straw]

⊙ Xylem translocates mainly water and minerals salt and some hormones.

⊙ Phloem translocate a Variety of Organic and inorganic solute. from leaves to other part of plant.

* How Do Plants Absorb Water ?

⊙ Water is absorbed with minerals by the root hairs by diffusion.

⊙ Extension of root epidermal cell increase the surface area for Absorption

⊙ Once water is absorbed by root hairs it can move deeper into root layer by two distinct pathways.

[i] Apoplast pathway
[ii] Symplast pathway

* Apoplast pathway :

⊙ It is the System of adjacent cell wall that is Continous except at the Casparin strip of Endodermis in root.

⊙ Apoplastic movement of water occur through intercellular space and the wall of cell.

⊙ Does not involve the Crossing the Cell membrane.

⊙ Depend on gradient.

⊙ Does not provide any barrier to water movement.

⊙ Mass flow is occur due to adhesive and Cohesive properties of water.

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* Symplastic pathway

⊙ It is the System of interconnected protoplast.

⊙ Cells are Connected through Cytoplasmic Strands that extend through plasmodesmata.

⊙ In Symplastic System water move through Cell Cytoplasm. Intercellur movement is through plasmodesmata.

⊙ Movement is relatively Slower.

(*) Most of water flow in root Occur via Apoplast as Cortical Cell are loosely packed and offer no resistance to water movement.

(*) Water molecules are Unable to penetrate the Casparian Strip of Endodermis.

(*) Water then move through Symplast and again Cross membrane to reach the Cells of Xylem.

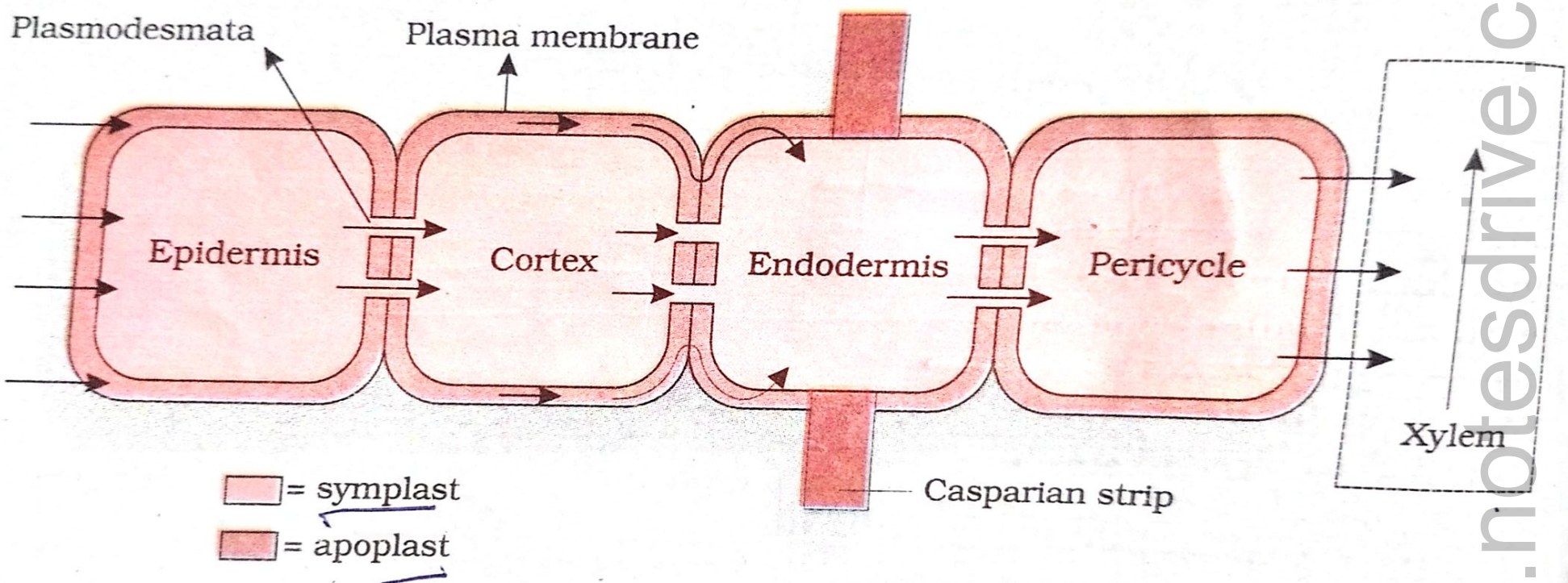

Figure 11.6 Pathway of water movement in the root

⊙ In young root's, water enters directly into xylem Vessels and/or Tracheids.

⊛ Mycorrhiza

⊙ It is a Symbiotic association of a fungus with a root System.

⊙ Fungus provide minerals and water to the roots

⊙ Roots provide Sugars and N-Containing Compound to fungus.

⊙ Some plants have an obligate associati with mycorrhizae.
Ex: Pinus seeds cannot germinate without the presence of mycorrhizae.

⊛ ROOT PRESSURE

⊙ Root pressure is positive pressure that develop in xylem due to entry of water and ions from soil.

⊙ Responsible for pushing up water to small heights.

⊙ Loss of water in liquid phase by herbaceous plants from tip of ~~root~~ leaf blades is known as guttation.

* Transpiration pull :

- Water is pulled due to driving force of transpiration from the leaves.
- Water molecule remain attached with one another by cohesion force.
- On account of tension created by transpiration, the water column of plant is pulled up passively from roots to great height.
- This is referred to as Cohesion - tension - transpiration pull model of water transport.

* TRANSPIRATION

- It is evaporative loss of water by plants. Occur mainly through stomata
- Exchange of Oxygen and Carbondioxide in leaf is also occur through stomata.
- The immediate cause of opening or closing of stomata is a change in

turgidity of guard cell.

⊙ When turgidity increase within two guard cell then stoma open.

⊙ When tugidity lose, due to loss of water than guard cell become flacid and stoma close.

⊙ Transpiration is affected by :-

Temperature, light, humidity, wind Speed

⊙ Plant factor that affected transpiration :-

(i) Number and distribution ~~include~~ of stomata.

[ii] Percent of open stomata

⊙ Transpiration driven ascent of xylem sap depend on following physical properties of water.

→ Cohesion : Mutual attraction b/w water molecule

→ Adhesion : Attraction of water molecule to polar surface

→ Surface tension :

⊙ Tensile strength: An ability to resist a pulling force.

⊙ Capillarity: Ability to rise in thin tube.

* TRANSPIRATION AND PHOTOSYNTHESIS

⊙ Transpiration has more than one purpose
⊙ Create transpiration pull for absorption and transport of water.

→ Supplies water for photosynthesis.
→ Transport minerals ~~for~~ from soil to part of plant.
→ Cool ~~new~~ leaf surface
→ Maintain the shape and structure of plant by keeping cell turgid.

⊙ Photosynthesis is limited by available water. C_4 plant are twice as effiecient as C_3 plants.

→ C_4 plant use half as much water as C_3 plant for same amount of Co_2 fixed

UPTAKE AND TRANSPORT OF MINERAL NUTRIENTS

⊙ Most of minerals enters the root by active absorption into cytoplasm of epidermal cells because:-

① Minerals are present in soil as charged particle [ions] which cannot move across cell membrane.

② The concentration of ion in soil is lower than that of concentration in roots.

⊙ Active absorption need energy in form of ATP.

⊙ Transport proteins of epidermal cells are control point where quantity and type of solutes that reach xylem is adjusted.

⊙ The ions that reaches to xylem by active transport move further upward along with transpirational pull.

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⊙ The cheif Sink of mineral elements are growing region of plant like apical meristem. and the storage organ.

⊙ Minerals are frequently remobilized from older senescing part of plant's to young growing parts of plants.

⊙ The elements most readily mobilized include phosphorus, Sulpher Nitrogen and potassium.

⊙ The elements like Calcium is not mobilized as it is structural component of plant body.

* PHLOEM TRANSPORT : Flow from source to sink.

⊙ Food [Sucrose] is transported by phloem from source to sink.

→ The part of plant that synthesize the food is called source.

• Part where food is used or store is called Sink.

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⊙ The source and sink can be reversed by plant depending upon season of plant's need.

→ Direction of movement in phloem is bidirectional.

⊙ phloem sap is mainly water and sucrose but other sugar, hormone and amino acid are also translocated through it.

* PRESSURE FLOW AND MASS FLOW Hypothesis

⊙ It is most accepted theory for translocation of sugar from source to sink.

⊙ Glucose is prepared at source by photosynthesis which is converted into disaccharides [Sucrose]

⊙ Sucrose move into Companion cell and then into sieve tube cells by active transport.

⊙ Loading of phloem at source creates a water potential gradient that facilitates the mass movement in phloem.

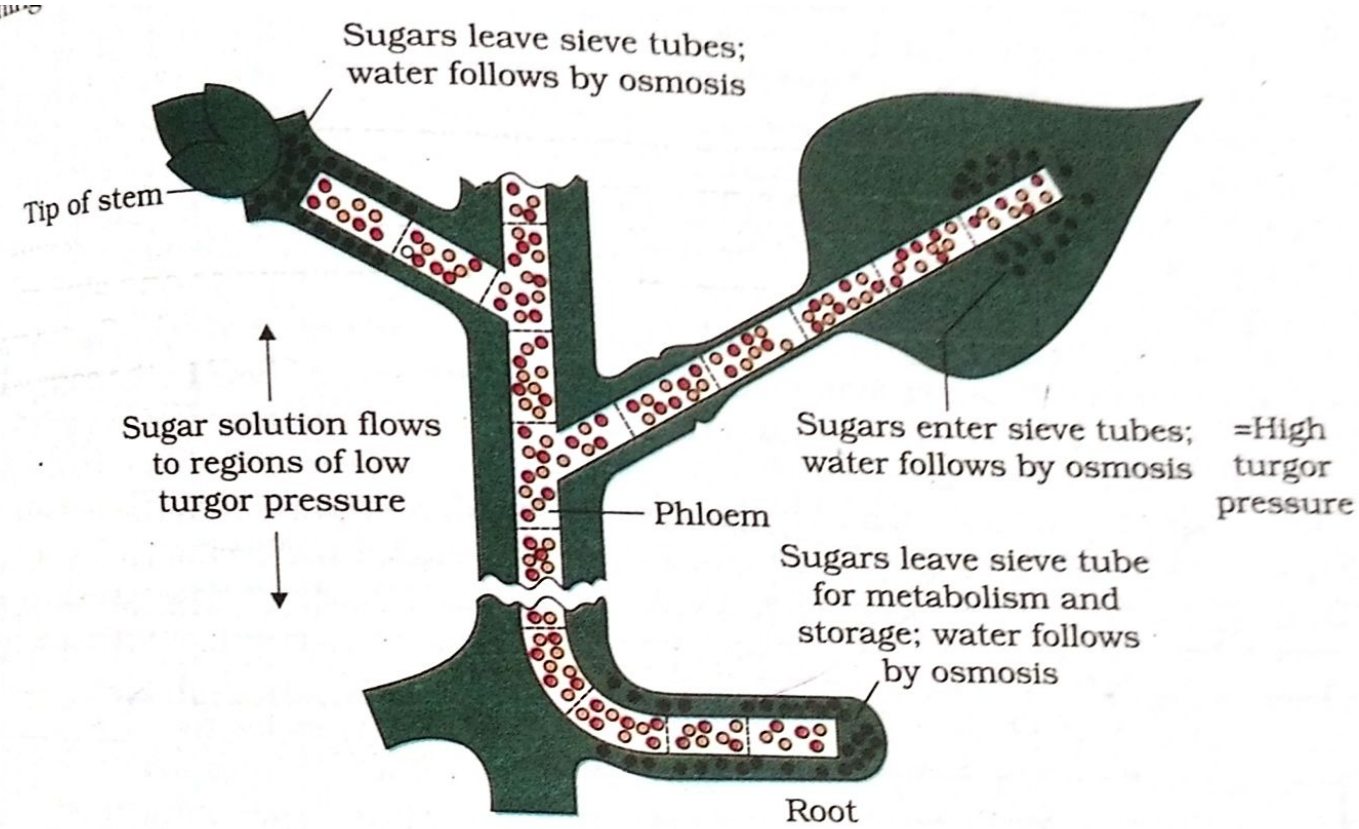

Figure11.10 Diagrammatic presentation of mechanism of translocation

- Sieve tube Cells of phloem forms a long Column with holes in their wall Called Sieve plates.
- Hydrostatic pressure developed in Sieve tube Cells moves the sap in phloem.
- At Sink, incoming Sugar is actively moved Out of phloem as Complex Carbohydrates.
- Loss of Solute produce high water potential in phloem and water passes Out and returning into Xylem.