14. TRANSPORT IN PLANTS

- Movement of material from one location to another location in plant is called Transport in plants.
- In plant Various type of materials are transportation like :

(i) Water
(ii) Mineral & Nutrition
(iii) Organic Matter
(iv) Plant growth regulators

➤ Transportation of plant in three Way:

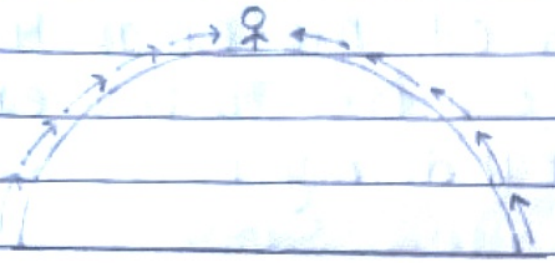
(1) Tonsport across the membrane
(2) Plant-Water relationship
(3) long distance transportation.

(1) Transport across the membrone:

➤ There are two type of transportation Can take place across the membrone:-

(i) Active Transport
(ii) Passive Transport →

Active Transport



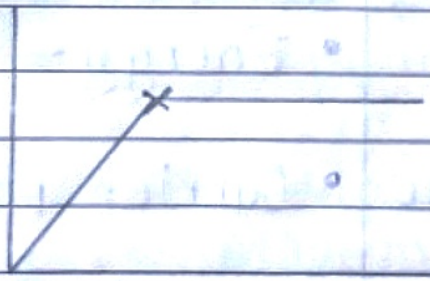
→ Uphill transport

→ L – H

→ Specific

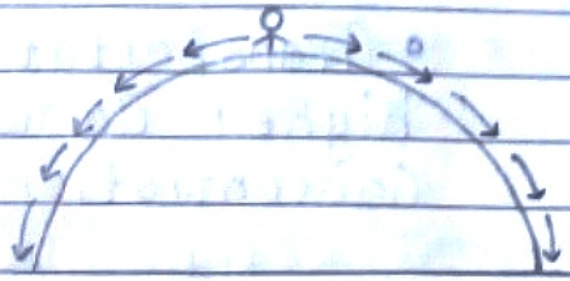
→ ATP (Energy)

→ Carrier protein required



Saturated Graph

Passive Transport



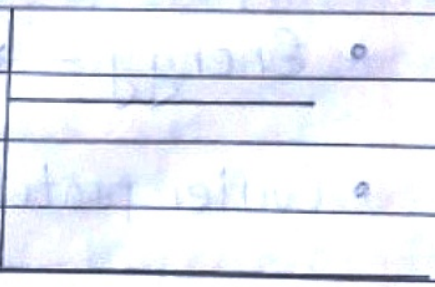
→ Downhill transport

→ H – L

→ Non-Specific

→ No ATP (No Energy)

→ No Carrier protein required



Uniform Graph

Passive transport

(i) Diffusion

(ii) Osmosis

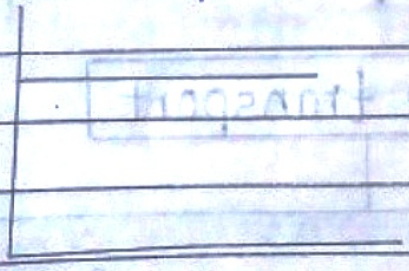
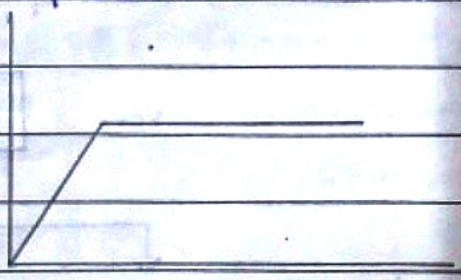
① Diffusion :-

- Transportation of material from its higher Concentration to lower Concentration randomly is called Diffusion.
- Maximum diffusion occur in

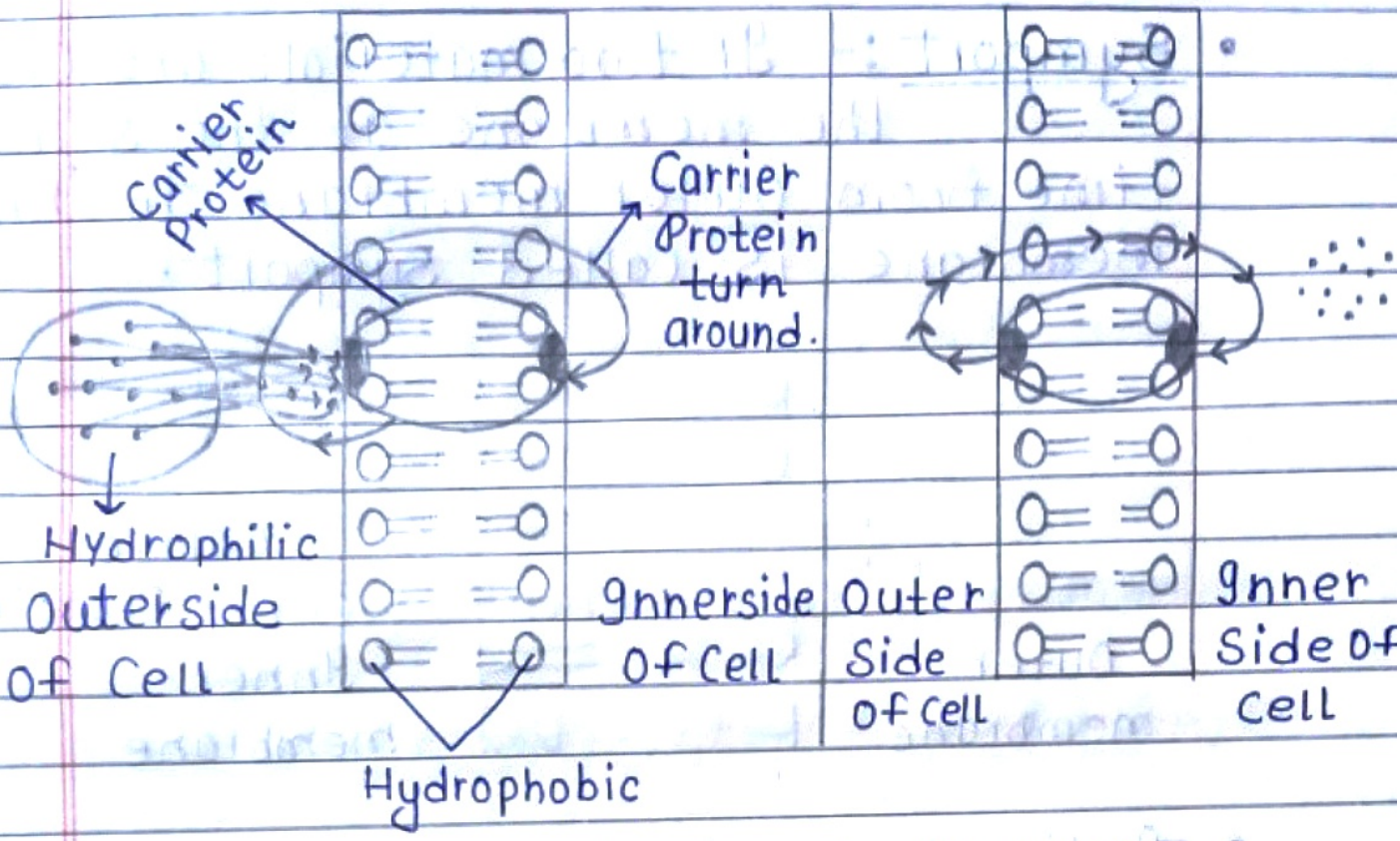
  Air > liquid > Solid

➤ Diffusion is of two type :-

① Simple diffusion ② Facilitative diffusion

Simple diffusion	Facilitative diffusion
• H ⟶ L	• H ⟶ L
• Energy ⟶ No	• Energy ⟶ No
• Carrier protein ⟶ No	• Carrier protein ⟶ Yes
• Non-specific	• Specific
	
Uniform Graph	Saturated Graph

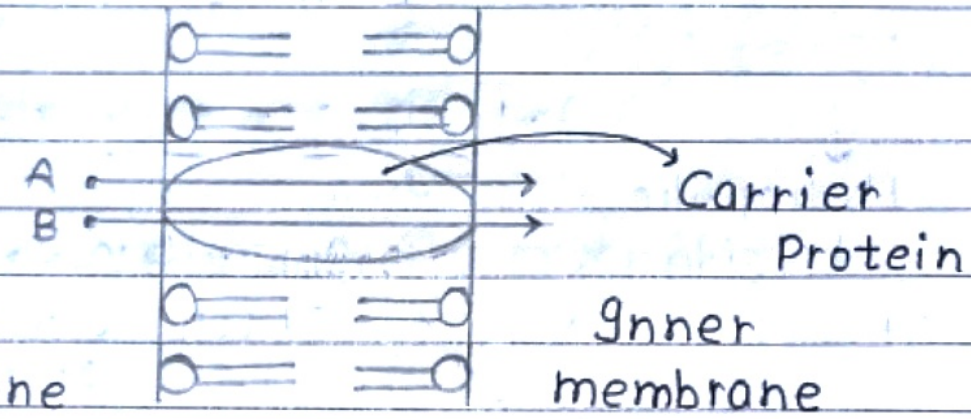
★ Facilitative diffusion mechanism:



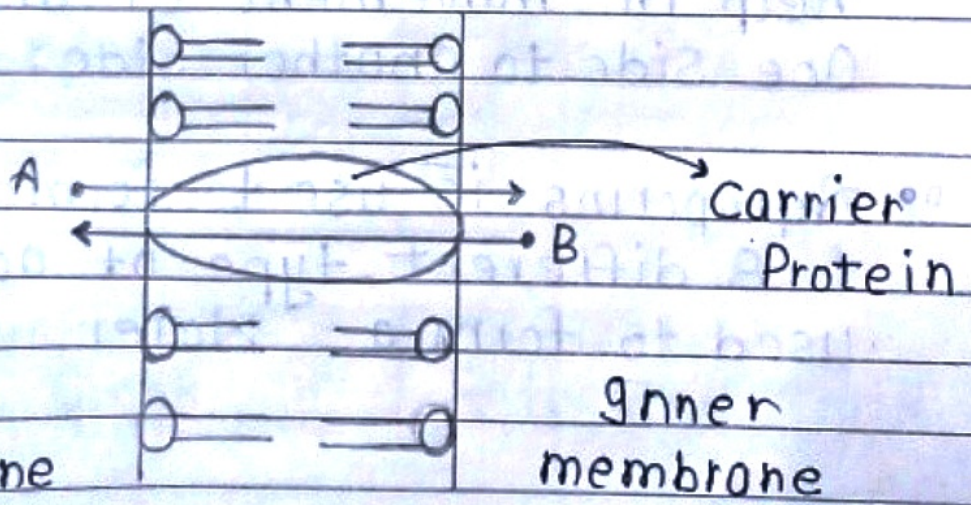
- During facilitative diffusion some of the Carrier proteins like ~~prot~~ porins help in transport of material from Outerside to innerside of membrane.
- For extra Cellular transport aquaporins help in movement of material from One side to another side.
- Aquaporins is use to form Water channels & 8 different type of aquaporins are used to form a Water channel.

★ Passive Symport and Antiports :

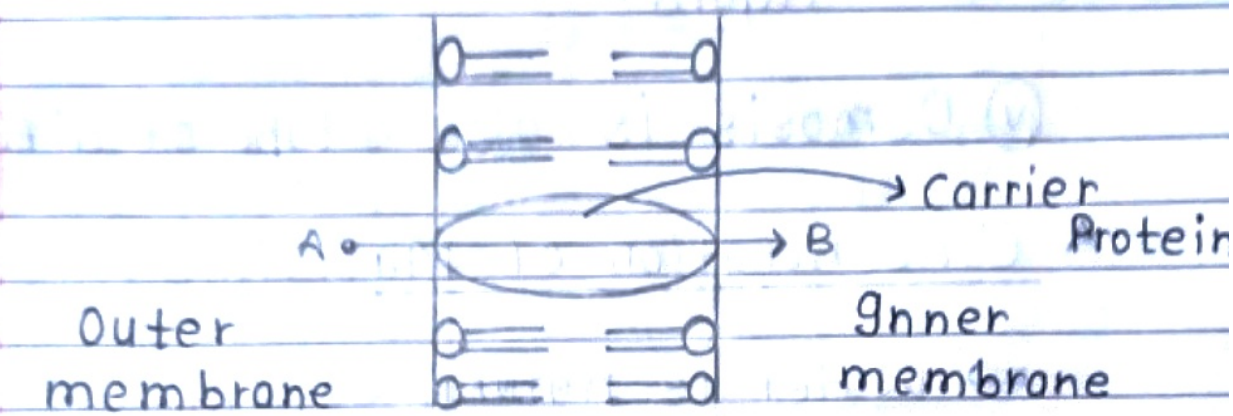
- **Symport** :- If two materials are cross the membrane at the same time from outer membrane to inner membrane is called Symport.



- **Antiports** :- At the same material from outer side of membrane to inner side of membrane as well as from inner side of membrane to Outer side of membrane transported with the help of carrier protein is Antiports type of facilitative diffusion.



- **Uniport** :- If only one material Cross at a time from outerside to innerside of membrane is uniport type of facilitative diffusion.



➤ **Factor affective rate of Diffusion** :-

(i) Temperature $\propto$ rate of diffusion

(ii) Density $\propto \frac{1}{\text{rate of diffusion}}$

(iii) Gas > liquid > Solid

(iv) Diffusion pressure $\propto$ rate of diffusion

(v) Size of particle $\propto \frac{1}{\text{rate of diffusion}}$

➤ **Significance of diffusion** :-

(i) Transport in plant occur by diffusion.

(ii) Cell to cell movement occur by diffusion.

(iii) Gaseous exchange in plant is due to diffusion.

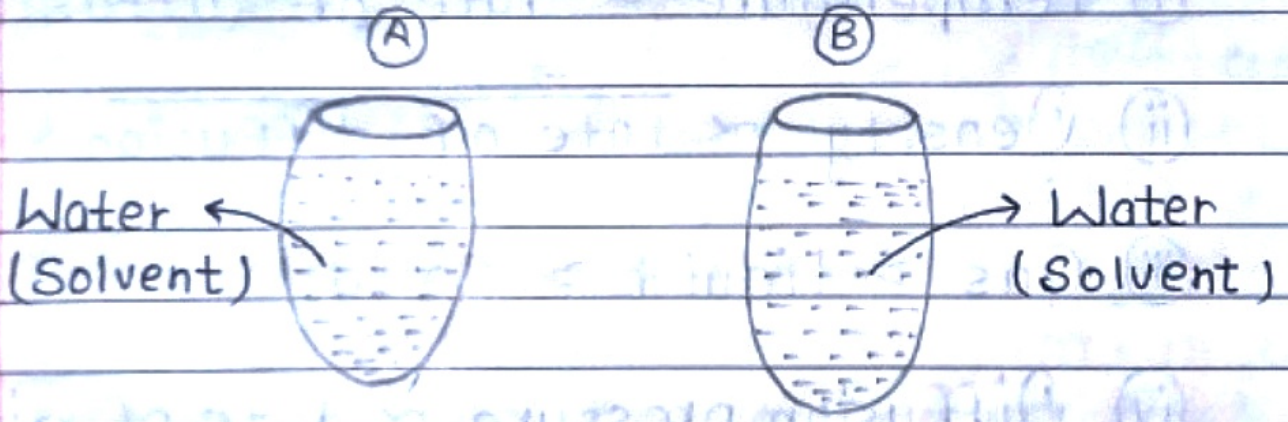
(iv) Diffusion in gas is obvious then liquid.

(v) Osmosis is also a type of diffusion.

★ **Concentration of Materials :-**

⇒ Water is natural Solvent.

* Solvent → Ex :- Water
  Solute → Ex :- Sugar, Salt etc.



(1.) Concentration of Water	Both having Same	
(2.) Concentration of Water	Mixed Sugar → low	Not mixed → High Sugar
(3.) Concentration of Solution	Mixed Sugar → High	Not mixed → low Sugar

(ii) Osmosis :—

- Movement of material from its higher Concentration to its lower Concentration through Selectively permeable membrane is called Osmosis.

- It is a type of diffusion.

- Osmosis through which plant root absorb water from soil.

- To understand Osmosis we have to understand Various factor of Osmosis Like —

(i) Osmotic Concentration
(ii) Osmotic Pressure

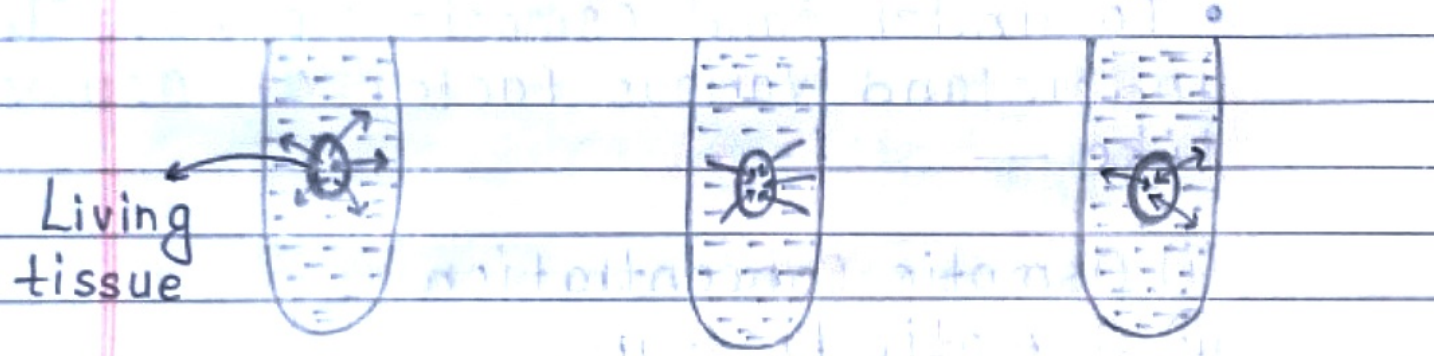
(i) **Osmotic Concentration** :— The amount of Solute present in per unit Volume of Solvent is called Osmotic Concentration.

➤ On the basis of Osmotic Concentration Solution is of three type —

Osmotic Concentration

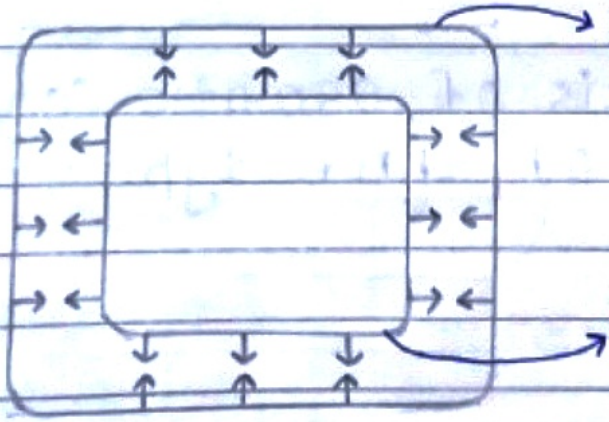
Solution is of 3 type

Hypertonic Solution	Hypotonic Solution	Isotonic Solution
⇓	⇓	⇓
Solute is more.	Solvent is more.	Solute & Solvent is in equal amount.



Exo-Osmosis | Endo-Osmosis | No-movement

★ Turgor Pressure and Wall Pressure :-



Cell Wall ⇒ "Wall pressure"

Cell membrane ⇒ "Turgor pressure"

Protoplasm = Cell + Cell Wall

Protoplast = Cell − Cell Wall

- **Plasmolysis** :- Under the influence of hypertonic solution if protoplast get shrinked is called "Plasmolysis".

* **Turgor Pressure** :- Pressure exerted by cell membrane on cell wall is called Turgor pressure & Membrane pressure.

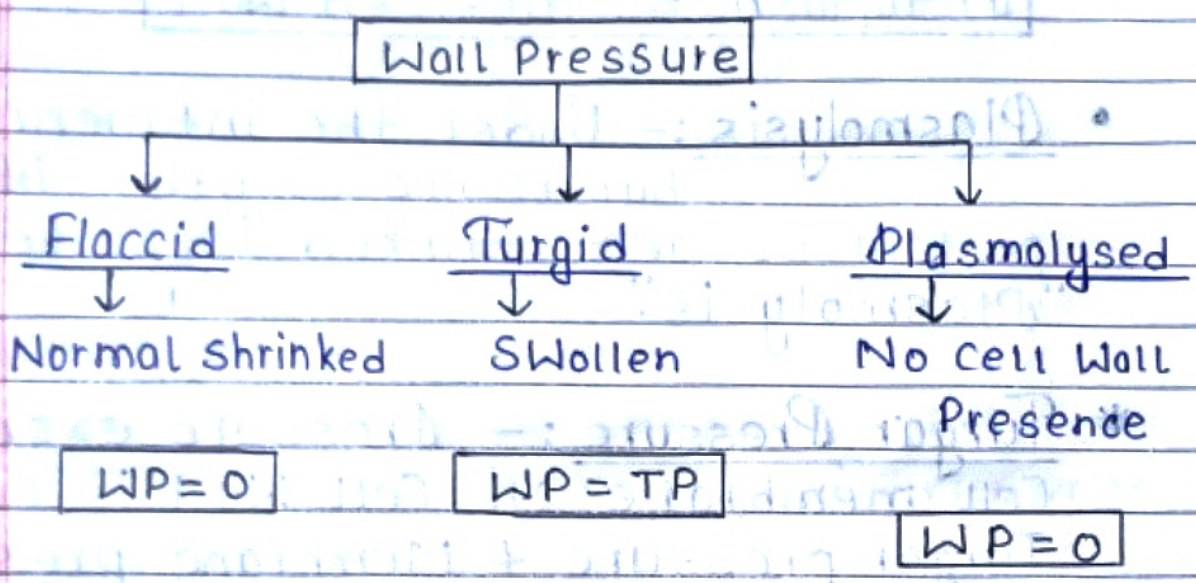
→ It is Positive pressure.

Turgor Pressure

Flaccid	Turgid	Plasmolysed
↓	↓	↓
Shrink / Normal	Swollen	Shrinking of Protoplast under the influence of Hypertonic Solution
TP = 0	TP = WP	TP = -ve

* **Wall Pressure** :- Pressure exerted by cell wall on cell membrane is called Wall Pressure.

→ It is Counter-act pressure on the effect of Turgor pressure.



★ Significance of Turgor pressure :-

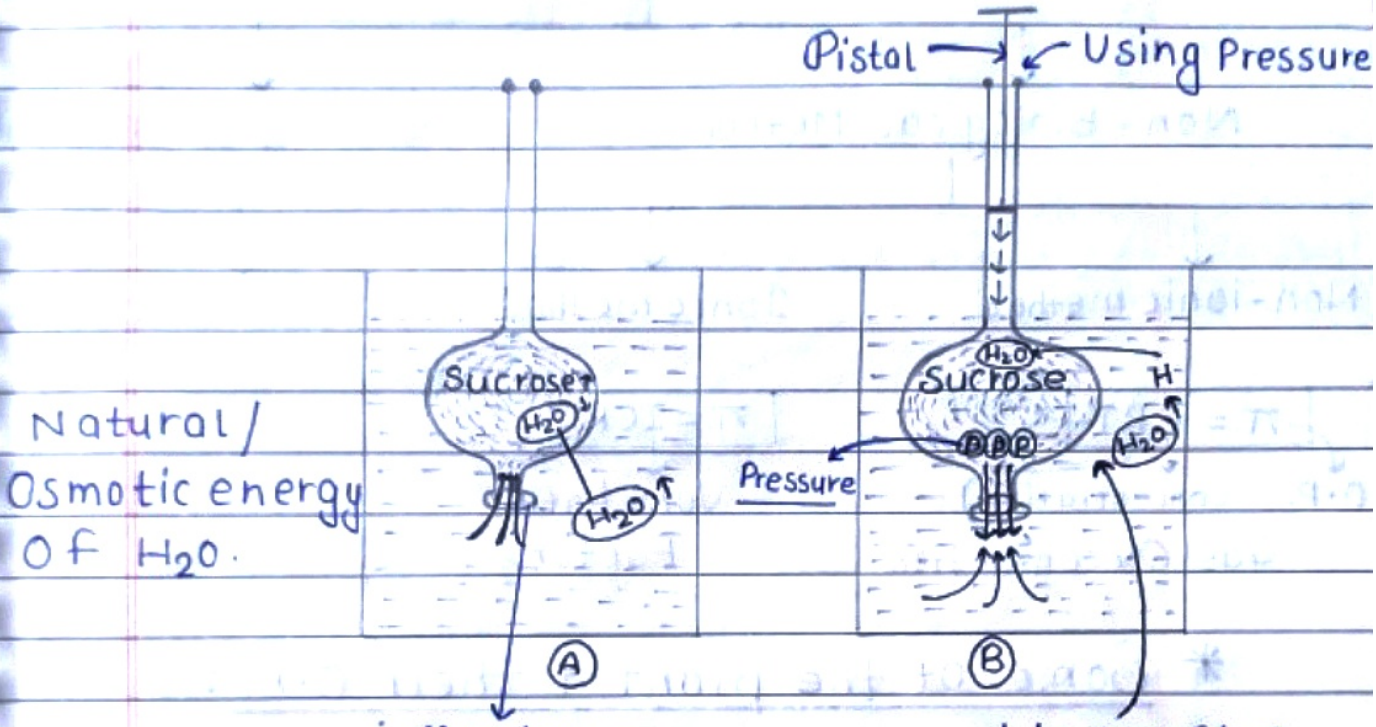
- Surface area maintain through in
- Transportation of material occur.
- Erect position of plant is due to turgor pressure.
- Different type of membrane permeability

★ Significance of Wall pressure :-

- It protect the Wall from Turgor pressure.

(ii) Osmotic Pressure :— Pressure exerted by cell to stop the Osmotic entry of Water is called Osmotic pressure.

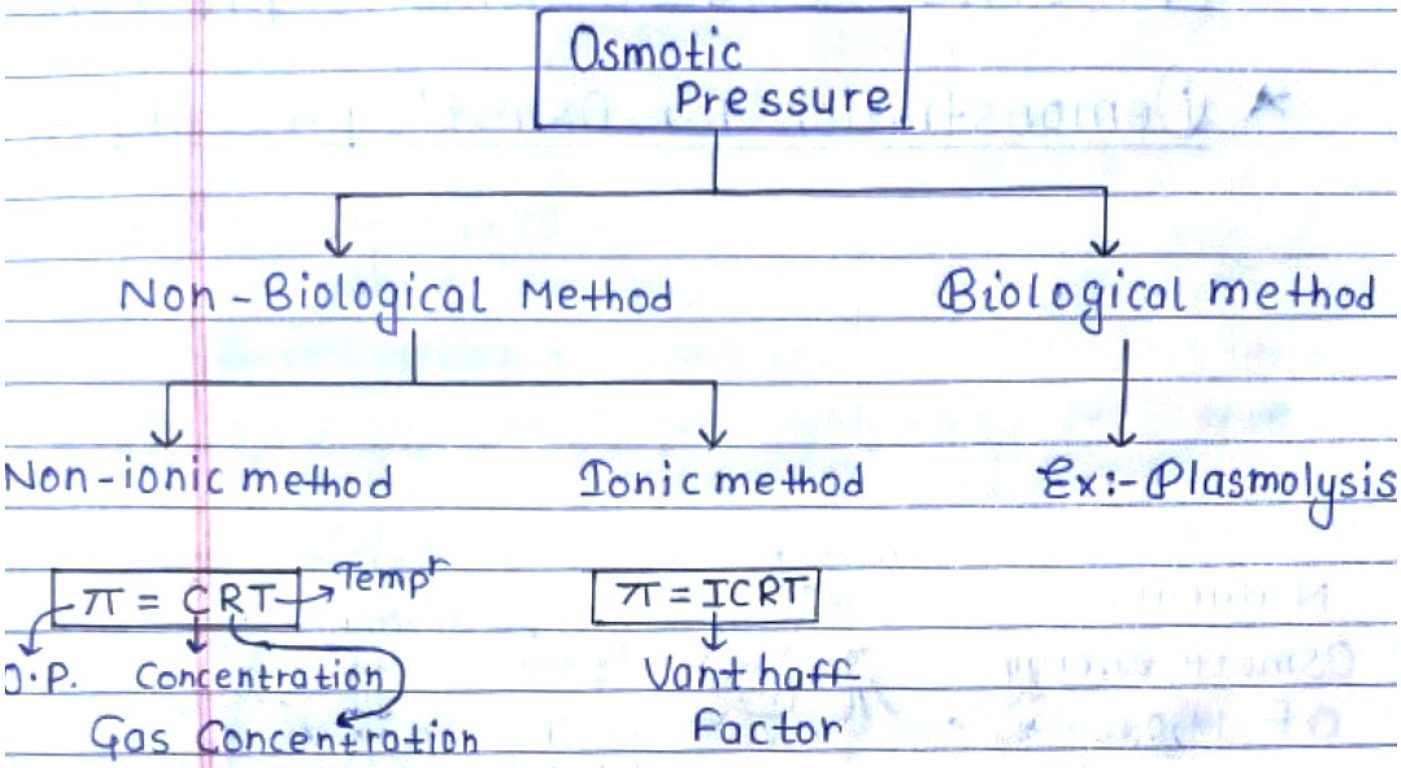
★ Demonstration for Osmotic pressure :-



- If Osmotic pressure applied that not means it permanently stop the Osmotic energy of Water.

- Osmotic pressure is Colligative (Collective) property. So, depend on number of Solute particle.

➤ Osmotic pressure is measured by two Way :—



* Some of the plant & their O.P. :—

Plants	O.P.
Hydrophytes	0 — 3
Mesophytes	3 — 15
Xerophytes	15 — 30
Halophytes	30 — 200

Note :—

Artiplex — 200 atm

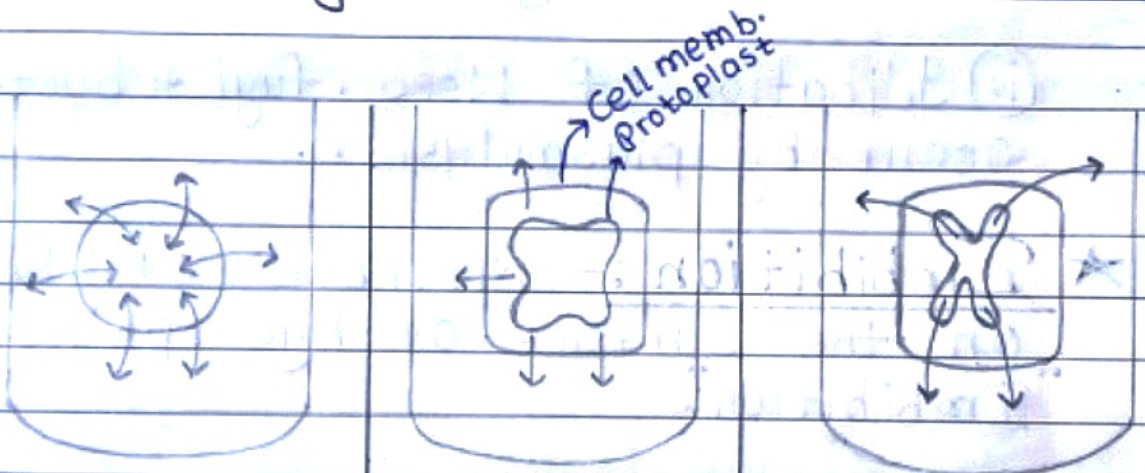
* O.P ∝ Solute

★ Factor affecting rate of Osmotic pressure :-

- Concentration $\propto$ O·P
- Temperature $\propto$ O·P
- Dissociation $\propto$ O·P
- Ionisation $\propto$ O·P
- Association $\propto \frac{1}{O \cdot P}$

* Plasmolysis :—

Protoplast ⇒ Cell - Cell Wall



Isotonic Solution | Just Hypertonic Solution | Hypertonic Solution

⇓

Protoplast Shrinked i.e.

↓

Plasmolysis.

⇒ If this Cell put in to Hypotonic Solution then it get de-plasmolysed

↓

Hypotonic Solution.

★ Significance of Plasmolysis :-

(i) Livingness of Cell is produced by plasmolysis.

(ii) Osmotic pressure is measured by plasmolysis.

(iii) Permeability of Cell membrane can be proved by plasmolysis.

(iv) Idication of Weed, fungi & bacteria occur by plasmolysis.

★ Imbibition :- Absorbtion of Water on the Surface of hydrophilic Colloid "Imbibition".

- Imbibition required imbibate & imbibant.
- Imbibate ⟶ Ex :- Seed
- Imbibant ⟶ Ex :- Water.

➤ Rate of imbibition :-

Agar-Agar > Pectine > Protein > Starch > Cellulose.

➤ Two thing is necessary for imbibition :-

(i) Potential of Water gradient
(ii) Diffusion

➤ Due to imbibition :-

(a) Increase in Volume
(b) Increase in Temperature
(c) Increase in Pressure

★ Factor affecting rate of Imbibition :-

(i) Temperature $\propto$ Imbibition
(ii) Texture $\propto \frac{1}{\text{imbibition}}$

★ Significance of Imbibition :-

(i) Germination of seed
(ii) Breaking of Rocks
(iii) Resurgence plant is reappeared by imbibition.

★ Water Potential :—

• Kinetic / free energy of Water is Called "Water potential" or differences in free energy of Water is Called "Water Potential".

- Concept of Water potential Was given by Slater & Taylor.
- It is represented by ψ or ψ_w.
- Water potential is measured in pascal.
- It is measured by Pascometere.
- Maximum Water potential of pure Water is 0.
- If we add Solute particle than it decrease the Value of Water potential & it value represented in Negative.
- Water potential (ψ_w) of pure Water would never be negative.
- Water potential of Solution (Solute + Solvent) may be negative.
- Movement of Water occur from higher Water potential to lower Water potential.
- $\boxed{\psi_w = \psi_s}$
- $\boxed{\psi_w = \psi_s + \psi_p}$

★ Solute Potential :—

- Decrease in free energy of Water due to addition of Solute is Called "Solute potential".
- It is represented by ψ_s.
- Value of Solute potential is always be negative.
- If we increase Solute than increase in negative value of Solute potential. Or. If we increase Solute than potential of Solute would be decreases.
- Solute potential is also known as Osmotic potential.
- That is value of Solute potential is numerically equal to osmotic pressure but sign in negative.

★ Pressure Potential :—

- Change in free energy of Water due to height of Water Column is Called "Pressure potential."

- Its value may be positive or negative but mostly it is positive.
- Pressure potential is represented by ψ_p.
- Pressure ~~are~~ potential of xylem meristem and plasmolysed cell is negative.

★ **Diffusion pressure Deficit :-**

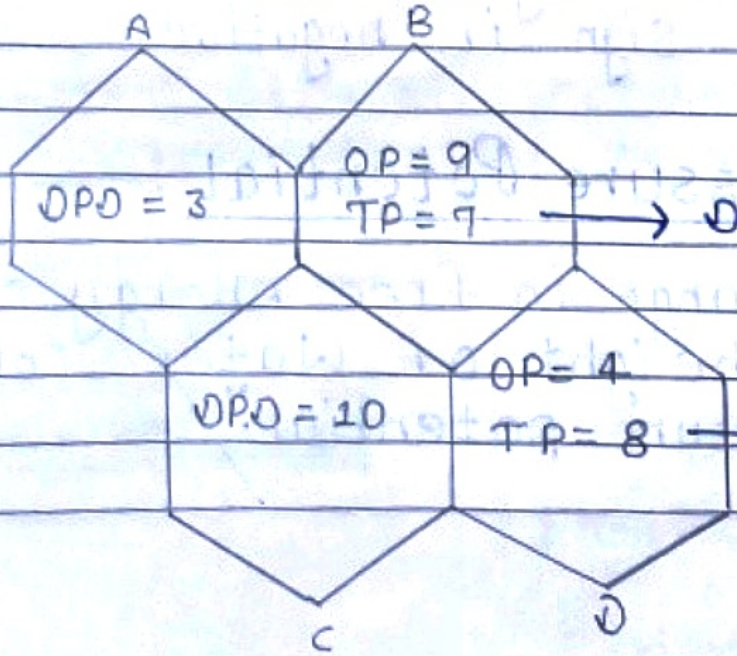
→ Diffusion pressure Deficit = OP - TP

DPD = Osmotic pressure - Turgar pressure

→ Movement of Water occur from lower DPD to higher DPD.

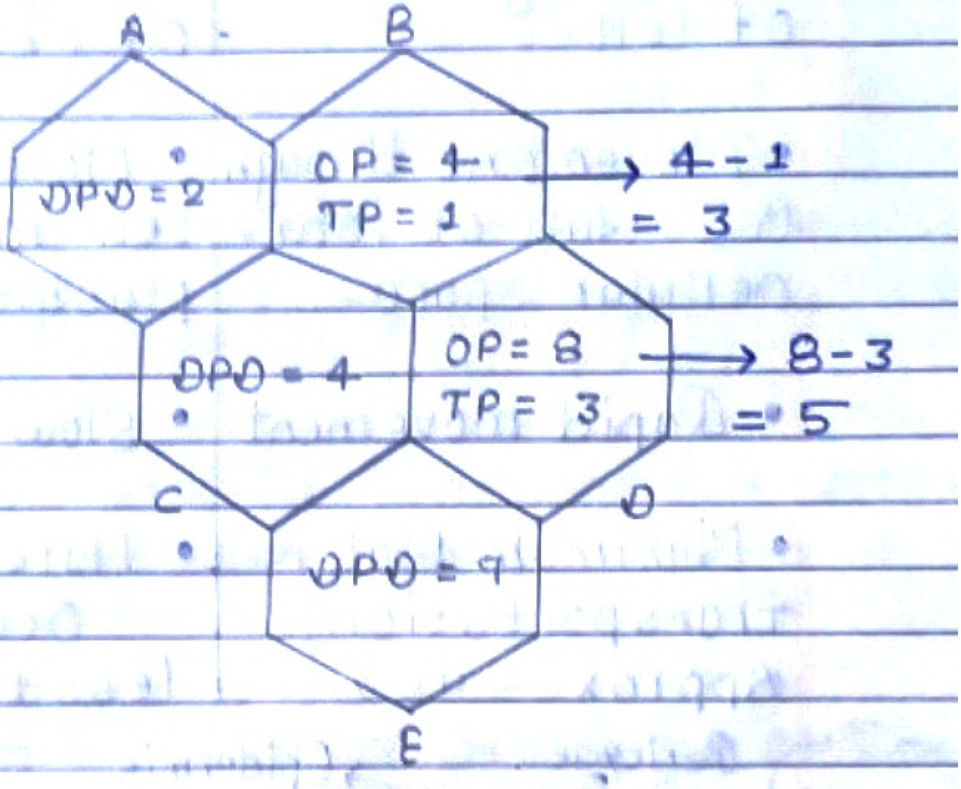
→ Movement of Water occur due to gradient of DPD.

Question ①:



A ← B
A → C
A ← D
B → C
B ← D
C ← D

Question ②:

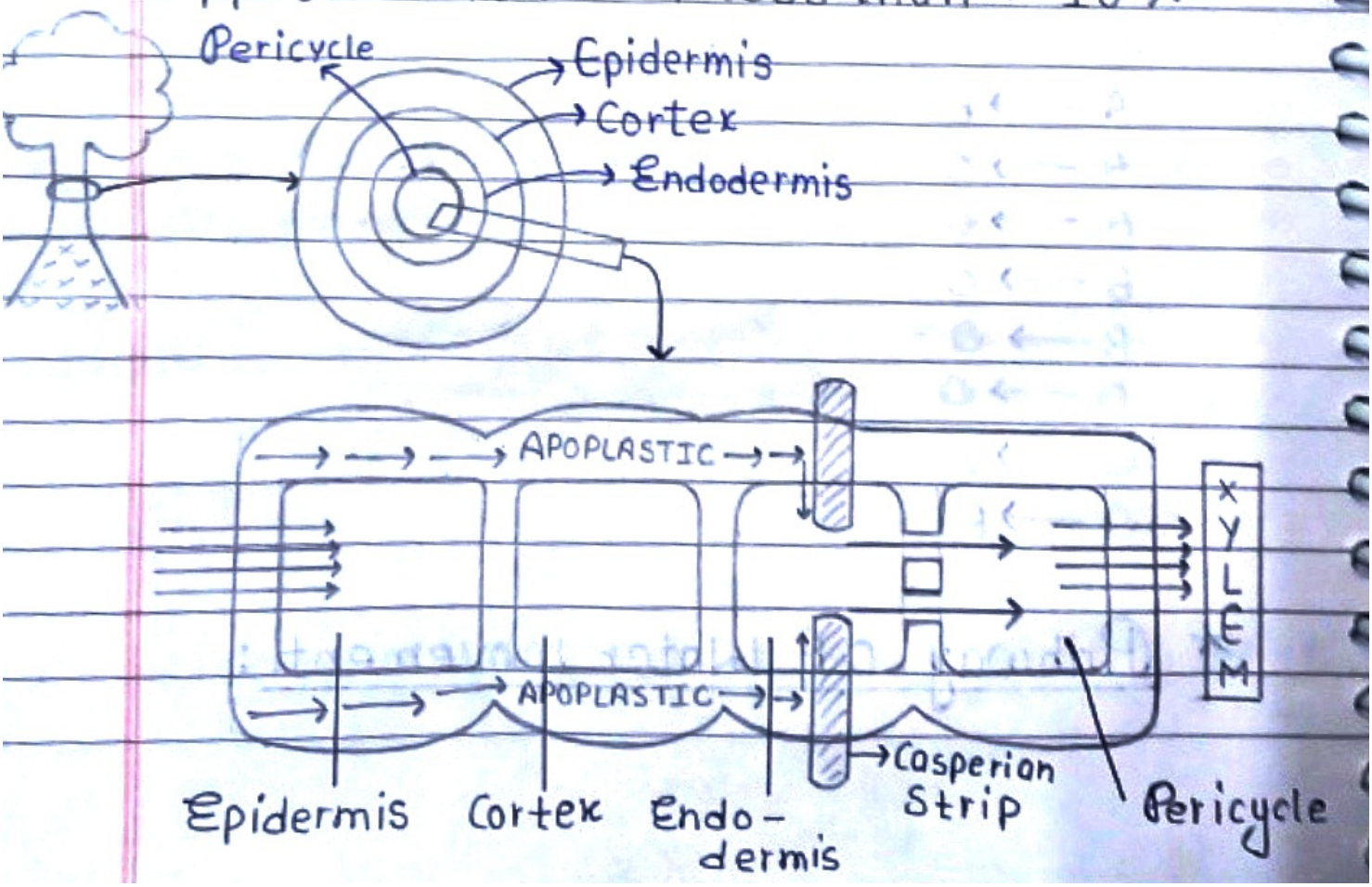


A → B
A → C
A → D
B → C
B → D
C → D
C → E
D → E

★ Pathway of Water movement :

→ It is of two type :-

(i) Apoplastic	(ii) Symplastic
• Movement through Non-living Constituent of cell.	• Movement through living Constituent of cell.
• Movement through Cell Wall or inter-cellular space.	• Movement through cell membrane or plasmodesmata.
• Rapid movement.	• Slow movement.
• Maximum Water transportation. Approx – 90 %.	• Water movement Occur less than – 10 %.



★ Transport of Water :-

⟶ It is occur by 2 way —

① Absorbtion of Water
② Ascent of SAP

① Absorbtion of Water :—

- Transport of Water from Soil Solution to root xylem is called Absorbtion of Water.

- It occur due to gradient of Water protential between Soil Solution & Root system.

- Long ~~Water~~ distance transport of Water, minerals and food occurs by mass flow or Bulk flow.

- Mass flow or Bulk flow is not dependent on Concentration gradient like diffusion.

- It depends on pressure potential gradient.

- Long distance transport of Water, minerals, food through vascular tissue

or Vascular Cambium is Called Translocation.

- Translocation of food occur through phloem while translocation of Water, minerals & Hormons occur through xylem.

② Ascent of SAP :-

- It is a mechanism in which either transportation occur through living or Non-living Cell.

➤ Ascent of SAP defined by two theory —

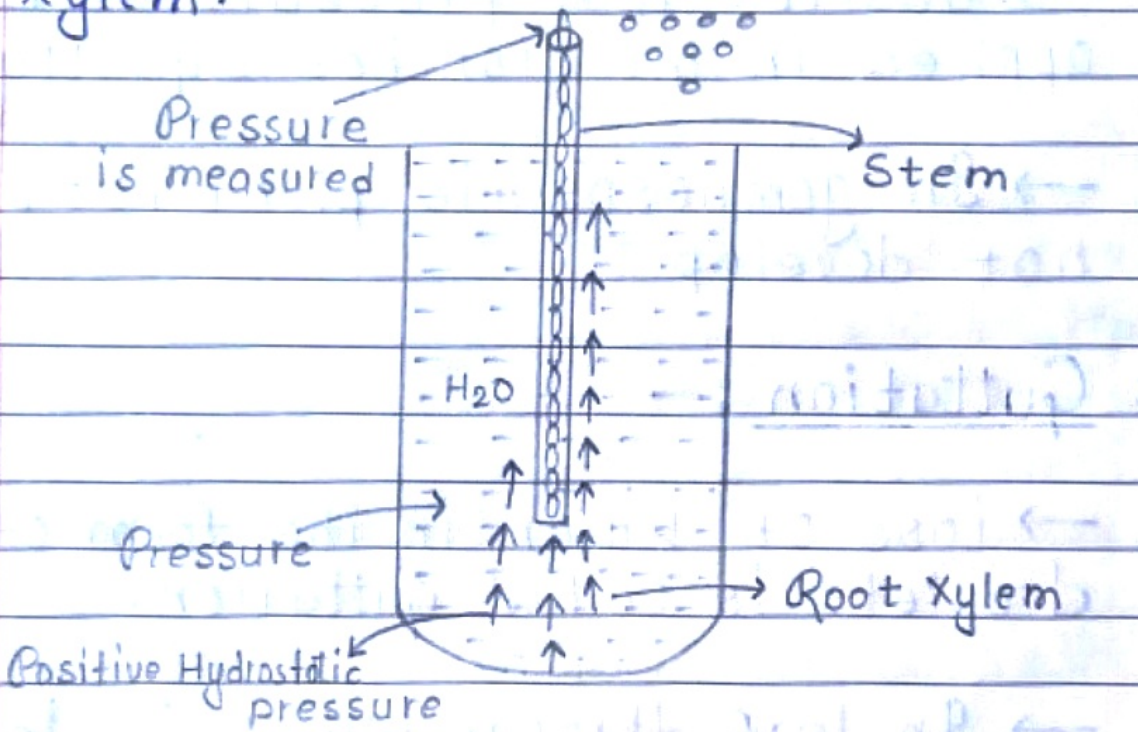
Rejected

(i) Vital force theory	(ii) Physical force theory
• Livingness of Cell is necessary.	• Livingness of cell is not necessary.
(i) Pulse theory: → given by J.C. Bosh	(i) Root pressure theory: → given by Pristley.
(ii) Relay Pump theory: → given by Gold lavsky.	(ii) Transpiration Pull theory: → given by Dixon & Jolly.

① Root Pressure theory :-

→ Root pressure theory is based on positive hydrostatic pressure.

→ Positive hydrostatic pressure help in transport of water through root xylem.



→ Usually in normal condition 1 to 2 atm or bar equivalent pressure is developed through root.

→ Since 1 atm pressure is responsible for 10 m of transportation. So, through 2 atm maximum 20 m can be possible by root pressure.

* Limitation of Root pressure theory :

→ It is not applicable for taller plant.

→ When rate of transpiration increase then root pressure decrease.

→ Positive root pressure is not applied in all branches equally.

→ In gemnospermic plant root pressure not develop.

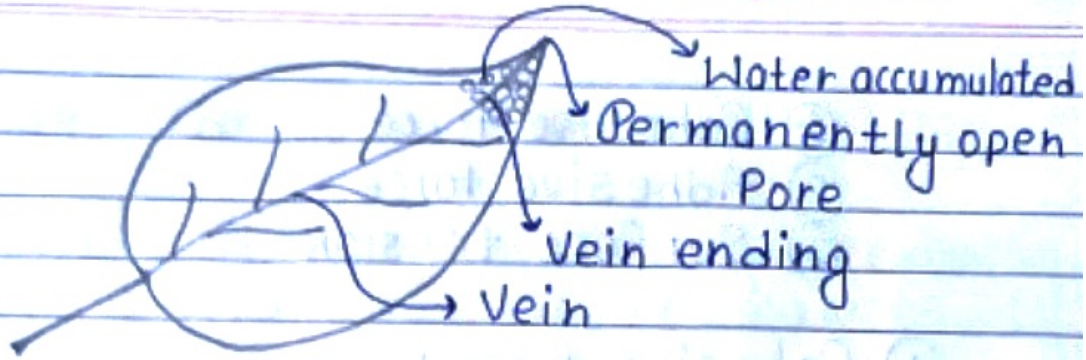
★ Guttation :—

→ loss of Water in the form of Water droplets is Called Guttation.

→ In leaf through Water is loss have a permanently open pore at the tip of leaf (mostly in monocoat plant) is Called Hydathode.

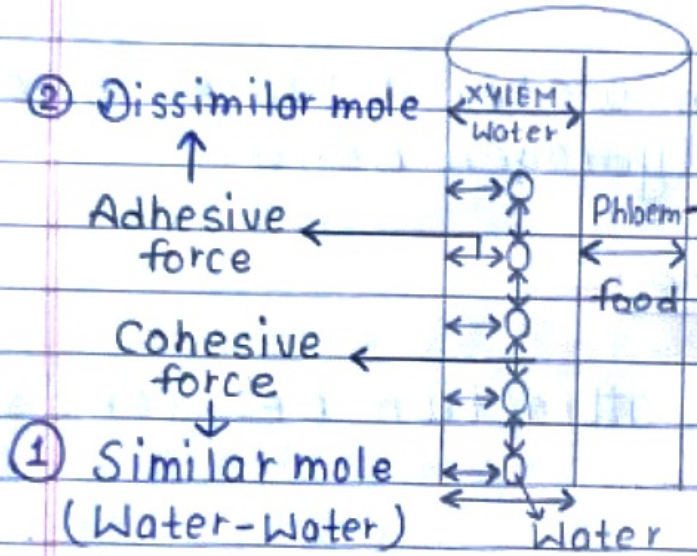
→ Water loss from guttation are not pure Water.

→ Water loss occur due to +ve hydrostatic pressure in root.



(ii) Transpiration pull theory :—

(3) Surface tension i.e. Water + Wall (Tracheids/Vesseles).



⟶ Transpiration pull theory was given Dixon + Jolly.

⟶ It is most accepted theory for Ascent of SAP.

⟶ For transpiration pull for ascent of SAP 3 force are applied i.e.

① Cohesive force
② Adhesive force
③ Surface tension

① Cohesive force :-

→ Force of attraction between Similar type of molecule.

Ex:- Between water & Water molecule through Hydrogen bond.

② Adhesive force :-

→ Force of attraction between disimilar molecules.

Ex:- Between Water & Wall of trachieds & Vesseles.

③ Surface tension :-

→ Surface tension is also Called Tension force.

→ When water molecules come out from leaf surface due to transpiration than a negative tension force generated in Water Coulomb. So transpiration

of Water (sap) takes place.

→ Through Surface tension approximatelly 13 atm or bar pressure is generated.

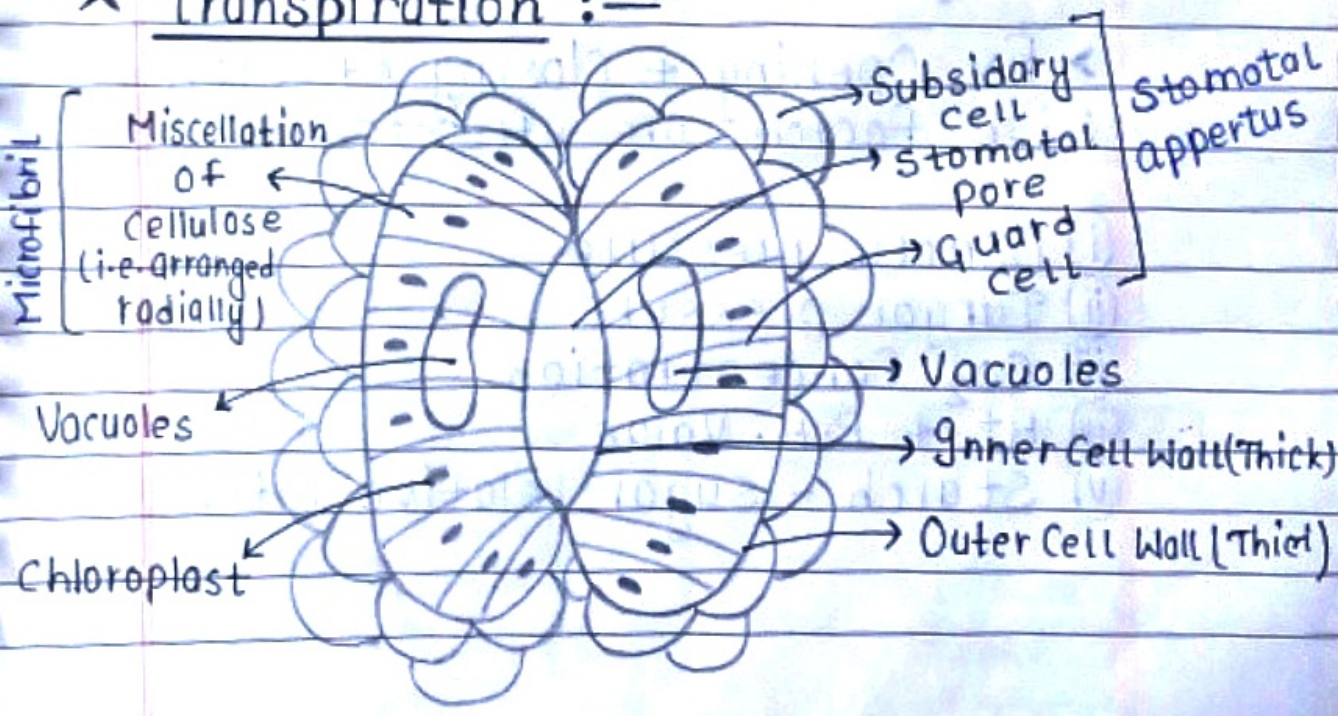
→ Pressure differences between pulling & pushing that generate 13 bar pressure.

→ Since, We known one atm pressure is responssible for 10 m of transportation. So 13 atm pressure can transport up to maximum 130 m of trasportation.

* Limitation of Transpiration pull theory :-

→ Root pressure is also applicable for transportation of Water.

★ Transpiration :—



- Stomatal Transpiration ⟶ 70-90%
- Cuticular Transpiration ⟶ 3-10%
(i.e. if Xerophytic Desert — up to 50%)
- Lenticels & Bark ⟶ 0.1 to 1%

⟶ Loss of Water in the form of Water vapour through apical part of plant is Called Transpiration.

⟶ Differential thickening of outer & inner guard cell along with radial micellation provide of preculiar or Unique shape to the guard cell. Which helps in opening & closing of stomata which occurs due to change in Turgity of guard cell.

➤ For Opening & Closing of Stomata five factors are affected —

(i) Osmotic pressure
(ii) Turgor pressure
(iii) CO_2 Concentration
(iv) H^+ & P.H. Value
(v) Starch - Sugar relative ratio.

➤ Opening & closing of stomata can be understand by two Concept —

(i) Starch-Sugar inter Conversion } LLOYD
(ii) Active $K^+ - H^+$ pump
$K^+ - H^+$ Active flux
$K^+ - H^+$ Active pump } PETER Mitchell

(i) Strach-Sugar inter Conversion :—

Stomata open → during day time

Guard Cell → Chloroplast → Photosynthesis

↓

Glucose / Sugar

↓ Convert

Starch

↓

Osmotic pressure ↑

↓

Endoosmosis

↓

Turgor pressure ↑

↓

Stomata Open

Stomata closed → during night time

Guard Cell → Chloroplast → No-Photosynthesis

↓

No-Glucose formed

Starch

↓ Convert

(used in respiration) → Glucose / Sugar

↓

Osmotic pressure ↓

↓

Endoosmosis

↓

Turgor pressure ↓

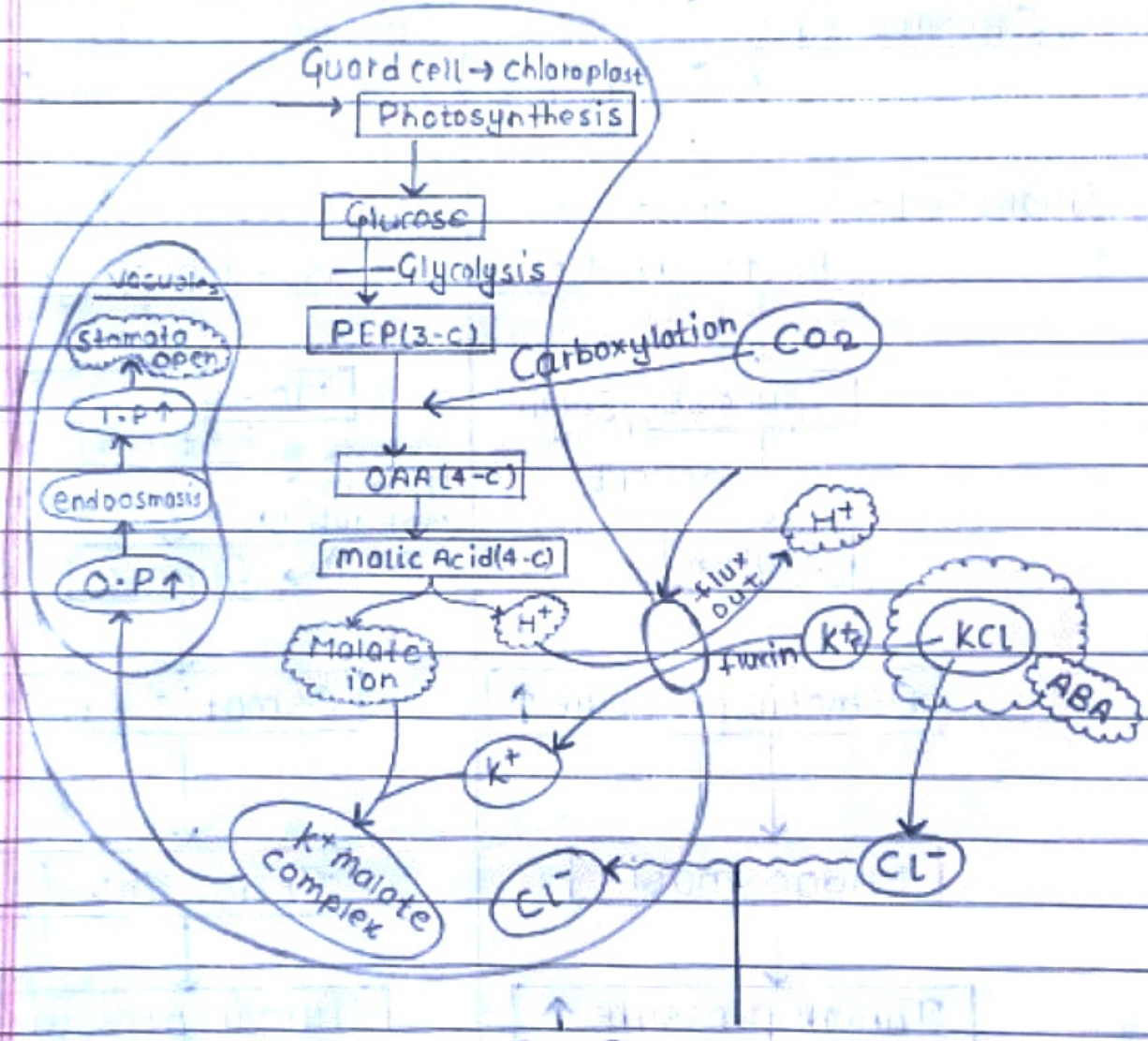
↓

Stomata Close

Limitation :-

→ All plants Can't convert their sugar in to starch (Monocoat plant like, Onion Convert their glucose in to glucose it self). Then, Starch-sugar Conversion Will fail.

(ii) Active $K^+ - H^+$ Pump :-



★ Factor affecting Stomatal movement :-

- Light ∝ stomatal movement

① Photo active stomata — Open during day time.

② Scoto active stomata — Open during night time.

Ex:- Xerophytic (Desert plant).

- $CO_2 \propto \frac{1}{\text{Stomatal movement}}$
- Temperature ∝ stomatal movement
- Humidity ∝ stomatal movement

★ Factor affecting rate of Transpiration :-

- Light ∝ Transpiration
- Temperature ∝ Transpiration
- Humidity $\propto \frac{1}{\text{Transpiration}}$
- Wind ∝ Transpiration
- Wind Velocity ∝ Transpiration
- $CO_2 \propto \frac{1}{\text{Transpiration}}$

★ Anti – Transpirant material :–

(i) CO_2
(ii) Aspirin
(iii) PMA (Phenyl mercury Acetate)
(iv) Silica
(v) Viscous Wax

★ Phloem Transportation :

- Phloem Transportation = Translocation
- Site – Phloem
- Use – B & K.

- In phloem transportation movement occur between source to sink and vice versa.

- Source and Sink are interchangeable according to season & life stages.

- Source is not exporter region.

- Sink is net emporter region.

- Phloem is multidirection While xylem is Unidirectional.

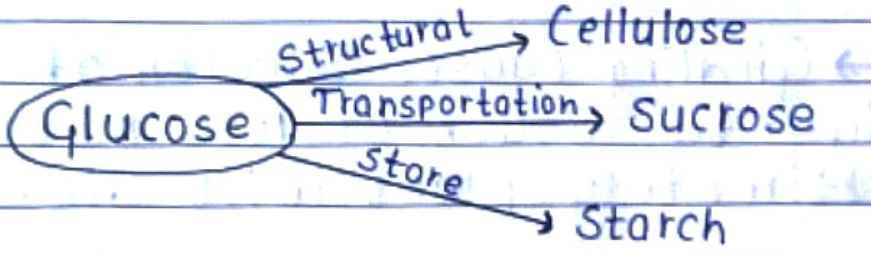
- Transport of food is occur in the

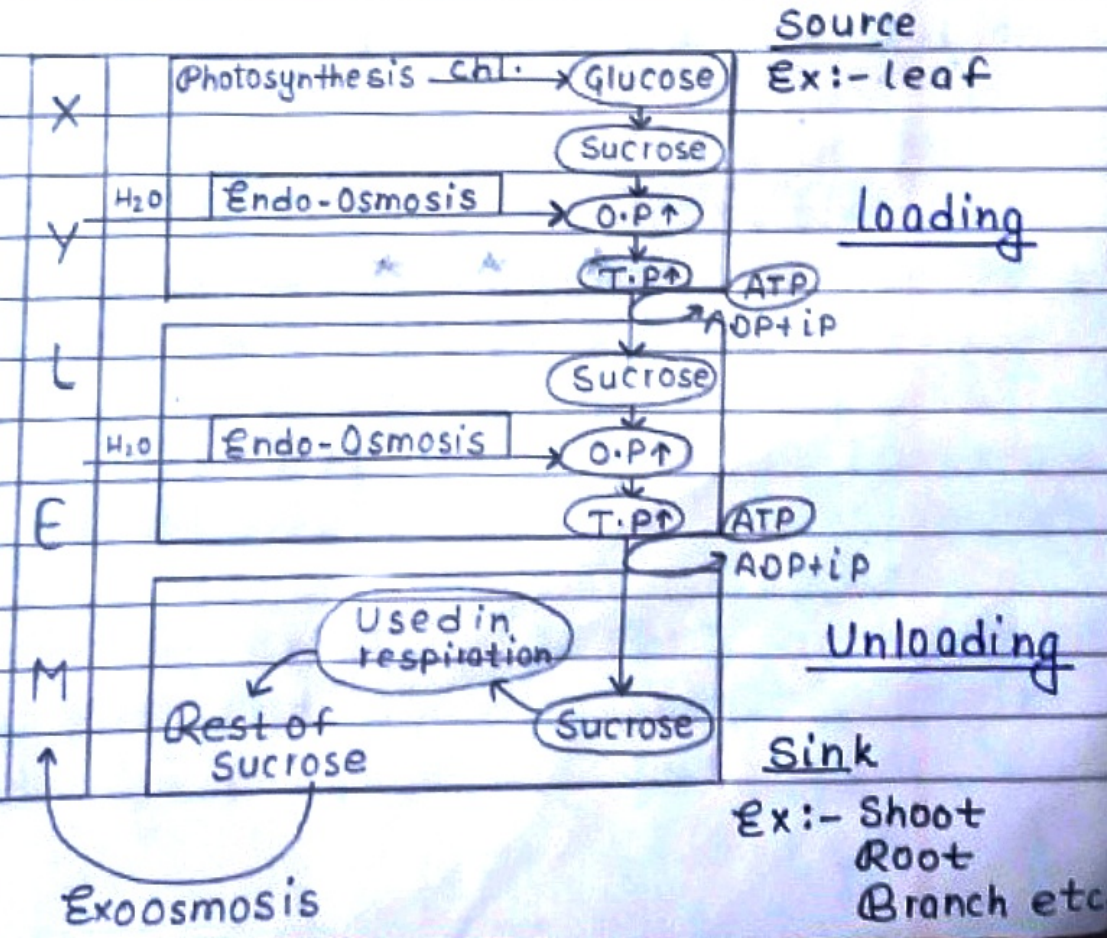
form of sucrose. since, sucrose is

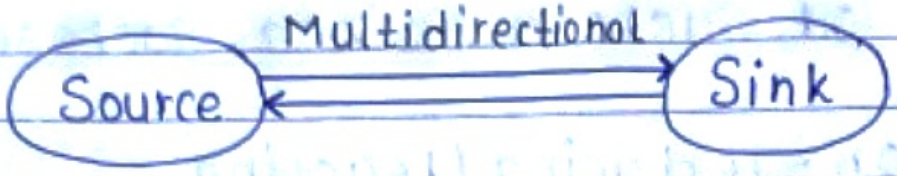
A. Non-reducing/reacting
B. Osmotically active
C. Chemically inactive sugar

- Translocation of food is active and Symplastic both.

- Glucose having different stages according to Situation —







Ex:- leaf
or
kitchen of plant

Ex :- Shoot
Root
Branch etc.

★ Girdling :-

→ Removal of Phloem from shoot System is Called Girdling.

→ Girdling causes Swollen of stem due to Stuck of food material. Ultimately plant will die.

★ ★ ★