Transport in Plants

Introduction

Plants need to move molecules over very long distances, much more than animals do; they also do not have a circulatory system in place. Water taken up by the roots has to reach all arts of the plant, up to the very tip of the growing stem. The photosynthates or food synthesised by the leaves have also to be moved to all parts including the root tips embedded deep inside the soil. Movement across short distances, say within the cell, across the membranes and from cell to cell within the tissue has also to take place.

In a flowering plant the substances that would need to be transported are water, mineral nutrients, organic nutrients and plant growth regulators. Over small distances substances move by diffusion and by cytoplasmic streaming supplemented by active transport. Transport over longer distances proceeds through the vascular system (the xylem and the phloem) and is called translocation.

Short Distance Transport

Diffusion:

"The movement of molecules or atoms or ions of a materials from an area of higher concentration to an area of their lower concentration is called diffusion."

Movement by diffusion is passive, and may be from one part of the cell to the other, or from cell to cell, or over short distances, say, from the inter- cellular spaces of the leaf to the outside.

No energy expenditure takes place. In diffusion, molecules move in a random fashion, the net result being substances moving from regions of higher concentration to regions of lower concentration.

Diffusion is a slow process and is not dependent on a 'living system'. Diffusion is obvious in gases and liquids, but diffusion in solids is more likely rather than of solids.

Diffusion is very important to plants since it is the only means for gaseous movement within the plant body.

Diffusion rates are affected by the gradient of concentration, the permeability of the membrane separating them, temperature and pressure.

- The diffusion is continue till the dynamic equilibrium is established. At this stage the net movement of molecule is equal in both direction.
- Diffusion of a substance is independent from the diffusion of other substances.

  Diffusion rate = **Gas > Liquid > Solid**

Factor	Rate of diffusion
Temperature ↑	Increase
Pressure ↑	Increase
Concentration difference ↑	Increase
Membrane	Depends on permeability

Significance of Diffusion:

- Exchange of gases like CO_2, O_2 take place through the diffusion.
- The distribution of hormones in the plants takes place through the diffusion.
- The process of transpiration is a diffusion process. The evaporation of water from the intercellular spaces is linked with diffusion during the transpiration.

Diffusion Pressure:

"The diffused molecules or ions exert a pressure on the substance or medium in which diffusion take place, known as Diffusion pressure."

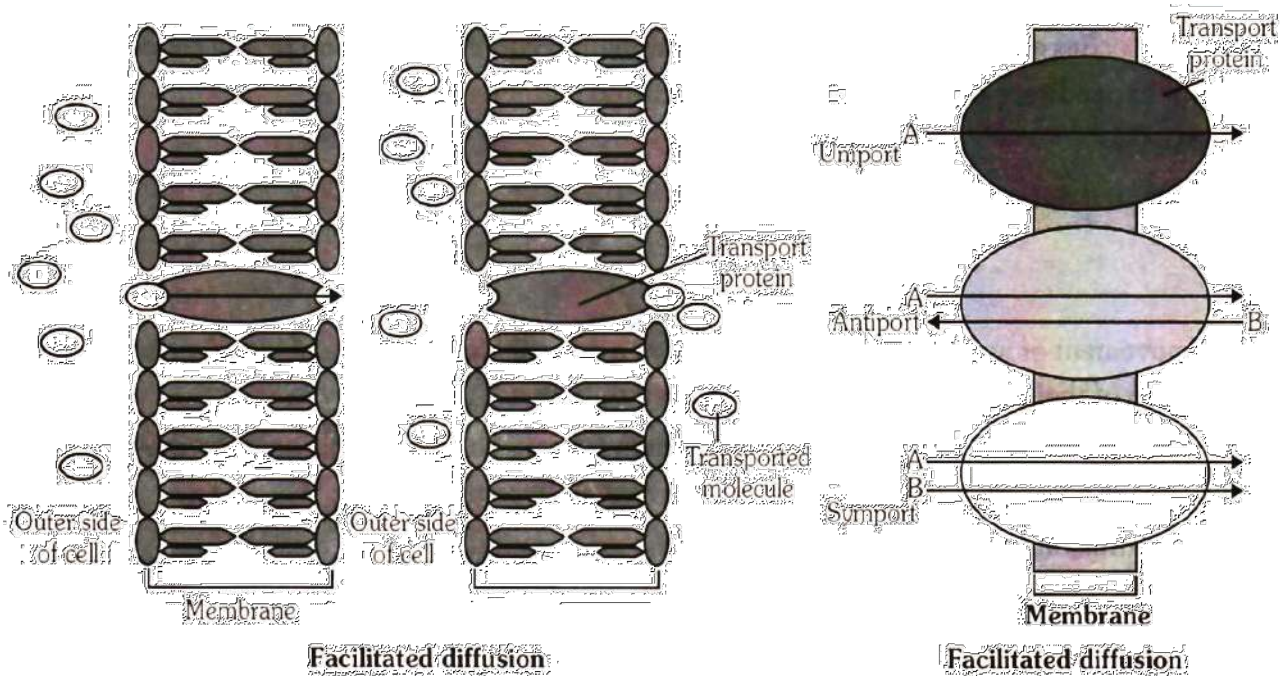
- This is developed due to difference in the concentration of molecules of the material. **Diffusion pressure of a pure solvent is always higher than its solution.**
- Water molecules move from their higher concentration to the their lower concentration in plants.
- The rate of diffusion decrease with increasing size of molecules.
- The speed and direction of movement of molecules of substances depends upon the concentration of the molecules.
- Due to the difference in the concentration of molecules, diffusion pressure results.
- The potential ability of a substance to diffuse from an area of its greater concentration to an area of less concentration, is called **diffusion pressure**.
- D.P. $\propto$ concentration of substance.

Facilitated Diffusion:

- Diffusion of any substance is depends upon solubility in main constituent of membrane, lipid. **Lipid soluble substance rapidly diffuse through membrane.**
- **Moiety of which substance is hydrophilic, diffused difficultly through membrane. So there is the need to simplify its movement. Membrane proteins provide space for transfer of these molecules. This process of diffusion with the help of membrane proteins is called facilitated diffusion.**
- **In facilitate diffusion, specific proteins helps in transfer of substances across the membrane and no ATP consume.** These specific proteins do not setup a concentration gradient, **a concentration gradient must already be present for molecules to diffuse even if facilitated by the proteins.**
- Extracellular molecules bind with transport proteins and later this **transport proteins release the molecules inside the cell by rotation movement.**
- **Transport rate reaches a maximum when all of the protein transporters are being used (saturation).**
- **Facilitated diffusion is very specific,** it allows cell to select substances for uptake. It is **sensitive to inhibitors which react with protein side chains.**

- The proteins form channels in the membrane for molecules to pass through. Some channels are always open, others can be controlled. Some are large, allowing a variety of molecules to cross.
- **The porins are proteins that form huge pores in the outer membranes of the plastids, mitochondria and some bacteria allowing molecules up to the size of small proteins to pass through.**

  Eg. Water channels made up of 8 different types of aquaporins.
- In **symport,** two molecules *move* across the membrane in similar direction, while in **antiport** they *move* in opposite directions. When a molecule *moves* freely across the membrane then this method is called **uniport.**



Active Transport:

- Active transport uses energy to pump molecules against a concentration gradient. Active transport is carried out by membrane proteins. Hence different proteins in the membrane play a major role in both active as well as passive transport.
- Pumps are proteins that use energy to carry substances across the cell membrane. These pumps can transport substances from a low concentration to a high concentration (‘uphill’ transport).
- Transport rate reaches a maximum when all the protein transporters are being used or are saturated. Like enzymes the carrier protein is very specific in what is carries across the membrane. These protein are sensitive to inhibitors that react with protein side chains.

Comparison of Different Transport Mechanisms

Property	Simple Diffusion	Facilitated Transport	Active Trans port
Requires special membrane proteins	No	Yes	Yes
Highly selective	No	Yes	Yes
Transport saturates	No	Yes	Yes
Uphill transport	No	No	Yes
Requires ATP energy	No	No	Yes
Hormonal control	No	Yes	Yes
Sensetive to inhibitors	No	Yes	Yes

Types of Solutions

(i) Isotonic Solution:

If solution in which a cell is placed, has equal osmotic concentration to that of cell sap, the outer solution is called **Isotonic Solution.**

(ii) Hypotonic Solution:

If the osmotic concentration of outer solution is lesser than that of the cell sap, the outer solution is called **hypotonic solution.** If a cell is placed in such solution **endosmosis** takes place, results, cell swells up.

(iii) Hypertonic Solution:

If the osmotic concentration of a solution is higher than that of the other (cell sap), solution is known as **hypertonic solution.**

- If a cell placed in this type of solution, **exosmosis** takes place. It means water of the cell sap diffused out into the outer solution, resulting cell become flaccid.

  e.g., Grapes placed in higher concentration of sugar solution becomes flaccid (contracts).

Osmosis:

"Osmosis is defined as the special diffusion of solvent (water in this context) from the solution of lower concentration to the solution of higher concentration when both the solutions are separated by a semipermeable membrane."

- Passing of **solvent** through the semipermeable membrane is the example of osmosis.
- The process of **osmosis is a special type of diffusion** of solvent molecules through semi-permeable membrane.
- The water moves into the cell during the osmosis is called **endosmosis.**

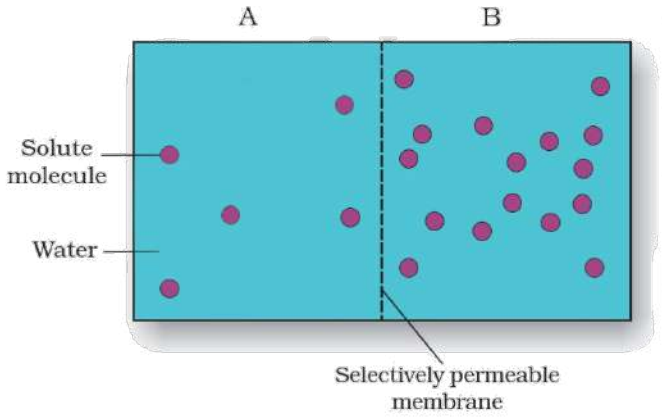
  Ex.: Grapes placed in water.
- When the water starts moving out of the cell then it is called **exosmosis.**

  Ex.: Grapes kept in salt solution.

(a) *Solution of which chamber has a lower water potential?* **Ans = B**

(b) *Solution of which chamber has a lower solute potential?* **Ans = B**

(c) *In which direction will osmosis occur?* **Ans = A to B**



(d) *Which solution has a higher solute potential?* **Ans = A**

(e) *At equilibrium which chamber will have lower water potential?* **Ans = None**

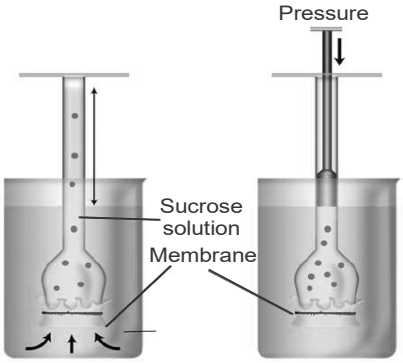
(f) *If one chamber has a Ψ of – 2000 kPa, and the other – 1000 kPa, which is the chamber that has the higher Ψ?* **Ans = –1000κPa**

(g) What will be the direction of the movement of water when two solutions with Ψ_w = 0.2 MPa and Ψ_w = 0.1 MPa are separated by a selectively permeable membrane?

Ans = 0.2 MPa to 0.1 MPa

Osmotic Pressure (OP)

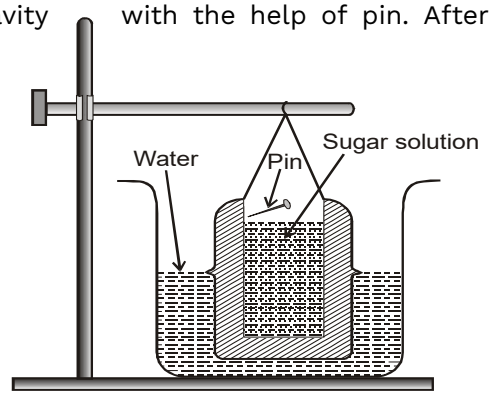
- **Osmotic pressure is the pressure developed in a solution when solution, and water are separated by semipermeable membrane (given by Pfeffer)**
  or "O.P. of solution is equal to pressure, which required to be applied on a solution in order to prevent an increase in it's volume due to tendency of solvent to enter in when the two are separated by a semipermeable membrane."
- The osmotic pressure of **pure water is zero. O.P. is due to presence of solute** into the solution.
- The osmotic pressure of solution is directly proportional to the **concentration of solute in** it.
- Osmotic pressure is **highest in leaves** and **lowest in roots.**
- The **highest osmotic pressure** is found in the **halophyte** group. *A triplex confortifolia* (202 atm)**.**
- The **lowest osmotic pressure** is found in aquatic plants or **hydrophytes.**
- **Hydrophytes < Mesophytes < Xerophytes < Halophytes.**
- Generally osmotic pressure is lesser during the night and higher at noon.
- Osmotic pressure of a solution is measured by **osmometer.**



A demonstration of osmosis. A thistle funnel is filled with sucrose solution and kept inverted in a beaker containing water. (a) Water will diffuse across the membrane (as shown by arrows) to raise the level of the solution in the funnel (b) Pressure can be applied as shown to stop the water movement into the funnel

Demonstration of Osmosis by Potato Osmoscope

Take a large sized potato tuber. Cut on side flat. Bore a cavity from the other side in such a way that only a thin base is left intact on the flat side. Also remove the skin near the edges of the flat end because the skin of the tuber is impermeable to water. Now place the cavity of the potato tuber by 10-20% sugar solution. Mark the level of sugar solution in the cavity with the help of pin. After some time the level of sugar solution rises in the cavity.



The rise in the level of sugar solution in the cavity of the potato tuber indicate that it has absorbed water from the petri dish. The two are separated from each other by a large number of cells.

The entry of water into sugar solution proves that

(i) Sugar solution is an osmotically active solution.

(ii) the cytoplasm of all the cells of the tuber that lie between the sugar solution and the water of petri dish act as a single semi-permeable membrane the phenomenon being known as osmosis.

- **Water moves from lower O.P. towards the higher O.P.**

  The formula of Vont Hoff for measuring O.P.:

  OP = mRT

  Here m = Molar concentration

  R = Gas constant [0.082 mole/molecules]

  T = Absolute temperature

  the osmotic pressure of 1 mole. glucose solution at 0ºC-

  OP $\Rightarrow$ 1 × 0.082 × 273 $\Rightarrow$ 22.4 atm., for non electrolytes.

  The **O.P. of electrolytes** is find out by the following formula-

  OP = iMRT

  Where I is the constant of ionisation of electrolytes.

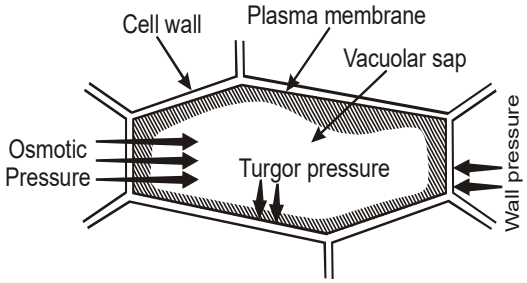
- The **osmotic pressure of electrolytes is h**igher than that of non electrolytes.
- For example - solution of 1 M NaCl and 1 M glucose. The molar concentration of both solutions are equal but **O.P. of 1 M NaCl is higher than solution of 1 M glucose.**

Turgor Pressure (TP):

"When a cell is immersed in water, then water enter into the cell because osmotic pressure of the cell sap is higher. The cell content press upon the wall or develop a pressure against the cell wall, which is called turgor pressure."

- Turgor pressure is **not applicable for free solution.** This is only applicable for osmotic system of a plant cell. Turgor pressure is also known **hydrostatic pressure.**

- The turgor pressure is counter balanced by an equal but opposite pressure of the thick cell wall on the enclosed solution or protoplasm is known as **wall pressure.** It means whatever the amount of pressure exerted is in inner side i.e. on the cytoplasm.



TURGOR PRESSURE

- Therefore, **wall pressure and turgor pressure are equal** to each other but W.P. is inward in direction.
- Plant cell does not burst, when placed in pure water due to wall pressure, but an animal cell bursts when placed in pure water because wall pressure is absent due to absence of cell wall.

  For example the consequence of endosmosis in animal cell can be demonstrated by placing RBCs of human blood in distilled water.
- A **flaccid cell has zero turgor pressure.**
- The **highest value of turgor pressure is found in fully turgid cell** and it is equal to the osmotic pressure. **Fully turgid cell has TP = OP**
- The value of **turgor pressure is normally from zero to in between the osmotic pressure** in plant cell.
- The value of **turgor pressure is assumed as negative (–ve) during the plasmolysis** of the cell.

Significance of TP:

- It **maintains the normal shaped of the cell**.
- Turgor pressure helps in **cell elongation or growth of cell.**

Diffusion Pressure Deficit (DPD) or Suction Pressure

DPD: The difference between the diffusion pressure of the solution and it's pure solvent at particular temperature and pressure is called DPD.

or The DPD of any solution is the difference between the diffusion pressure of the water, which is present in the solution and diffusion pressure of pure water.

- **DPD determines the direction of osmosis and it is the power of absorption of water for the cell (Suction Pressure)**
- This is also known as **demand of water in cell.**

  DPD α concentration of solute.

- The **diffusion of water** takes place from the **region of lower DPD to the region of higher DPD** in the process of osmosis.

  Lower $\xrightarrow[H_2O]{SPM}$ DPD Higher DPD

- Normally, **osmotic pressure is greater than the turgor pressure** in a cell. The difference between osmotic pressure and turgor pressure is called **suction pressure** or DPD.

  DPD = OP – TP

- The DPD of any **free solution** is equal to the osmotic pressure of that solution.

  DPD = OP

(i) DPD in Partialy Turgid or Normal Cell:

DPD = OP – TP

(ii) DPD for Fully Turgid Cell:

- When a cell is placed in pure water or hypotonic solution then water enter into the cell, results turgor pressure develop in the cell. The cell starts swelling due to the turgor pressure. Simultaneously, concentration of cell sap decreases due to continuous inflow of water. Therefore **OP is goes on decreasing** and **T.P. increase due** to this, when value of TP will be equal to the OP then DPD will be zero.

  At this stage cell becomes **fully turgid.** Therefore in a fully turgid cell.

  DPD = OP – TP

  When, OP = TP or OP – TP = O

  So that **DPD = O**

(iii) DPD in Flaccid Cell:

- If, the cell is in flaccid state then its T.P. or WP would be zero and value of DPD would be equal to O.P. TP or WP = O

  Therefore, **DPD or S.P. = OP**

- If a flaccid cell placed in water then waters enter into cell because DPD of the cell sap is higher.

(iv) DPD for Plasmolysed Cell:

- Sometimes the value of turgor pressure is negative as in plasmolysed cell. In this state

  DPD = OP – TP

  ∴ **[TP = – Ve]**

  DPD = OP – [– TP] = OP + TP

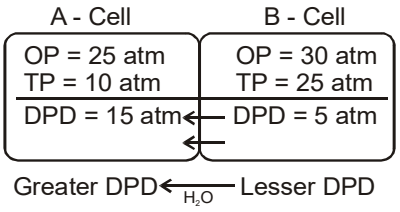
- So that the **DPD of the plasmolysed cell is greater than osmotic pressure.**

  It means - **DPD = OP + TP**

  Demand of water = **Plasmolysed cell > Flaccid cell > Partially turgid cell > Fully turgid cell**

- The **demand of water in plasmolysed cell is highest.**
- It means, when the osmotic pressure and turgor pressure will be equal, then the DPD will be zero. Water will not enter in this type of cell and **cell become fully turgid.**
- But, when turgor pressure is lesser than the osmotic pressure, in normal cell then some DPD will be definitely present in the cell and water would enters into the cell.

  For Ex.



Water Potential Or Ψ_W

"The difference between the free energy of molecules of pure water and free energy of the solution is called water potential of the system."

- Now a day according to concept of free energy and thermodynamics, DPD of a solution is also represented by **water potential.** (Given by **Taylor** and **Slatyer**)
- The **water potential of pure water is maximum** the pure water has greater free energy. The **free energy, lower down by addition of solute.**
- **Water always flows from higher water potential to lower water potential.**
- Water potential is represented by Greek word Ψ (Psi)/ Ψ_W and it is measured in **bars** or **Pascal (Pa).** Water potential is equal to **DPD,** but opposite in sign. Its value is **negative.**

  $\Psi_W = \Psi_S + \Psi_P$

  So, $\boxed{\psi_W = -\text{DPD}}$ Ψ_S = Solute potential = – O.P.

  Ψ_P = Pressure potential = T.P.
- Water potential has following components:

1. **Osmostic Potential (Ψ_s):**
   - Osmotic potential or solute potential represents the concentration of the solutes. Water potential (Ψ_W) is negative in the presence of solutes because of negative value of osmotic potential when other factors are constant.
   - More is the solute, less (more –ve) is the solute potential.
   - Ψ_S = Solute potential = – O.P.
   - OP = 22.4 atm $\Rightarrow$ osmotic potential = –22.4 atm. (1 M glucose solution)
2. **Pressure potential (Ψ_P):**
   - Turgor pressure is known as **pressure potential** in a plant cell.

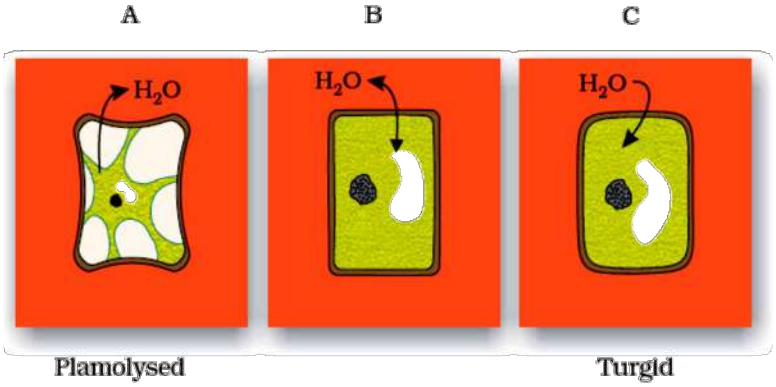
- Ψ_P = Pressure potential = T.P.
- 1 atmospheric pressure is neglected. In an open system Ψ_P is equal to artificially applied pressure.

  Conclusion: As Ψ_m and Ψ_g (Matric potential and gravitational potential) are negligible

Plasmolysis

"If a plant cell placed in a hypertonic solution, water molecules diffused out from the cell. As a result of exosmosis, the protoplasm of the cell detached from the cell and starts shrinking. This is called plasmolysis.

Water is first lost from cytoplasm and then from vacuole.



Imbibition

Adsorption of undissolved liquid by any solid material is called imbibition or adsorption of water by hydrophilic colloids is known as imbibition.

- This is a physical process by which a dry solid colloid material swells up by adsorption of water.
- The cell wall is made up of colloidal substance as cellulose, pectin, hemicellulose etc. All they are hydrophilic in nature. Therefore they imbibe water.
- Proteins, Agar - agar, starch etc, these are all imbibant **materials**.

  Agar - agar can adsorbs 99 times more water than that of its weight. Some of the proteins adsorb 15 times more water.

  Imbibition power = Agar – Agar > Pectin > Protein > Starch > Cellulose

  Affinity must be between imbibant and liquid material and movement of water occurs in order of water potenti al gradient.
- The heat released during the **imbibition** is called **heat of wetting.**
- A huge pressure is developed in material due to imbibition. This pressure is called **Imbibition pressure (IP).**
- The imbibition is less in compact arranged material like wood, and more in lighter or soft material like gelatin.

Significance of Imbibition:

- Swelling of dry seeds and wood.
- **Absorption of water** during due the seed germination is only initiate through the imbibition.
- **Breaking of seed coat** during the seed germination is due to imbibition process. Proteins, fats and starch is present in the kernel. This kernel swells up more as compared to the seed coat which breaks the seed coat.
- Initial process of water absorption in roots by root hairs is imbibitions.
- Resurrection in many plants like Selaginella, Lichen take place due to the process of imbibition.
- Dry wood is filled in the natural grooves of rocks and watered them. The rocks are broken due to their swelling.

Movement of water molecules:

Higher D.P. $\longrightarrow$ Lower D.P.

Lower O.P. $\longrightarrow$ Higher O.P.

Lower DPD $\longrightarrow$ Higher DPD

Higher (less –ve) Ψ_w $\longrightarrow$ Lower (more –ve) Ψ_w

Higher T.P. $\longrightarrow$ Lower T.P.

Hypotonic $\longrightarrow$ Hypertonic

Lower conc. of solution $\longrightarrow$ Higher conc. of solution.

Concept Builder

1. Which of the following is not dependent on a living system ?

(1) Diffusion (2) Facilitated diffusion

(3) Osmosis (4) Both (2) and (3)

2. Which of following is correct statement:

(1) Facilitated transport and active transport both are highly selective

(2) Facilitated transport and simple diffusion both do not requires ATP energy

(3) Facilitated and active transport both are highly selective

(4) All the above

3. Symport transport is movement of:

(1) Two molecules in the same direction

(2) One molecules independently

(3) Two molecules in the opposite directions

(4) All the above

4. Diffusion process is:

(1) Active (2) Passive (3) Active & Passive (4) All the above

5. Antiport transports are:
(1) Two molecules move in the opposite direction
(2) Two molecules move in the same direction
(3) Unidirectional movement
(4) Two molecules move in the same direction independently

6. Active transport is:
(1) Requires special membrane protein (2) Highly selective
(3) Requires ATP energy (4) All the above

7. Water potential are:
(1) $\Psi w = \Psi s + \Psi p$ (2) $\Psi w = \Psi s - \Psi p$ (3) $\Psi w = \Psi s$ (4) All

8. For a solution at atmospheric pressure
(1) $\Psi w = 0$ (2) $\Psi w = \Psi s$ (3) $\Psi s = 0$ (4) None of above

9. Wooden pieces generally swell up in rainy season due to:
(1) Diffusion (2) Osmosis (3) Imbibition (4) Wilting

Concept Builder (Answer-Key)									
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Ans.	1	4	1	2	1	4	1	2	3

Transpiration

Introduction:

- Though large quantities of water is absorbed by the roots from soil, but only 2-5% of it is utilized by plant and rest 95-98% is lost in form of **transpiration**.
- Definition:- The loss of water from the aerial parts of plant in the form of vapours is **called transpiration**.
- The instrument used for measuring transpiration is **potometer**.
- **"Transpiration is an essential evil" - by Crutis.**
- The minimum transpiration is found in succulent xerophytes and no transpiration in submerged hydrophytes.
- **Maximum transpiration is found in mesophytes.**

Significance of Transpiration:

[1] In Regulation of Temperature:

- **Cooling effect** on the surface of leaves is produced by the process of transpiration, due to which temperature remains constant in plants.
- The plant are protected from the burning of heat due to transpiration. Evaporation of water produces cooling effect.

[2] In Mineral Absorption:

- Mass flow of water is found during the passive absorption of water also helps in uptake of some minerals.

[3] In Ascent of Sap (Rise of Water)

[4] In Water Absorption

Types of Transpiration:

(A) Stomatal Transpiration:

- Loss of water through **stomata** (small opening on the epidermis of leaves).
- **50** to **90%** of total transpiration occurs through **stomata**.
- The water lost from leaves is called **foliar transpiration.**

(B) Cuticular Transpiration:

- **9** to **9.9%** of total transpiration occurs from **surface**, outer wall of epidermis of aerial parts.
- The outer wall has cuticle which affects diffusion of water. It is inversely proportional to thickness of cuticle & amount of water.

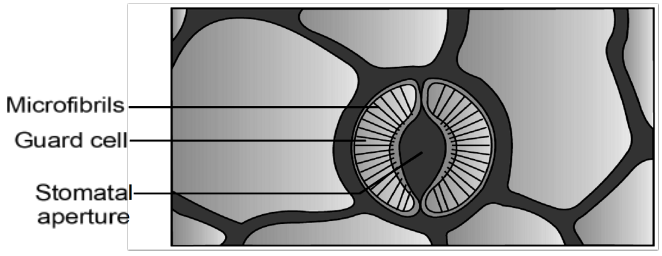
(C) Lenticular Transpiration:

- Loss of water through **lenticels** (pores found in epidermis of mature stems, some roots & some fruits)
- It results in **0.1 to 1%** of water loss out of total transpiration.

Stomata

- Stomata cover 1-2% of leaf area.
- Algae, fungi and submerged plants do **not possess stomata**.

Structure of Stomata:



A stomatal aperture with guard cells

- Stomata are small **elliptical pores** found on the epidermis of plant leaves and herbaceous stem.
- This pore is surrounded by epidermal cells called **guard cells**.
- Guard cells are bean shaped in dicots and dumbell shaped in monocots.
- Guard cells are living & have nucleus, chloroplast, vacuole and cytoplasm.
- Inner wall is thick & less elastic and outer wall is thin & more elastic in guard cells.
- Guard cells are surrounded by specialized epidermal cells called **subsidiary** or **accessory cells**.
- The pore opens or closes by the movement of guard cells.
- Radially arranged cellulose microfibrils are present between inner and outer wall (radial micellation).
- The air cavities to which the stomata opens are called as **substomatal cavity.**

Mechanism of Transpiration

This Involves 3 Steps:

Osmotic Diffusion of Water in The Leaf:

- Inside the leaf mesophyll cells are in contact with xylem & also with inter cellular spaces above the stomata.
- Mesophyll cells draw water from the xylem which makes the cells turgid. Their diffusion pressure deficit and osmotic pressure decreases and in turn they release water in the form of vapours in intercellular spaces close to stomata by diffusion.
- After releasing water the O.P. & D.P.D. of mesophyll cells increases & hence they draw water from xylem again.

Opening & Closing of Stomata:

- When guard cells becomes **turgid** stomatal pore **opens**, while when they becomes **flaccid** stomatal pore **closes**.
- Stomata generally open during the day and closed during the night except in CAM plants.

Active K^+ H^+ exchange theory or active proton pump mechanism -

- Given by **Levitt (1973-74)**.

  (i) Cabohydrates PEP + CO_2 OAA

  (ii) O.A.A. $\longrightarrow$ Malic Acid

  (iii) Malate + $K^+ \longrightarrow$ K-malate $\longrightarrow$ Conc. of GC increased

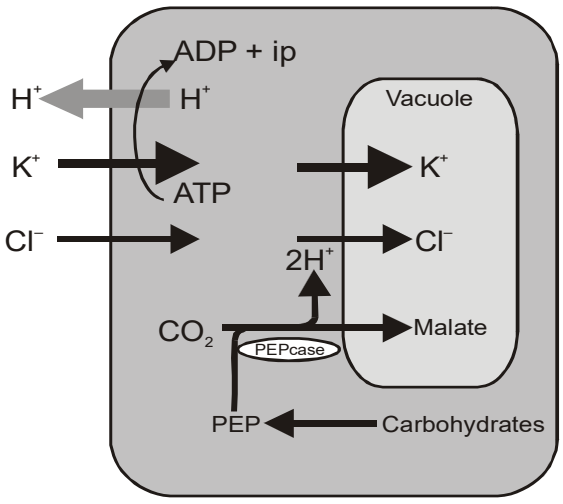


Fig. Role of potassium, chloride and malate ions in stomatal opening. The ions accumulate in the vacuole of guard cells, lowering the water potential and thereby increasing water uptake and subsequently opening the stomata (PEPcase = Phosphoenol pyruvate carboxylase)

Entry of H_2O in GC $\rightarrow$ **GC turgid** $\rightarrow$ **Stomata open**

- **Closing of Stomata:** Plant hormone ABA-acts on guard cells, which interfere the exchange of K^+ H^+ ions in gurad cells, results in reverse of rxn. of opening of stomata, hence stomata closed. pH of guard cells is decrease during night, which favours stomatal closing.
- High concentration of K^+ ions in guard cells is electrically balanced by uptake of Cl^- and malate ions in guard cells.

  Note: Stomata opens during the night in succulent plants and closed during the day. This nature of stomata in opuntia is called **Scotoactive stomata.**
- In CAM plants organic acid is formed during night which broken down during day and CO_2 is liberated which is used in photosynthesis.

Transpiration and Photosynthesis – A Compromise

Transpiration has more than one purpose; it

- Creates transpiration pull for absorption and transport of plants
- Supplies water for photosynthesis
- Transports minerals from the soil to all parts of the plant
- Cools leaf surfaces, sometimes 10 to 15 degrees, by evaporative cooling
- Maintains the shape and structure of the plants by keeping cells turgid
- An actively photosynthesising plant has an insatiable need for water.
- Photosynthesis is limited by available water which can be swiftly depleted by transpiration. The humidity of rainforests is largely due to this vast cycling of water from root to leaf to atmosphere and back to the soil.
- The evolution of the C_4 photosynthetic system is probably one of the strategies for maximising the availability of CO_2 while minimising water loss. C_4 plants are twice as efficient as C_3 plants in terms of fixing carbon (making sugar). However, a C_4 plant loses only half as much water as a C_3 plant for the same amount of CO_2 fixed.

Factors Affecting the Rate of Transpiration

Factors affecting the rate of transpiration are divided into two types:

[A] External Factors (Environmental Factor) :

[1] Atmospheric Humidity: $T_r \propto \frac{1}{\text{Relative humidity}}$

This is the most important factor. The rate of transpiration is higher in low atmospheric humidity while at higher atmospheric humidity, the atmosphere is moistened, resulting decreasing of rate of transpiration.

- Therefore, the rate of transpiration is high during the summer and low in rainy season.

[2] Temperature: $\boxed{T_r \propto \text{Temperature}}$

- The value of Q_{10} for transpiration is 2. It means by increasing 10ºC temperature, the rate of transpiration is approximately double. (By Loftfield)
- Water vapour holding capacity of air increased at high temperature, resulting the rate of transpiration increased.
- On contrary vapour holding capacity of air decreased at low temperature so that the rate of transpiration is decreased.

[3] Light:

- Light stimulates, transpiration by heating effect on leaf.
- **Action spectrum** of transpiration is **blue** and **red.**
- Rate of transpiration is **faster in blue light** than that of red light. Because stomata are completely opened as their full capacity in the blue light.

[4] Wind Velocity: $T_r \propto$ Wind velocity

Transpiration is less in constant air but if wind velocity is high the rate of transpiration is also high, because wind removes humid air (saturated air) around the stomata.

- Transpiration increases in the beginning at high wind velocity [30-50 km./hour] But latter on it cause closure of stomata due to mechanical effect and transpiration decrease.

[5] Atmospheric Pressure:

- The speed of the air increase at low atmospheric pressure, due to this rate of the diffusion increase which increase the rate of transpiration.
- The rate of transpiration is found maximum in the high intensity of light at high range of hills.

[6] Anti Transpirants:

- Chemical substances which reduce the rate of transpiration are known as **antitranspirants.** Anti transpirants are as follows-
- **Phenyl Mercuric Acetate (PMA), Abscisic acid (ABA), Silicon oil, CO_2 and low viscous was.**
- PMA closed the stomata for more than two weeks partially.
- Anti transpirants are used in dry farming.

[B] Internal Factors:

- These factors are concerned with structure of plants. These are following types:

[1] Transpiration Area:

Pruning increase the rate of transpiration per leaf but overall reduce the transpiration.

[2] Anatomical Characteristics of Leaf and Leaf Orientation:

Several structures of leaf effect the transpiration as follows:-

Stomatal Characteristics:

Transpiration is effected by the structure of stomata, position of stomata, distance between the stomata, number of stomata per unit area and activity of the stomata.

[3] Water status of leaves

[4] Canopy structure

Note: **(1) Cobalt-chloride test:** This method is used for the comparision of transpiration at both the surface of the leaves. (Blue + Moisture = Pink)

Special Point :

- **Porometer** is used for measuring the size of stomata.
- **Manometer** is used for measuring root pressure the size of stomata.
- **Potometer** is used for measuring the rate of transpiration.

Concept Builder

1. Water loss in liquid form margin of leaves is called:

(1) Guttation (2) Osmosis

(3) Transpiration (4) Bleeding

2. Select the correct statement:

(1) Cohesion – Attraction between H_2O molecules

(2) Adhesion – Attraction of H_2O to polar surface

(3) Surface tension – H_2O molecules are attracted to each-other in the liquid phase

(4) All the above

3. Purpose of transpiration

(1) Supplies water for photosynthesis

(2) Transport minerals from the soil

(3) Cool the leaf surface

(4) All the above

4. Guard cells are surrounded by:

(1) Cuticle (2) Epidermis

(3) Subsidiary cell (4) Periderm

5. Guard cells regulate:

(1) Respiration (2) Photosynthesis (3) Transpiration (4) Food transport

6. Mostly transpiration occurs through:

(1) Stomata (2) Lenticel (3) Cuticle (4) Stem

7. Stomata opening is under the control of:

(1) Epidermis cell (2) Subsidiary cell

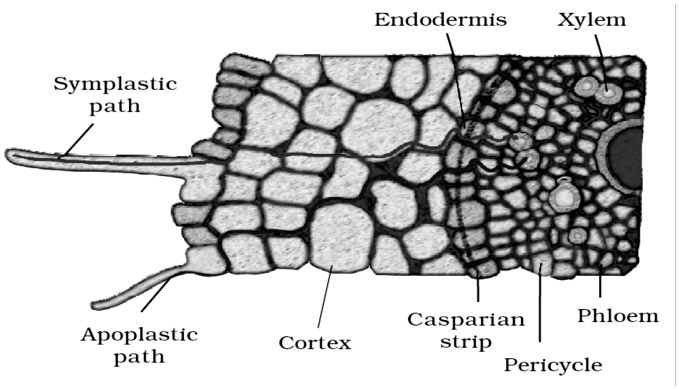
(3) Guard cell (4) Endodermis

Concept Builder (Answer-Key)							
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Ans.	1	4	4	3	3	1	3

Path of Movement of Water

- Water present in soil must reach the xylem of roots. Root hair is in contact with soil water. Their cell wall is thin & water easily diffuses in.
- From root hairs water reaches epidermis & from their to cortex made of parenchymatous cells.
- From innermost layer of cortex water enters in endodermis consisting of thin walled **passage cells** found against each protoxylem.
- In last, water reaches to xylem passing through **thin** walled **pericycle**.

  In Short: Soil water → Root hair → Epiblema → Cortex → endodermis (passage cells) → Pericycle → Protoxylem → Metaxylem



Symplastic and Apoplastic Pathways of Water and Ion Absorption and Movement in Roots

Apoplastic and Symplastic Path of Water Movement:

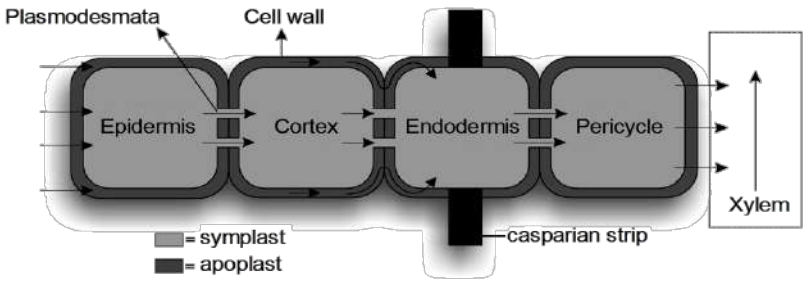
- Term **"Apoplast"** & **"Symplast"** given by **Munch**

  (A) Symplast:

  A substainable **living path** is known as symplast. This is the living passage. The movement of water from cell to cell through plasmodesmata is called **symplastic path** in plant. This movement of water through cell membrane is also called as **transmembrane pathway.**

  (B) Apoplast:

  This is the **non living path** in plants. Watered cell wall, intercellular space and xylem cavity associate together to form apoplast.



Pathway of water movement in the root

- The path of water from root hair to cortex, may be apoplastic or symplastic. In **endodermis** subarised **casparian strips** blocks the apoplast, thus water must passes through passage cell via symplast.

Mechanism of Water Absorption:

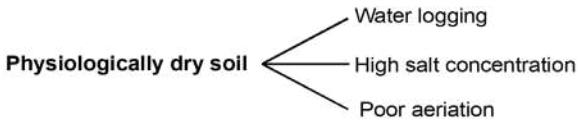
- Term active & passive absorption was proposed by **Ranner.**
- Water is absorbed by two different ways-
  - **(1) Active Absorption of Water** → According to this method water is absorbed due to the osmotic acitivity of roots or by indirect expenditure of ATPs. Active absorption of minerals increases OP of roots due to which water enters into roots.
  - **(2) Passive Water Absorption** → It is supported by transpiration pull. Most amount of water absorption occurs by this process.

Factors Affecting Water Absorption:

[1] Available Soil Water:

[2] Transpiration:

- The rate of water absorption is directly proportional to the rate of transpiration. The rate of absorption increases due to increase in the transpiration. Because passive water absorption increases due to transpiration.



Ascent of Sap (Water Rise)

It is upward movement of water and minerals and small amount of organic compounds to top parts of plants.

(A) Path of Ascent of Sap:

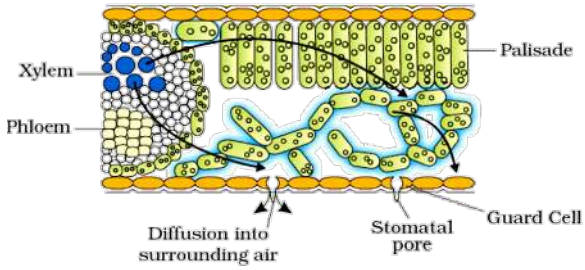
- The path of ascent of sap is **xylem**.
- Experiment on Balsam plant by using eosin dye proved that xylem is path of ascent of sap.

Mechanism of Ascent of Sap

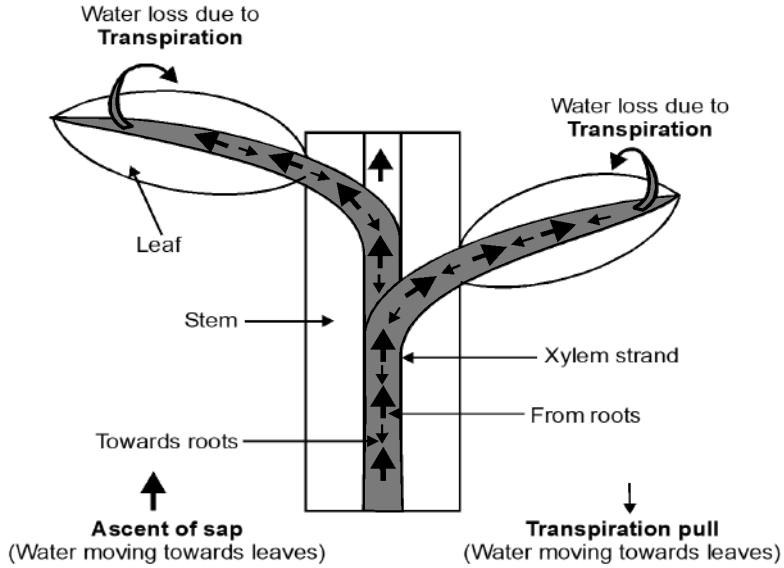
(A) Transpiration Pull-Cohesion Adhesion Force Theory:

- This theory was proposed by **Dixon** and **Jolly** (1894).
- **Most accepted** accepted theory of ascent of sap. According to it three components are involved in ascent of sap.
  - **(a) Cohesion:** Mutual **attraction between the water molecule** is called **cohesion force,** which helps in forming water Colum in xylem elements.
  - **(b) Adhesion: Attraction between xylem walls and water molecules** is called **adhesion force,** which helps in maintenance of water column of xylem.

(c) Transpiration Pull: A tension or negative pressure develops in xylem due to rapid transpiration in leaves (because of high DPD), this creates a transpiration pull, which is responsible for the pulling up of water column in xylem. So ascent of sap is constitutive effect of cohesion, adhesion and transpiration pull.



Water movement in the leaf. Evaporation from the leaf sets up a pressure gradient between the outside air and the air spaces of the leaf. The gradient is transmitted into the photosynthetic cells and on the water-filled xylem in the leaf vein.



Transpiration pull (tension) and ascent of sap

(B) Root Pressure:

- Root pressure is the **positive hydrostatic pressure** which develops due to turgidity of cortical cells of root which excert pressure on the xylem sap of roots due to accumulation of water absorbed by roots, during night.
- Root pressure is developed when **rate of osmotic active water absorption is more than the rate of transpiration** and due to which water is pushed up in tracheary elements of roots.
- When a plant is cut near the base, the oozing of the liquid from the cut end is called **bleeding or exudation**. It is indicative of root pressure.
- The **maximum value** of root pressure can be upto **2 atm.**
- Its maximum value is found in plants growing in well aerated, well watered soil under and moist environment.
- Guttation is also the **result of root pressure**.

- Root pressure is high under favourable conditions (rains and spring). At this time **transpiration** rate is comparatively **low**. **In summers**, when there is greatest need for water, **root pressure is lacking**.
- Thus root pressure is not important in most plants. It may be effective in herbaceous plants which transpire slowly, during night.
- It helps in preventing breaking of water column in xylem.

Guttation

Loss of water from the margin of leaves of the herbaceous plant in the form of water droplets through hydathodes is called as guttation.

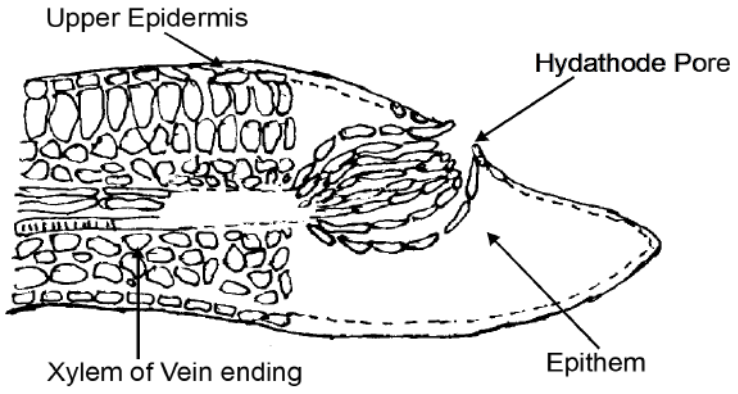


Fig.: Hydrathode

- Exuded liquid of guttation along with water contains some **organic and inorganic (dissolved)** substances. It means it is not pure water.
- Normally, guttation process is found in herbaceous plants like **Grasses, Tomatos** and in some of the plants of **Cucurbitaceae** family.
- Guttation occurs from the margins of the leaves through the special pore (always open) like structure are called **hydathodes** or **water stomata.**
- Generally guttation occurs during mid night or early morning.
- Parenchymatous and loose tissue are lie beneath the hydathode, which are known as **epithem** or **transfer tissues.**
- The process of guttation take place due to **root pressure,** develope in cortex cells of root.

Bleeding

Fast flowing of liquid from the injured or cut parts of the plants is called bleeding or exudation.

- This process takes place due to high **root pressure.**
- Sugar is obtained from the sugar mapple by this process.
- The highest bleeding is found in ***Caryota urens*** (Toddy palm) (about 50 liter per day)
- Bleeding is important in economic biology, because **Opium, latex of rubber** is obtained by this.

Concept Builder

1. Find out the correct match :

(a) DPD - Responsible for entry of water in side the cell

(b) Turgor pressure - Applicable for free solution

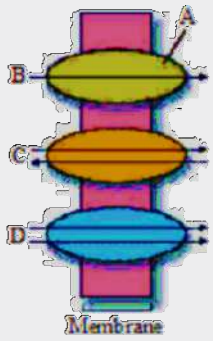
(c) Solute potential - Decrease with increase in solute concentration

(d) Solute potential - Always negative value

(1) Only a, b and c are correct (2) Only a and b are correct

(3) Only a and c are correct (4) Only a, c & d are correct

2. Identify the parts labelled as A, B, C & D in the diagram



(1) A - Carrier protein, B - Uniport, C - Symport D - Antiport

(2) A - Pump B - Symport, C - Antiport D - Uniport

(3) A - Pump B - Antiport, C - Uniport D - Symport

(4) A - Carrier protein B - Uniport, C - Antiport D - Symport

3. When the stomata are opening ; we observe following changes in the guard cells ?

(1) OP increase, TP decreases (2) OP & TP increases

(3) OP decreases, TP increases (4) OP & TP decreases

4. The primary difference between the apoplast and the symplast is that the :

(I) Apoplast is non- living path (2) Apoplast relies on active transport

(3) Symplast is non-living path (4) Apoplast prevents passive diffusion.

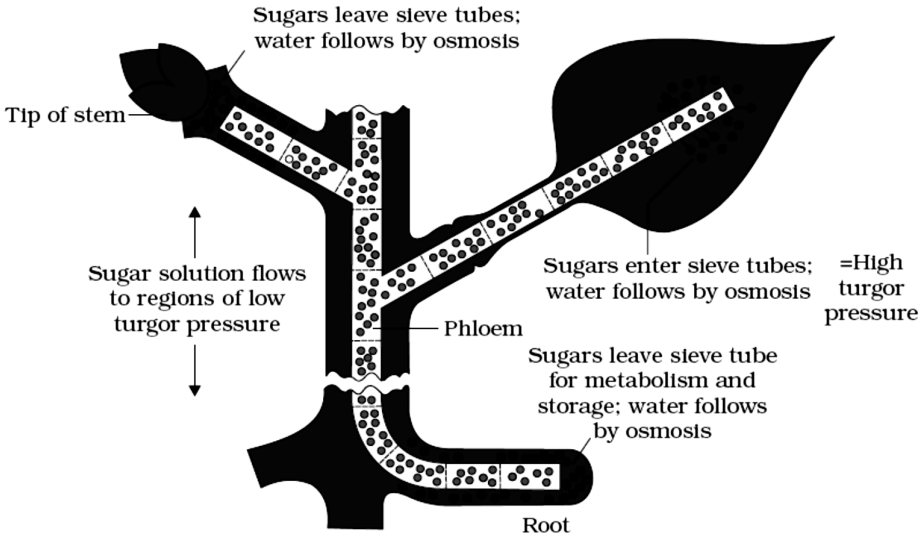
5. Which of the following is not diffusion :-

(1) Imbibition (2) Osmosis (3) Uphill transport (4) Passive transport

Concept Builder (Answer-Key)					
Que.	**1**	**2**	**3**	**4**	**5**
Ans.	4	4	3	1	3

Food Translocation in Plants

- Food/organic material conduction in plants mainly occurs by phloem. (Proved by Girdling experiment).
- Food conduction occurs in between source and sink. Source is net exporter while sink is net importer.
- Generally green photosynthetic plant parts acts as **source** like leaves while non photosynthetic parts like root, shoot, fruits acts as **sink**.
- Food conduction may be in any required direction or **bidirectional** unlike the water conduction which is a unidirectional process.
- Translocation of food mainly occurs in the form of **sucrose** or it is non-reducing sugar and chemically inert in it's pathway of conduction.
- **Pressure Flow/Mass Flow Hypothesis of Food/Sucrose Translocation - Given by E. Munch (1930).**
  This is the most accepted theory of food conduction in plants.
  According to it food translocation occur in between source and sink in order of turgor pressure gradient i.e., high T.P. to low T.P.
- **Phloem Loading/Sucrose Loading at Source** $\rightarrow$ It is an active process occurs with expenditure of ATP and helped by carrier molecules. At source due to phloem loading concentration of sieve cells increase, results in increase in osmotic pressure and water will moves from nearby xylem into sieve cells results in **increase in turgor pressure** (T.P.) and increase in water potential (Ψ_W). It establish a higher T.P at source end in sieve tubes. Sucrose moves from source in sieve tube towards sink from high T.P./ High $\psi\omega$ to towards the low T.P./low Ψ_W.
- **Phloem Unloading/Sucrose Unloading at Sink** $\rightarrow$ It is also active process occurs with expenditure of ATP and helped by carrier molecules. At sink sucrose is unloaded results in decrease in osmotic pressure (O.P.), it results in exit of water into near by xylem leads to decrease in Turgor pressure (T.P.) and water potential (Ψ_W) of phloem. In sink cells the unloaded sucrose is either changed into starch (as starch not change O.P.) or consumed, to maintain low O.P. and continuous unloading .
- The translocation of food between source and sink end through phloem is **passive process** as occurs in order of T.P. or Ψ_W gradient.
- So, the process of sucrose loading at source and unloading at sink continues. This turgor pressure difference will maintained and water will continue to move in at source and out at sink.



Diagrammatic presentation of mechanism of translocation

Concept Builder

1. Food transport occurs through:

(1) Xylem (2) Phloem (3) Cortex (4) Xylem and phloem

2. Food transport process is:

(1) Unidirectional (2) Bidirectional (3) Multidirectional (4) Undirectional

3. Transport of food in phloem from:

(1) High T.P. to Low T.P. (2) Low T.P. to High T.P.

(3) High DPD to Low DPD (4) All of the above

4. Translocation of food takes place in the form of:

(1) Non-reducing sugar (2) Starch

(3) Reducing sugar (4) Monosaccharides

5. Phloem loading and phloem unloading process is respectively:

(1) Active process, Passive process (2) Passive process, Active process

(3) Active process, Active process (4) Passive process, Passive process

Concept Builder (Answer-Key)					
Que.	**1**	**2**	**3**	**4**	**5**
Ans.	2	2	1	1	3

Exercise - I

Diffusion, Osmosis & Related Terms

1. The physical process involved in the release of molecular oxygen from leaves is: -

(1) Diffusion (2) Transpiration

(3) Osmosis (4) Capillarity

2. One molar solution of which substance will have maximum O.P: -

(1) NaCl (2) Glucose

(3) Fructose (4) Starch

3. The movement of molecules from their higher concentration to lower concentration is called-

(1) Active transport

(2) Diffusion

(3) DPD

(4) Turgor pressure

4. Osmosis is the diffusion of a solution of a weaker concentration when both are separated by semi-permeable membrane. What is error in the statement?

(1) The movement of solvent molecule is not specified

(2) There is no mention of DPD

(3) Behavior of semipermeable membrane is not specified

(4) The exact concentration of solutions are not indicated

5. What statement can be cited for 10% sodium chloride solution and 10% sugar solution present?

(1) Both have equal OP

(2) The concentration of sodium chloride solution will be less than concentration of sugar solution

(3) The OP of sugar solution will be higher than OP of sodium chloride solution

(4) DPD of sodium chloride solution will be higher than DPD of sugar solution

6. If a plant cell is immersed in water, the water continues to enter the plant: -

(1) Concentration of the salts is the same inside the cells as outside

(2) Cell bursts

(3) Concentration of water is the same inside the cell as out side

(4) Diffusion pressure deficit is the same inside the cell as out side

7. If a cell swells, after being placed in solution, the solution is: -

(1) Neutral (2) Hypotonic

(3) Hypertonic (4) Isotonic

8. Osmosis means: -

(1) Solute from low concentration to higher through SPM

(2) Solute from higher concentration to low through SPM

(3) Solvent from low concentration of solution to higher conc. of solution through SPM

(4) Solvent from higher concentration solution to low concentration solution through SPM

9. If cell is reduced in size (shrinks) of placing in a solution of sugar, the solution is: -

(1) Hypertonic (2) Hypotonic

(3) Isotonic (4) None of the above

10. A cell placed in a strong salt solution will shrink because: -

(1) They cytoplasm will be decomposed

(2) Mineral salts will break the cell wall

(3) Salt will enter the cell

(4) Water will move out the cell by exosomosis

11. Grapes placed in salt solution shrink due to:

(1) Imbibition (2) Endosmosis

(3) Exosmosis (4) Osmosis

12. Process of selective transmission of a solvent through semi / selectively permeable membrane is called:-

(1) Diffusion

(2) Osmosis

(3) Plasmolysis

(4) Transmission

13. Water enters into the root hair from the soil in its normal condition because the osmotic pressure of the soil solution:-

(1) Remains lesser than that of root hair sap

(2) Remains equal to that of root hair sap

(3) Remains higher than that of root hair sap

(4) Root hair sap remains zero

14. Which helps in maintaining the form and structure of cells & soft parts of plants ?

(1) Osmotic pressure

(2) Turgor pressure

(3) Atmospheric

(4) DPD

15. Plasma membrane controls:

(1) Passage of water only

(2) Passage of water and solutes in and out of the cell

(3) Passage of water and solutes into the cell only

(4) Movement of cell contents out the cell only

16. When a plant cell is placed in a hypotonic solution, which of the following will not apply?

(1) Wall pressure is decreased

(2) The cell becomes turgid

(3) Suction pressure of the cell sap will decrease

(4) Water potential of the cell sap will increase

17. Osmotic pressure is highest in: -

(1) Xerophytes (2) Hydrophytes

(3) Halophytes (4) Mesophytes

18. If osmotic potential of a cell is – 10 bars and its pressure potential is 5 bars, its water potential would be:-

(1) – 5 bars (2) 5 bars

(3) – 10 bars (4) 10 bars

19. Osmosis means: -
(1) Movement of molecules from higher concentration to lower concentration
(2) Uptake of mineral by roots
(3) Passage of solvent from a weaker solution to stronger solution across a semipermeable membrane
(4) Passage of solute from a weaker to a stronger solution separated by a membrane

20. Tonoplast is: -
(1) Permeable membrane
(2) Semi permeable membrane
(3) Impermeable membrane
(4) Selectively permeable membrane

21. Osmosis is the phenomenon expressed by:-
(1) Solutes present in the solution
(2) Solution
(3) Semi-permeable membrane
(4) O_2

22. Maximum osmotic pressure is found in: -
(1) Root hair
(2) Cortex cell of the root
(3) Passage cell of the root
(4) Mesophyll cell

23. The osmotic pressure is due to: -
(1) Solute
(2) Semi permeable membrane
(3) Hypertonic solution
(4) Water

DPD (SP)

24. When a cell is fully turgid which of the following will be zero ?
(1) Turgor pressure
(2) Wall pressure
(3) Suction pressure
(4) Osmotic pressure

25. Water from the soil enters in to the root hairs on account of: -
(1) Turgor pressure
(2) Suction pressure or DPD
(3) Wall pressure
(4) Osmotic pressure

26. In a fully turgid cell the values of DPD, OP and TP should be: -
(1) DPD = 10 atm., OP = 15 atm., TP = 5atm
(2) DPD = 5 atm., OP = 12 atm., TP = 7atm
(3) DPD = 10 atm., OP = 15 atm., TP = 5atm
(4) DPD = 0 atm., OP = 15 atm., TP = 15atm

27. When the cell is placed in water, it takes water this is due to ?
(1) Osmotic pressure
(2) DPD
(3) Diffusion
(4) Water potential and TP

28. What is the direction of the movement of water if two cells have the same OP but differ in TP ?
(1) No net flow
(2) From lower T.P to higher TP
(3) From higher TP to lower TP
(4) Data is insufficient

29. The hydrostatic pressure developed in the cell due to entry of water is called:
(1) Turgor pressure
(2) Wall pressure
(3) Osmotic pressure
(4) Suction pressure

30. In fully turgid cell: -
(1) DPD = WP (2) DPD = OP
(3) DPD = OP - TP (4) DPD = 0

31. In flaccid cell: -

(1) DPD = WP (2) DPD = OP

(3) DPD = 0 (4) DPD = OP–TP

32. Turgor pressure of a plasmolysed cell is considered as: -

(1) Positive (2) Zero

(3) Negative (4) None of these

33. When water enters into a cell what happens to its OP, TP and DPD ?

(1) OP & TP increase & its DPD increase

(2) OP & DPD increase & TP decrease

(3) TP & DPD decrease & OP increase

(4) OP & DPD decrease & TP increase

34. Under natural conditions the osmotic pressure is:

(1) More than turgor pressure

(2) Less than turgor pressure

(3) Equal to turgor pressure

(4) Zero

35. What maintains the shape of a cell ?

(1) Osmotic pressure (2) Turgor pressure

(3) Suction-pressure (4) Wall-pressure

36. Osmotic potential is numerically equal to:-

(1) Turgor pressure (2) Wall pressure

(3) Osmotic pressure (4) D.P.D

37. You are given three cells, a root hair, a cell of the inner cortical layer and a cell of the mesophyll arrange them in ascending order of DPD: -

(1) Root hair < Cortical cell < Mesophyll

(2) Cortical cell < Mesophyll < Root hair

(3) Mesophyll < Root hair < Cortical cell

(4) Root hair < Mesophyll < Cortical cell

38. The direction of the movement of water: -

(1) From low OP to high OP

(2) From low DPD to high DPD

(3) From high DP to low DP

(4) All of the above

39. The entry of water from the soil up to xylem elements of root is due to: -

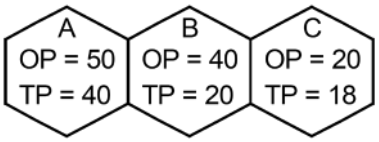
(1) Gradient of suction pressure

(2) Turgor pressure

(3) Degree of imbibition

(4) Concentration of ions in water

40. The three cells A, B & C are joined in a linear manner. Demonstrate the movement of water & direction in these ?



(1) A → B → C (2) A ← B ← C

(3) A → B ← C (4) A ← B → C

41. When the solute has been added in the solution, then following observation can be made ?

(1) The DPD of the solution decreases

(2) The Ψ_w of the solution increases

(3) DPD of the solution decreases while its Ψ_w increases

(4) DPD of the solution increases while its Ψ_w decreases

42. If the given solution is of 25% concentration; then what cannot be presented for this:-

(1) OP (2) DPD

(3) Solute potential (4) TP

43. In a flaccid cell which condition does not occur:

(1) TP = 0 (2) SP = 0

(3) WP = 0 (4) SP = OP

44. The accurate relationship between DPD, OP, TP can be expressed as -

(1) DPD = OP + TP (2) OP = DPD – TP

(3) TP = DPD – OP (4) DPD = OP – TP

45. In which condition the Turgor pressure of the cell becomes equal to the osmotic pressure: -

(1) In flaccid cell

(2) In plasmolysed cell

(3) In fully turgid cell

(4) It never happens

46. The best condition by which fully turgid cell can be identified is: -

(1) TP is minimum (2) SP is maximum

(3) OP less than SP (4) TP = OP

Plasmolysis & Permeability

47. Plasmolysis can be used for: -

(1) Good growth of plants

(2) Good growth of weeds

(3) Killing the weeds

(4) Selective weed control

48. Along with plasmolysis which decreases in the cell -

(1) Osmotic pressure

(2) Diffusion pressure

(3) Imbibition pressure

(4) Turgor pressure

49. If a plasmolysed cell is placed in distilled water then it returns to its original state & become turgid, this is called as: -

(1) Plasmolysis (2) Exosmosis

(3) Endosmosis (4) Deplasmolysis

50. If there is high amount of fertilizer present in soil & it is deficient in water then what will be the effect

(1) Over growth

(2) Under growth

(3) No effect

(4) Wilting of plants

51. Plant cells do not burst in distilled water because:

(1) Cell wall is permeable

(2) Cell wall is living

(3) Cell wall is elastic, rigid and get stretched

(4) Cell wall is dead and impermeable

52. When a plant cell is placed in a hypertonic solution it becomes plasmolysed what shall be present between cell wall and plasmalemma at this stage ?

(1) Water and air

(2) Cell sap

(3) Hypertonic solution

(4) Solutes

Water Potential

53. When the solute has been added to the solution; it water potential will ?

(1) Increases

(2) Decreases

(3) Remains unchanged

(4) First increases then decreases

54. Water potential of a cell when its placed in hypertonic solution: -

(1) Decreases

(2) Increases

(3) First increases then decreases

(4) No change

55. Osmotic potential (Ψ_S) of a solution is always:

(1) Positive (2) Negative

(3) Zero (4) Variable

56. When the water potential of a cell become zero, it is said to be in?

(1) Fully turgid state

(2) Flaccid state

(3) Incipiently plasmolysed state

(4) Completely plasmolysed state

57. The solute potential can be determined in a simple manner by: -

(1) Water potential

(2) DPD

(3) Osmotic pressure

(4) Suction pressure

58. The accurate equation for presenting water potential is: -

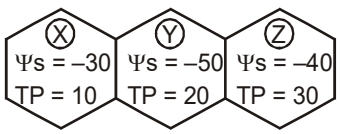
(1) $\Psi\omega = \Psi_s + \Psi_p$

(2) $\Psi_s = \Psi\omega + \Psi_p$

(3) $\Psi\omega = \Psi_s - \Psi_p$

(4) $\Psi\omega = -\Psi_s - \Psi_p$

59. The direction of the water flow in given cells X,Y & Z can be presented as: -



(1) X → Y ← Z (2) X → Y → Z

(3) X ← Y ← Z (4) X ← Y → Z

60. The water potential & osmotic potential of pure water is: -

(1) 100 & zero (2) Zero & zero

(3) 100 & 200 (4) Zero & 100

61. The relationship between DPD & Ψ_w can be expressed as:

(1) DPD = Ψ_w (2) Ψ_w – DPD = 0

(3) $\frac{DPD}{\Psi_w} = 0$ (4) Ψ_w = – DPD

62. In plant water relations, Ψ_w indicates -

(1) DPD

(2) Solute potential

(3) Water potential

(4) Suction pressure

63. If the solute is added in the given solution than what osbervation can be made -

(1) Its DPD decreases

(2) It's water potential decreases

(3) DPD & water potential remains unchanged

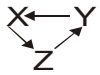
(4) Its water pontential increases

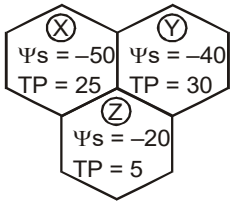
64. If three cells X, Y and Z are joined to each other & their solute potential & Turgor pressure values are given in the figure; then demonstrate the direction of flow of water in this system:

(1) 

(2) 

(3) 

(4) 



65. If a cell is placed in a hypertonic solution then Ψ_w of the cell will be: -

(1) Increased

(2) Decreased

(3) Unchanged

(4) First increases then decreases

Imbibition

66. Seeds swell when placed in water due to: -

(1) Osmosis (2) Imbibition

(3) Hydrolysis (4) All of these

67. During rainy season wooden doors generally swell up due to: -

(1) Osmosis (2) Imbibition

(3) Bad workmanship (4) Wood quality

68. The most powerful imbibant is: -

(1) Agar - agar (2) Proteins

(3) Cellulose (4) Lignin

69. First step of influx of water into a plant (or) a root hair cell (or)a seed is: -

(1) Osmosis (2) Imbibition

(3) Absorption (4) Suction

70. Which of the following is imbibiant?

(1) Proteins

(2) Pectin

(3) Starch

(4) All of the above

71. Which of the following seeds develop a greater imbibition pressure?

(1) Wheat seed

(2) Gram seed

(3) Rice seed

(4) Mustard oil seed

72. Swelling in wooden block placed in water is due to

(1) Endosmosis

(2) Capillarity

(3) Absorption

(4) Imbibition

73. The right sequence for imbibition is: -

(1) Agar agar > cellulose > protein

(2) Protein > cellulose > agar agar

(3) Agar agar > protein > cellulose

(4) Agar agar < protein < cellulose

74. To initiate cell plasmolysis, the salt concentration must be: -

(1) Isotonic

(2) Hypotonic

(3) Hypertonic

(4) Atonic

75. When a plasmolysed cell is placed in a hypotonic solution then water will move inside the cell this will happen due to which force

(1) DPD (2) OP

(3) W.P (4) TP

76. Which of the following statement is not correct?

(1) Plants absorb excess quantity of water

(2) Plants take small quantity of mineral salts through soil water

(3) Water and inorganic salts may be simultaneously absorbed by root hair

(4) Plant absorb only one thing at a time water or inorganic salts

77. The pathway of water from soil upto the secondary xylem:

(1) Soil → root hair → cortex → endodermis → pericycle → protoxylem → Meta xylem

(2) Metaxylem → protoxylem → pericyle → cortex → endodermis → soil → root hair

(3) Cortex → root hair endodermis → pericycle → protoxylem → metaxylem

(4) Pericycle → soil → root hair → cortex → endodermis→ protoxylem → metaxylem

78. Water will passively absorbed by root hairs when: -

(1) Concentration of salts in the soil is high

(2) Concentration of solutes in the cell sap is high

(3) The plant is rapidly respiring

(4) They are separated from the soil by a semipermeable membrane

79. Water in plants is transported by ascent of sap takes place through: -

(1) Cambium

(2) Phloem

(3) Xylem

(4) Epidermis

80. In poorly aerated soil, the rate of water absorption will: -

(1) Increase

(2) Decrease

(3) Remains the same

(4) None of these

81. Passive absorption of water takes place by: -

(1) Osmosis

(2) The presence of energy

(3) Root pressure

(4) Transpiration pull

82. All the following involves osmosis except:

(1) Movement of water from soil to root

(2) Movement of water from root hair to endodermis and pericycle

(3) Movement of water between xylem elements

(4) Movement of water from xylem to mesophyll cells of the leaves

83. Energy dependent absorption of water against osmotic phenomenon is: -

(1) Active absorption

(2) Passive absorption

(3) Imbibition

(4) Bulk absorption

84. In a young root the most active absorption of water takes place through: -

(1) Root cap region

(2) Root hair region

(3) Zone of elongation

(4) Mature region with a corky layer

85. Water is actively absorbed by root when: -

(1) Soil solution is hypotonic

(2) Soil solution is hypertonic

(3) Transpiration rates are high

(4) Shoot pressure is high

86. Maximum absorption of water by a root occur in the region of: -

(1) Cell division

(2) Cell elongation

(3) Cell maturation

(4) Cell division and root cap together

87. Absorption of water is increased when: -

(1) Transpiration is increased

(2) Photosynthesis is decreased

(3) Respiration is increased

(4) Root pressure is increased

88. Passive absorption of water from the soil by the root is mainly effected by: -

(1) Typical tissue organisation

(2) Respiratory activity of root

(3) Tension on cell sap due to transpiration

(4) None of the above

89. Active absorption of water from the soil by the root is mainly effected by: -

(1) Typical tissue organisation

(2) Respiratory activity of root

(3) Tension on cell sap due to transpiration

(4) None of the above

90. Which of the following factors inhibit the absorption of water by roots ?

(1) Low soil temperature

(2) High concentration of soil solution

(3) Low soil aeration

(4) All of the above

91. When the concentration of the soil solutes is low, the absorption of water is ?

(1) Retarted

(2) Increased

(3) Remains normal

(4) Stopped

92. Which method is responsible for most of the absorption in higher plants?

(1) Active absorption

(2) Passive absorption

(3) Osmotic absorption

(4) Non osmotic absorption

93. Halophytes can grow on physiologically dry soil due to -

(1) Dry soil

(2) Excessive humidity outside

(3) Excessive salts in plants

(4) Excessive salts in water

Stomata & Transpiration

94. Opening of stomata is due to: -

(1) Turgidity of guard cells

(2) Size of guard cells

(3) Number of guard cells

(4) Amount of CO_2 in the atmosphere

95. Transpiration in plants will be lowest when:-

(1) Stress is high humidity in the atmosphere

(2) High wind velocity

(3) There is excess of water in the soil

(4) Environmental conditions are very dry

96. The metal ion involved in the stomatal regulation is

(1) Iron (2) Magnesium

(3) Zinc (4) Potassium

97. Transpiration from plants would be rapid when

(1) There is low humidity in atmosphere

(2) Slow wind is blowing

(3) Temperature is high

(4) All of the above

98. Processes occur in leaves, which may lower their temperature is: -

(1) Respiration (2) Photosynthesis

(3) Hydrolysis (4) Transpiration

99. Wilting of a plant result from excessive: -

(1) Respiration (2) Photosynthesis

(3) Absorption (4) Transpiration

100. The rate of transpiration is high when: -

(1) The atmosphere is saturated with water vapors

(2) Light is very dim

(3) The temperature is low

(4) The atmosphere is dry and the temperature is high

101. Excessive loss of water causes wilting of leaves, it can be prevented by: -

(1) Keeping the plant in bright light

(2) Spraying the plant with alcohol

(3) Applying Vaseline on the leaf surface

(4) Adding high amounts of fertilizers to the soil

102. Leaves which appear wilted in the day time recover at night because: -

(1) Light is essential for photo synthesis

(2) The stomata close down, temperature decrease, transpiration is reduced and the plant is able to absorb water from the soil

(3) Respiration and translocation of organic substance both increases

(4) The plant is ***sleeping*** because of dark conditions

103. Increase in CO_2 concentration around leaf results in: -

(1) Rapid opening of stomata

(2) Partial closure of stomata

(3) Complete closure of stomata

(4) No effect on stomatal opening

104. The rate of transpiration will be high when

there is ?

(1) Rainy season

(2) Winter season

(3) Summer season

(4) None of these

105. Which type of transpiration is more common -

(1) Cuticular

(2) Stomatal

(3) Lenticular

(4) Bark transpiration

106. Maximum transpiration is taking place through the

(1) Stomata (2) Lenticel

(3) Hydathode (4) Cuticle

107. When the stomata are opening; we observe following changes in the guard cells ?

(1) OP increase, TP decreases

(2) OP & TP increases

(3) OP decreases, TP increases

(4) OP & TP decreases

108. Which of the following is produced during water stress condition?

(1) Cytokinin (2) ABA

(3) Phytochrome (4) ATPase

109. Which chemical is used to detect transpiration comparatively?

(1) Calcium carbonate

(2) Cobalt carbonate

(3) Cobalt chloride

(4) Mercuric acetate

110. Cuticular transpiration is observed mainly in:-

(1) Xerophytes

(2) Herbaceous plants

(3) Trees

(4) Shrubs

111. The most important factor affecting transpiration is

(1) Light

(2) Temperature

(3) Wind

(4) Atmospheric humidity

112. OP of guard cells is increased by:

(1) K^+ only (2) K^+ & $Malate^-$

(3) K^+ and H^+ (4) Water

113. Which of the following plant do not transpire ?

(1) Algae

(2) Fungi

(3) Submerged hydrophytes

(4) All the above

114. Significance of transpiration lies in: -

(1) Circulation of water

(2) Absorption and distribution of water

(3) Regulating the temperature of the plant body

(4) All of the above

115. In the mechanism of the opening to stomata, the important factor is: -

(1) Turgidity of the guard cells

(2) Chlorophyll content of the guard cells

(3) Hormone content of the subsidiary cells

(4) Protein content of the epidermal cells

116. Stomata open at day because in day the guard cells have:-

(1) To help gas exchange

(2) A low pH

(3) A high level of sugar, organic acid ATP & K^+ ion

(4) Unequally thickened walls

117. Basic of stomatal opening is: -

(1) Exosmosis in guard cells

(2) Endosmosis in guard cells

(3) Decrease in cell sap concentration

(4) Plasmolysis of guard cells

118. Shape of guard cells in Gramineae family:-

(1) Kidney shaped

(2) Oval

(3) Round

(4) Dumbbell shaped

119. Scotoactive stomata are occurs in: -
(1) Succulent xerophytes
(2) Hydrophytes
(3) Mesophytes
(4) None of the above

120. With decrease in atmospheric pressure the rate of transpiration will: -
(1) Remain unaffected
(2) Increased
(3) Decrease slowly
(4) Decrease rapidly

121. Which of the following statement is not true ?
(1) Transpiration is increased when root shoot ratio is increased
(2) Transpiration is increased when latex & mucilage is increased in tissue
(3) Transpiration is decreased when stomata are sunken
(4) Transpiration is decreased when leaves becomes leathery of hairy

122. Which one of the following will reduce the rate of transpiration ?
(1) Increase in wind velocity
(2) Rise in temperature
(3) Increase in water uptake by plants
(4) Decrease in light intensity

123. The most important function of transpiration in plants is to cause: -
(1) Loss of surplus water
(2) Cooling of the plant
(3) Rapid ascent of sap
(4) Rapid rise of minerals

124. Before opening of stomata accumulation of the following ion is seen in: -
(1) PO_4 (2) K^+
(3) Mg^{++} (4) Na^+

125. In succulent plants the stomata opens at night and closes by day. Which of following would be best hypothesis to explain the mechanism of stomata opening at night only?
(1) CO_2 used up, increased pH results in accumulation of sugars
(2) CO_2 accumulates, reduces pH stimulates enzymes resulting in accumulation of carbohydrate
(3) Increase in CO_2 concentration, conversion of organic acids in to starch resulting in the increased uptake of potassium ions and water
(4) High CO_2 concentration causes accumulation of organic acids in guard cells resulting in to the increased concentration of cell sap

126. Guard cells differ from other epidermal cells in having:-
(1) Large vacuoles
(2) Secondary walls
(3) Chloroplast with PEP-carboxylase enzyme
(4) Absence of mitochondria

127. The diffusion of water vapors through aerial parts of the plants is called: -
(1) Osmosis (2) DPD
(3) Transpiration (4) All

128. If the absorption is more, but transpiration is less; then process affected will be: -
(1) Root pressure (2) Guttation
(3) Bleeding (4) All

129. Active $K^+ \rightleftharpoons H^+$ exchange theory explained -
(1) Ascent of sap
(2) Phloem conduction
(3) Ion absorption
(4) Stomatal movement

130. Which of the following theory gives the latest explanation for closure of stomata ?
(1) ABA theory
(2) Munch theory
(3) Starch-glucose theory
(4) Active K^+ transport theory

131. The potometer is based on the principle that: -
(1) Transpiration is based on stomatal opening
(2) Stomata open during day time
(3) Absorption = Transpiration
(4) Transpiration tension present in leaves

132. Guttation is dependent on: -
(1) Root pressure
(2) Passive absorption of minerals by root
(3) Flaccidity of root cortical cells
(4) High rate of transpiration

133. Due to increasing temperature, transpiration:-
(1) Increases
(2) Decreases
(3) First increases then decreases
(4) Unaffected

134. If temperature remains constant then with increasing altitude, the transpiration will: -
(1) Increase
(2) Decrease
(3) First decrease then increase
(4) Remain unaffected

135. Transpiration increases when atmospheric temperature rises, due to: -
(1) Wider opening of stomata
(2) Stomatal opening becomes narrow
(3) Water holding capacity of the air increases
(4) More photosynthesis in guard cells

136. Due to more wind velocity, the transpiration rate will be: -
(1) Less
(2) More
(3) Unaffected
(4) First increases then decreases

137. Foliar transpiration: -
(1) Includes stomatal and cuticular transpiration
(2) Does not occur in higher plants
(3) Includes all type of transpiration
(4) Shows stomatal transpiration

138. The Sugarcane plant has: -
(1) Dumb-bell shaped guard cells
(2) Pentamerous flowers
(3) Reticulate venation
(4) Capsular fruits

Ascent of Sap

139. Water rises in the stem due to: -
(1) Cohesion and transpiration pull
(2) Turgor pressure
(3) Osmotic pressure
(4) Wall pressure

140. Sap ascends in woody stem because of: -
(1) Transpiration pull
(2) Respiration in plant cells
(3) Molecular adhesion
(4) Photosynthesis

141. The continuity of water column in xylem is maintained due to: -
(1) Presence of air bubbles
(2) Cohesive property of water
(3) Evaporation power of water
(4) None of the above

142. Transpiration - cohesion - tension theory operates in: -
(1) Active absorption
(2) Passive absorption
(3) Active & passive absorption
(4) None of the above

143. Attractive forces of xylem cell for water molecules is termed as: -
(1) Adhesion (2) Cohesion
(3) Osmosis (4) Plasmolysis

144. If all the tissue of a plant to certain points are removed except the xylem which is left intact:
(1) The leaves will wilt
(2) The stem will die first
(3) The root will die first
(4) The whole plant will die at the same time

145. Which tissue are removed when a plant is girdled ?
(1) Xylem & pith
(2) Xylem & Phloem
(3) Phloem to epidermis
(4) Phloem to pith

146. Removal of a ring of bark from the trunk of a tree eventually kills it because: -
(1) Water can not go up
(2) Fungi & insects attack exposed parts
(3) Food does not travel down & root becomes starved
(4) Air blocks the xylem

147. Which would do maximum harm to a tree ?
(1) The loss of half of its leaves
(2) The loss of all its leaves
(3) The loss of half of its branches
(4) The loss of its bark

148. Ringing experiment can not be done on a sugar cane plant because: -
(1) Its xylem is scanty
(2) Its phloem is with out phloem parenchyma
(3) Its vascular bundles are scattered
(4) Its phloem is present inside the xylem

149. In plants the translocation of food (organic solutes) take place through: -
(1) Epidermis (2) Xylem
(3) Phloem (4) Pith

150. Ringing experiment is to show: -
(1) Path of food translocation
(2) Comparison of transpiration
(3) Passive absorption
(4) Stomatal opening & closing

151. By which process absorbed water reaches up to the leaves ?

(1) Transpiration (2) Guttation

(3) Root pressure (4) Ascent of sap

Guttation, Bleeding, Root Pressure, Wilting

152. Root presence is maximum, when: -

(1) Transpiration is high and absorption is very low

(2) Transpiration is very low and absorption is high

(3) Absorption is very high and transpiration is also very high

(4) Absorption is low and transpiration is also very low

153. Wilting in plant occurs when: -

(1) Xylem is blocked

(2) Epidermis is pealed off

(3) Pith is removed

(4) Phloem is blocked

154. Pressure exerted on the fluid contents of the cortical cells of root by turgidity. Which forces the water in to xylem vessels and upward in the stem for a certain height is: -

(1) Imbibition (2) Root pressure

(3) Capillarity (4) Turgor pressure

155. Guttation take place during night when: -

(1) Root pressure is positive

(2) Root pressure is negative

(3) Always take place

(4) It does not takes place at all

156. The hydathodes are related with: -

(1) Transpiration (2) Guttation

(3) Bleeding (4) All

157. Root pressure can be measured by the instrument

(1) Potometer (2) Auxanometer

(3) Manometer (4) Barometer

158. In summer afternoon, rate of transpiration is greater than the rate of absorption then what happens to plants: -

(1) Temporary wilting

(2) No effect

(3) Leaves becomes yellow

(4) Plant will die

159. Which conditions favors “Guttation” ?

(1) High water absorption

(2) High transpiration

(3) Low transpiration

(4) (1) and (3) both

160. When stem of a herbaceous plant is cut, water or sap oozes out, this is due to?

(1) Guttation

(2) Transpiration pull

(3) Root pressure

(4) Imbibition

161. Guttation usually occurs in a well watered herbaceous plant and well drained soil only in:

(1) Morning hours

(2) Evening hours

(3) Noon hours

(4) Day hours

162. Hydathodes open during: -

(1) Night hours (2) Day hours

(3) Noon hours (4) Always open

163. Water of guttation is: -

(1) Pure water

(2) Water with dissolved salts

(3) Solution of organic food

(4) Condensed water vapors

164. Cells present on hydathodes is -

(1) Complementary cells

(2) Epithem cells

(3) Guard cells

(4) Kranz cells

165. The whitish powder around hydathode is due to:

(1) Guttation

(2) Salt deposition from air

(3) Salt formation over surface

(4) Bleeding

166. The loss of water in the form of water drops is taking place through the:

(1) Hydathodes (2) Lenticels

(3) Stomata (4) All

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ans.	1	1	2	1	4	4	2	3	1	4	3	2	1	2	2	1	3	1	3	4	3	4	1	3	2
Que.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Ans.	4	2	3	1	4	2	3	4	1	2	3	1	4	1	3	4	4	2	4	3	4	3	4	4	4
Que.	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	3	2	1	2	1	3	1	1	2	4	3	2	3	2	2	2	1	2	4	2	4	3	3	1
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	1	2	3	2	4	3	1	2	2	3	1	3	2	4	2	2	3	1	1	4	4	4	4	4
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
Ans.	3	2	2	3	2	1	3	2	3	2	4	2	4	4	1	3	2	4	1	2	2	4	2	2	4
Que.	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
Ans.	3	3	4	4	1	3	1	3	1	3	4	1	1	1	1	2	2	1	3	3	3	4	3	3	1
Que.	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166									
Ans.	4	2	1	2	1	2	3	1	4	3	1	4	2	2	1	1									

Exercise - II

1. When stomata open, the pH of guard cells: -
(1) Increases (2) Decreases
(3) Remains same (4) Both (1) and (2)

2. Water lost in guttation is: -
(1) Pure water
(2) Impure water
(3) In vapors form
(4) Either (1) and (2)

3. What will ultimately happen if plant cells are placed in hypertonic solution:
(1) Turgid (2) Plasmolysed
(3) Deplasmolysed (4) Partialy turgid

4. Loss of water from tips of leaves is called:
(1) Bleeding (2) Guttation
(3) Respiration (4) Transpiration

5. Which of the following is related with transfer of food material:
(1) Xylem (2) Collenchyma
(3) Phloem (4) Parenchyma

6. Which of the following apparatus is commonly used to measure the rate of transpiration is:
(1) Porometer (2) Altimeter
(3) Potometer (4) Luxmeter

7. Which one is not related to transpiration:
(1) Regulation of plant body temperature
(2) Absorption and distribution of mineral salt
(3) Circulation of water
(4) Bleeding

8. Supply ends in transport of solute are:
(1) Green leaves and storage organs
(2) Root and stem
(3) Xylem and Pholem
(4) Hormones and enzymes

9. Stomata can open at night in:
(1) Xerophyte
(2) Gametophyte
(3) Hydrophyte
(4) All sporophytes

10. Stomata open and close due to:
(1) Turgor pressure change
(2) Hormone change
(3) Temperature change
(4) All of the above

11. In plasmolysed cell, the space between cell wall and Protoplasm is occupied by:
(1) Hypotonic solution
(2) Hypertonic solution
(3) Isotonic solution
(4) Distil water

12. The real force responsible for the movement of water from cell to cell is:
(1) OP
(2) TP
(3) DPD
(4) WP

13. If a cell shrinks when placed in a solution, this solution is:
(1) Hypotonic
(2) Hypertonic
(3) Isotonic
(4) Pure solvent

14. If a cell A with DPD 4 bars is connected to cell B, C, D whose osmotic pressure and turgor pressure are respectively 4 and 4, 10 and 5, 7 and 3 bar, the flow of water will be:

(1) B to A, C and D (2) A to D, B and C

(3) C to A, B and D (4) A to B, C and D

15. Guard cell controls:

(1) Intensity of light entering

(2) Photosynthesis

(3) Closing and opening of stomata

(4) Change in green color

16. Active transport:

(1) Releases energy

(2) Requires energy

(3) Produces ATP

(4) Produces a toxic substance

17. In a fully turgid plant cell which one is zero:

(1) Turgor pressure

(2) Wall pressure

(3) Suction pressure

(4) None of these

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ans.	1	2	2	2	3	3	4	1	1	1	2	3	2	1	3	2	3

Exercise – III – (Previous year Question)

[AIPMT-2003]

1. Stomata of CAM plants: -

(1) Are always open

(2) Open during the day & close at night

(3) Open during the night & close during the day

(4) Never open

2. Stomata of a plant open due to: -

(1) Influx of potassium ions

(2) Efflux of potassium ions

(3) Influx of hydrogen ions

(4) Influx of calcium ions

[AIPMT-2005]

3. Potometer works on the principle of:

(1) Amount of water absorbed equals the amount transpired

(2) Osmotic pressure

(3) Root pressure

(4) Potential difference between the tip of the tube and that of the plant

[AIPMT-2009]

4. Guard cells help in: -

(1) Fighting against infection

(2) Protection against grazing

(3) Transpiration

(4) Guttation

[AIPMT-2010 (Pre)]

5. Which one of the following structures between two adjacent cells is an effective transport pathway?

(1) Endoplasmic reticulum

(2) Plasmalemma

(3) Plasmodesmata

(4) Plastoquinone

[AIPMT-2010 (Mains)]

6. Transport of food material in higher plants takes place through:

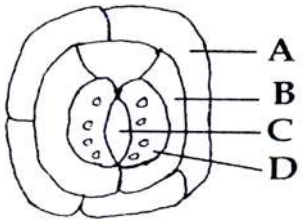
(1) Transfusion tissue

(2) Tracheids

(3) Sieve elements

(4) Companion cells

7. Given below is the diagram of a stomatal apparatus. In which of the following all the four parts labelled as A, B, C and D are correctly identified?



	A	B	C	D
(1)	Guard cell	Stomatal aperture	Subsidiary cell	Epidermal cell
(2)	Epidermal cell	Guard cell	Stomatal aperture	Subsidiary cell
(3)	Epidermal cell	Subsidiary cell	Stomatal aperture	Guard cell
(4)	Subsidiary cell	Epidermal cell	Guard cell	Stomatal aperture

[AIPMT-2011 (Pre)]

8. In land plants, the guard cells differ from other epidermal cells in having:

(1) Chloroplasts

(2) Cytoskeleton

(3) Mitochondria

(4) Endoplasmic reticulum

[AIPMT-2011 (Mains)]

9. Guttation is the result of :

(1) Root pressure (2) Diffusion

(3) Transpiration (4) Osmosis

10. Function of companion cells is :

(1) Loading of sucrose into sieve elements

(2) Providing energy to sieve elements for active transport

(3) Providing water to phloem

(4) Loading of sucrose into sieve elements by passive transport

[RPMT-2011]

11. The chief sinks for the mineral elements are -

(1) Senescent leaves

(2) Ripe fruits

(3) Lateral meristems

(4) Bark

[NEET-UG 2013]

12. Which of the following criteria doe not pertain to facilitated transport ?

(1) Uphill transport

(2) Requirement of special membrane proteins

(3) High selectivity

(4) Transport saturation

[AIPMT–2014]

13. The osmotic expansion of a cell kept in water is chiefly regulated by:

(1) Mitochondria

(2) Vacuoles

(3) Plastids

(4) Ribosomes

[AIPMT–2015]

14. In a ring girdled plant:

(1) The root dies first

(2) The shoot and root die together

(3) Neither root nor shoot will die

(4) The shoot dies first

15. Transpiration and root pressure cause water to rise in plants by:

(1) Pulling and pushing it, respectively

(2) Pushing it upward

(3) Pushing and pulling it, respectively

(4) Pushing it upward

[Re-AIPMT 2015]

16. Root pressure develops due to:

(1) Increase in transpiration

(2) Active absorption

(3) Low osmotic potential in soil

(4) Passive absorption

17. A column of water within xylem vessels of tall trees does not break under its weight because of:

(1) Positive root pressure

(2) Dissolved sugars in water

(3) Tensile strength of water

(4) Lignification of xylem vessels

18. Which one of the following is wrong statement?

(1) Phosphorus is a constituent of cell membranes, certain nucleic acids and all proteins

(2) Nitrosomonas and Nitrobacter are chemoautotrophs

(3) Anabaena and Nostoc are capable of fixing nitrogen in free-living state also

(4) Root nodule forming nitrogen fixers live as aerobes under free-living conditions

[NEET – 2016]

19. Water vapors comes out from the plant leaf through the stomatal opening. Through the same stomatal opening carbon dioxide diffuse into the plant during photosynthesis. Reason out the above statements using one of following options.

(1) Both processes cannot happen simultaneously.

(2) Both processes can happen together because the diffusion coefficient of water and CO_2 is different.

(3) The above processes happen only during night time.

(4) one process occurs during day time, and the other at right.

20. Specialized epidermal cells surrounding the guard cell are called:

(1) complementary cells

(2) subsidiary cells

(3) Buliform cells

(4) lenticels

21. A few drops of sap were collected by cutting across a plant stem by a suitable method. The sap was tested chemically. Which one of the following test results indicates that it is phloem sap ?

(1) Alkaline

(2) Low refractive index

(3) Absence of sugar

(4) Acidic

[NEET – 2017]

22. The water potential of pure water is :

(1) Zero

(2) Less than zero

(3) More than zero but less than one

(4) More than one

23. Which of the following facilitates opening of stomatal aperture?

(1) Contraction of outer wall of guard cells

(2) Decrease in turgidity of guard cells

(3) Radial orientation of cellulose microfibrils in the cell wall of guard cells

(4) Longitudinal orientation of cellulose microfibrils in the cel wall of guard cells

[NEET – 2018]

24. Stomatal movement is **not** affected by:

(1) O_2 concentration

(2) Light

(3) Temperature

(4) CO_2 concentration

25. Stomata in grass leaf are:

(1) Rectangular

(2) Kidney shaped

(3) Dumb-bell shaped

(4) Barrel shaped

26. The process responsible for facilitating loss of water in liquid form from the tip of grass blades at night and in early morning is:

(1) Plasmolysis

(2) Transpiration

(3) Root pressure

(4) Root pressure

[NEET – 2019]

27. What is the direction of movement of sugars in phloem?

(1) Downward

(2) Bi-directional

(3) Non-multidirectional

(4) Upward

28. Xylem translocates:

(1) Water only

(2) Water and mineral salts only

(3) Water, mineral salts and some organic nitrogen only

(4) Water, mineral salts, some organic nitrogen and hormones

[NEET – 2019 – (Odisha)]

29. The main difference between active and passive transport across cell membrane is:

(1) Passive transport is non-selective whereas active transport is selective

(2) Passive transport requires a concentration gradient across a biological membrane whereas active transport requires energy to move solutes

(3) Passive transport is confined to anionic carrier proteins whereas active transport is confined to cationic channel proteins

(4) Active transport occurs more rapidly than passive transport

30. Which of the following is not a feature of active transport of solutes in plants?

(1) Occurs against concentration gradient

(2) Non-selective

(3) Occurs through membranes

(4) Requires ATP

31. What will be the direction of flow of water when a plant cell is placed in a hypotonic solution?

(1) Water will flow in both directions

(2) Water will flow out of the cell

(3) Water will flow into the cell

(4) No flow of water in any direction

[NEET (UG) 2020 – (COVID-19)]

32. Select the **incorrect** statement.

(1) Transport of molecules in phloem can be bidirectional.

(2) Movement of minerals in xylem is unidirectional

(3) Unloading of sucrose at sink does not involve the utilization of ATP.

(4) Elements most easily mobilized in plants from one region to another are: Phosphorus, Sulphur, nitrogen and potassium.

[NEET – (UG) – 2021]

33. Match **List–I** with **List–II.**

List-I		List-II	
(a)	Cohesion	(i)	More attraction in liquid phase
(b)	Adhesion	(ii)	Mutual attraction among water molecules
(c)	Surface tension	(iii)	Water loss in liquid phase
(d)	Guttation	(iv)	Attraction towards polar surfaces

Choose the **correct** answer from the options given below.

	(a)	**(b)**	**(c)**	**(d)**
(1)	(ii)	(iv)	(i)	(iii)
(2)	(iv)	(iii)	(ii)	(i)
(3)	(iii)	(i)	(iv)	(ii)
(4)	(ii)	(i)	(v)	(iii)

[NEET–(UG)–2022]

34. Which of the following is not observed during apoplastic pathway?

(1) Movement of water occurs through intercellular spaces and wall of the cells.

(2) The movement does not involve crossing of cell membrane

(3) The movement is aided by cytoplasmic streaming

(4) Apoplast is continuous and does not provide any barrier to water movement.

35. "Girdling Experiment" was performed by plant Physiologists to identify the plant tissue through which:

(1) water is transported

(2) Food is transported

(3) For both water and food transportation

(4) osmosis is observed

36. Addition of more solutes in a given solution will:

(1) raise its water potential

(2) lower its water potential

(3) make its water potential zero

(4) not affect the water potential at all

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Ans.	3	1	1	3	3	3	3	1	1	2	3	1	2	1	1	2	3	1	2	2	1	1	3	1	3
Que.	26	27	28	29	30	31	32	33	34	35	36														
Ans.	3	2	4	2	2	3	3	1	3	2	2														