

Chapter-11

TRANSPORT IN PLANTS

POINTS TO REMEMBER

Translocation : Transport of substances in plants over longer distances through the vascular tissue (Xylem and Phloem) is called translocation. The transport of water and mineral in Xylem is unidirectional while transport of organic and mineral nutrients in phloem is multi-directional.

Means of transport : The transport of material into and out of the cells is carried out by a number of methods. These are diffusion, facilitated diffusion and active transport.

Diffusion : Diffusion occurs from region of higher concentration to region of lower concentration across the permeable membrane. It is passive and slow process. No energy expenditure takes place.

Facilitated diffusion : The diffusion of hydrophilic substances along the concentration gradient through fixed membrane transport protein without involving energy expenditure is called facilitated diffusion. For this the membrane possess aquaporins and ion channels. No ATP energy is utilized in this process.

Methods of Facilitated Diffusion

Symport	Antiport	Uniport
(Two molecules cross the membrane in the same direction at the same time.)	(Two molecules move in opposite direction at the same time.)	(Single molecule moves across membrane independent of other molecules.)

Active transport : Active transport is carried by the movable carrier proteins (pumps) of membrane. Active transport uses energy to pump molecules against a concentration gradient from a low concentration to high concentration (uphill-transport). It is faster than passive transport.

Water potential : The chemical potential of water is called water potential. It is denoted by Ψ_w (Psi) and measured in pascals (Pa). The water potential of a cell is affected by solute potential (Ψ_s) and pressure potential (Ψ_p).

$$\Psi_w = \Psi_s + \Psi_p$$

Water potential of pure water at standard temperature which is not under any pressure is taken to be zero (by convention).

Chemical Potential : The free energy per mole of any chemical substance in a solution is expressed in terms of chemical potential.

Osmosis : Osmosis is movement of solvent or water molecules from the region of their higher diffusion pressure or free energy to the region of their lower diffusion pressure or free energy across a semi-permeable membrane.

Water molecules move from higher water potential to lower water potential until equilibrium is reached.

Plasmolysis : Process of shrinkage of protoplast in a cell due to exosmosis in hypertonic solution. If a plasmolysed cell is placed in water or a hypotonic solution it becomes turgid.

Casparian strip : It is the tangential as well as radial walls of endodermal cells having the deposition of water impermeable suberin.

Imbibition : Imbibition is the phenomenon of adsorption of water or any other liquid by the solid particles of a substance process imbibition the size of adsorbant is increased without forming a solution. In causing it to increase in volume.

Some examples of Imbibition :

- (i) If a dry piece of wood is placed in water, it swells and increases in its volume.
- (ii) If dry gum or pieces of agar-agar are placed in water, they swell and their volume increases.
- (iii) When seeds are placed in water they swell up.

Conditions essential for imbibition

1. Water potential gradient between the surface of the adsorbant and the imbibed liquid.
2. affinity between the adsorbant and the imbibed liquid.

Transport of water in plants : Water is absorbed by root hairs by diffusion then water moves upto xylem by two pathways - apoplast and symplast pathway.

The transport of water to the tops of trees occurs through xylem vessels. The forces of adhesion and cohesion maintain a thin and unbroken columns of water in the capillaries of xylem vessels through which it travel upward. Water is mainly pulled by transpiration from leaves.

(Cohesion-tension-transpiration pull Model)

Root pressure : A hydrostatic pressure existing in roots which pushes the water up in xylem vessels.

Guttation : The water loss in its liquid phase at night and early morning through special openings of vein near the tip of leaves. These openings are called hydathode.

Transpiration : The loss of water through stomata of leaves and other aerial parts of plants in form of water vapours.

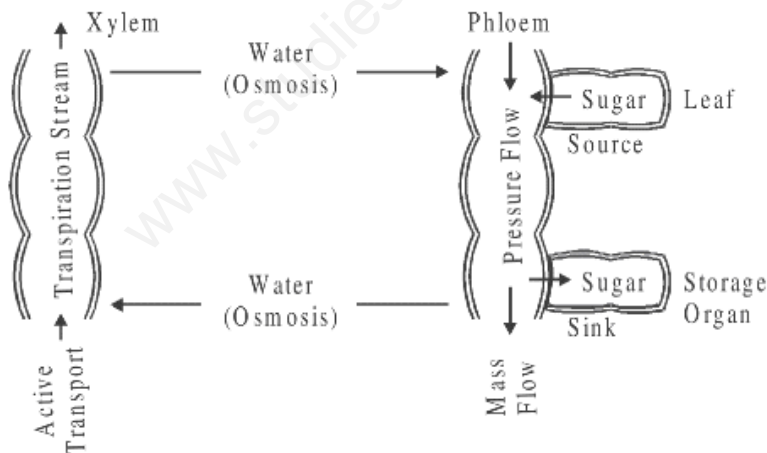
Factors affecting transpiration : Temperature, light, humidity, wind speed, number and distribution of stomata, water status of plant, canopy structure.

Uptake and transport of mineral nutrients : Ions are absorbed by the roots by passive and active transport. The active uptake of ions require ATP energy. Specific proteins in membranes of root hair cells actively pump ions from the soil into the cytoplasm of epidermal cells and then xylem. The further transport of ions to all parts of the plant is carried through the water stream. Older dying leaves export much of their mineral content to younger leaves. Elements phosphorous, sulphur, nitrogen and potassium are most readily mobilised.

Mass flow : Mass flow is the movement of substances (water, minerals and food) in bulk from one point to another as a result of pressure differences between two points.

The Pressure or Mass Flow Hypothesis : The glucose is prepared at the source by the process of photosynthesis and is converted to sucrose (sugar). This sugar is then moved into sieve tube cells by active transport. It produces hypertonic condition in phloem. Water in the adjacent xylem moves into phloem by osmosis. Due to osmotic (turgor) pressure, the phloem sap moves to the areas of lower pressure.

At the sink, osmotic pressure is decreased. The incoming sugar is actively transported out of the phloem and removed as complex carbohydrates (sucrose). As the sugar is removed, the osmotic pressure decreases, the water moves out of the phloem and returns to the xylem.



Mycorrhiza : A mycorrhiza is a symbiotic association of a fungus with a root system. The fungal hyphae absorb mineral ions and water from the soil, and provide them to the roots of plant, in turn the roots provide sugars and nitrogen containing compounds to the mycorrhizae.

QUESTIONS

Very Short Answer Questions (1 mark each)

1. Which part of the root is related with the absorption of water ?
2. What makes the raisins to swell up when kept in water ?
3. Casparian strip is made of a substance which is impervious to water. Name this substance.
4. What will happen to water potential when a solute is added to water ?
5. A plant cell when kept in a solution got plasmolysed. What was the nature of the solution ?
6. Mention two ways of absorption of water by root hairs in plants.
7. Which form of sugar is transported through phloem ?
8. Give one example of imbibition.
9. A flowering plant is planted in an earthen pot and irrigated. Urea is added to make the plant grow faster, but after some time the plant dies. Give its possible reason.
10. Why is energy required to develop root pressure ?

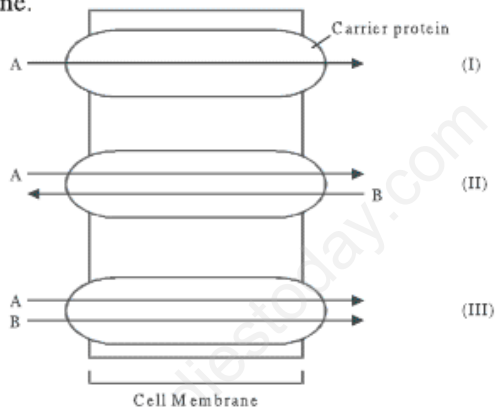
Short Answer Questions-II (2 marks each)

11. A well watered potted herbaceous plant shows wilting in the afternoon of a dry sunny day. Give reason.
12. Do different species of plants growing in the same soil show the same rate of transpiration of a particular time ? Justify your answer.
13. What is casparian strip ? Write its significance in plants.
14. Xylem transport is unidirectional and phloem transport bi-directional. Why ?
15. How is transpiration different from guttation ? Give two points.

Short Answer Questions-I (3 marks each)

16. When any dry plant material or seeds is/are kept in water, they swell up.
 - (a) Name the phenomenon involved in this change.
 - (b) Define this phenomenon.
 - (c) Give two conditions essential for the phenomenon to occur.
17. Differentiate between temporary and permanent wilting. Do any of them indicate the water status of the soil ?

18. What is mycorrhiza ? How is the mycorrhizal association helpful in absorption of water and minerals in plants ?
19. Observe the given figure and give the answers of the following :
- Identify the process occurring in (I), (II) and (III).
 - Differentiate between the process II and III.
 - How many types of aquaporins form the water channels in the cell membrane.



20. Give the scientific term for the following statements/processes :
- Movement of water in roots exclusively through the cell wall
 - The positive hydrostatic pressure developed inside the cell or cell wall.
 - A solution having relatively less concentration.
 - Loss of water vapour from the aerial parts of the plants in the form of water vapours.
 - Movement of a molecule across a membrane independent of other molecule.
 - Water loss in its liquid phase through the special openings of veins near the tip of leaves of many herbaceous plants.

Long Answer Questions (5 marks each)

21. Minerals are present in the soil in sufficient amount. Do plants need to adjust the types of solutes that reach the xylem ? Which molecules help to adjust this ? How do plants regulate the type and quantity of solutes that reach xylem.

22. How do plants absorb water ? Explain transpiration pull model in this regard.
23. (a) Describe the pressure flow hypothesis of translocation of sugar in plants.
(b) Explain the mechanism of closing and opening of stomata.

ANSWERS

Very Short Answers (1 mark each)

1. Root hairs.
2. Endosmosis.
3. Suberin
4. Water potential will decrease.
5. Hypertonic.
6. Apoplast and symplast pathway.
7. Sucrose.
8. Swelling of seed when put in water/moist soil.
9. Due to exosmosis ie water comes out the plant.
10. Every activity requires energy. Root pressure develops due to activity of living cell.

Short Answers-II (2 marks each)

11. During noon, the rate of transpiration becomes higher than the rate of water absorption by plant. It causes loss of turgidity and leads to wilting.
12. Rate of transpiration is not same because transpiration is affected by numbers and distribution of stomata, and their opening.
13. Refer page 185, NCERT, Text Book of Biology for Class XI
14. Refer page 190, NCERT, Text Book of Biology for Class XI

15. Transpiration	Guttation
(i) Loss of water by a plant in form of vapours.	(i) The loss of liquid droplets from the plant.
(ii) Occurs through the general surface of leaves (stomata) and	(ii) Occurs at the margins and the tips of the leaves.

Short Answers-I (3 marks each)

16. (a) Imbibition.
 (b) Refer to 'Points to Remember.'
 (c) Condition necessary to imbibition.
 (i) Water potential gradient between the absorbant and the liquid imbibed.
 (ii) Affinity between the adsorbant and the liquid imbibed.

17.	Temporary wilting	Permanent wilting
(i)	Plant recovers from temporary wilting after sometime.	(i) Automatic recovery is not possible. It may recover if water is provided soon.
(ii)	Much damage is not caused.	(ii) Much damage is caused.
(iii)	It commonly occurs during mid-day only.	(iii) It occurs throughout day and night.

When wilting is permanent, water present in soil is largely unavailable form. The soil contains 10-15% water depending upon its texture.

18. Refer points to remember
19. (a) (i) Uniport (ii) Antiport (iii) Symport
 (b) Refer 'Points to Remember'.
 (c) 8 types of aquaporins.
20. (a) Apoplast pathway
 (b) Turgor pressure
 (c) Hypotonic
 (d) Transpiration
 (e) Uniport
 (f) Guttation

Long Answers (5 marks each)

21. Refer page 189, NCERT, Text Book of Biology for Class XI.
 22. Refer page 186-187, NCERT, Text Book of Biology for Class XI.
 23. (a) Refer points to remember.
 (b) Refer page 191, NCERT, Text Book of Biology for Class XI.