CHAPTER > 11

Transport in Plants

NEET KEY NOTES

- In flowering plants, the substances that would need to be transported are water, mineral nutrients, organic nutrients and plant growth regulators.
- Over small distances, the substances move by diffusion and cytoplasmic streaming supplemented by active transport, while transport over long distance takes place through xylem and phloem and is called **translocation**.
- In rooted plants, transport in xylem (of water and minerals) is essentially unidirectional, from roots to the stems. Organic and mineral nutrients however undergo multidirectional transport.

Means of Transport

Different materials in plants are transported through the various means given below

1. Diffusion

- It is the physical process in which different solvent molecules or solute ions are transported passively without the expenditure of energy.
- During diffusion, the substances move from the region of higher concentration to the region of lower concentration and is affected by the permeability of the membrane separating the two regions, temperature and pressure.

2. Facilitated Diffusion

- It is for those substances which have hydrophilic moiety. These find it difficult to pass through the membrane and thus their movement is facilitated by special proteins present across the membrane.
- These transport proteins are very specific and allow the cell to select substance for uptake without the expenditure of ATP. There are two types of transport proteins, i.e. the **carrier proteins** and the **channel proteins**.
- **Carrier proteins** are the proteins which attach to a particular substance and transfer it to other side of the membrane.
- In relation to facilitated diffusion, some carrier proteins allow the movement of molecules only if two molecules moves together.
- This type of movement is known as **cotransport**. It can be of following three types
  - **Uniport** When a molecule moves across a membrane independent of other molecules.
  - **Antiport** When the two types of molecules move in opposite directions.
  - **Symport** Allows diffusion only when two types of molecules cross the membrane in the same direction.
- **Channel proteins** These proteins form channels in the membrane for molecules to pass through. The channel proteins cause diffusion of solutes.
- Some channels are always open while the opening and closing of others are controlled.
- The large transporter proteins which create huge pores in the outer membranes of the plastids, mitochondria and bacteria to cross a variety of molecules up to the size of small proteins are called **porins**, e.g. water channels are made up of eight different types of **aquaporins**.

3. Active Transport

- It uses energy in the form of ATP to pump molecules or ions against a concentration gradient (i.e. uphill transport from a region of low concentration to a region of high concentration).
- This is carried out by membrane proteins or pumps in the plasma membrane.
- When the transporters become saturated, the rate of transport reaches its maximum level. It is faster than passive transport.

Comparison of Different Transport Processes

The table given below shows a comparison of the different transport mechanisms.

Property	Simple Diffusion	Facilitated Transport	Active Transport
Requires special membrane proteins	No	Yes	Yes
Highly selective	No	Yes	Yes
Transport saturates	No	Yes	Yes
Uphill transport	No	No	Yes
Requires ATP	No	No	Yes

Plant-Water Relation

- Water is essential for all physiological activities of plants and plays a very important role in all living organisms. It provides the medium in which most substances are dissolved.
- Terrestrial plants take up huge amount of water daily, but most of it is lost to the air through evaporation from the leaves, i.e. **transpiration**.
- Because of high demand of water by plant, it is often the limiting factor for plant growth and productivity in both agricultural and natural environment.

1. Water Potential (ψ_w)

- The water molecules possess free energy. The difference between the free energy of water molecules in pure water and the free energy of water in solution is termed as **water potential**.
- Water potential is denoted by ψ_w and is expressed in pressure units such as Pascal (Pa). It is a negative value.
- The water potential of pure water is zero at standard temperature and pressure.
- The solutes decrease the free energy of water.
- The difference in water potential causes water molecules to move from a region of its high water potential to its lower water potential.
- The water potential (ψ_w) of a living cell has **solute potential** (ψ_s) or **osmotic potential** and **pressure potential** (ψ_p).

Solute Potential (ψ_s)

- This is due to the presence of solutes in a solution. The presence of solutes in water lowers the value of water potential.
- The value of solute potential is always negative. With increase in solute concentration, the value of solute potential lowers (becomes more negative).
- For a solution at atmospheric pressure
  Water potential (ψ_w) = Solute potential (ψ_s).

Pressure Potential (ψ_p)

- The pressure which develops due to the entry or exit of water through osmosis in an osmotic system is called pressure potential. It is expressed as ψ_p.
- This pressure potential is usually positive, though in plants, negative potential or tension in the water column in the xylem plays a major role in water transport up a stem.
- Water potential of a cell is affected by both solute and pressure potential. The relationship between them is as follows

$$\psi_w = \psi_s + \psi_p$$

2. Osmosis

- It is the diffusion of water across a differentially or selectively-permeable membrane. It occurs from higher diffusion pressure to lower diffusion pressure or free energy region. It occurs spontaneously in response to a driving force.
- Net direction and rate of osmosis depends on **pressure gradient** and **concentration gradient**.
- Water will move from its region of higher chemical potential to its region of lower chemical potential until equilibrium is reached.
- The pressure needed to prevent osmosis is called **osmotic pressure** and it has a positive value.

3. Plasmolysis

- The behaviour of the plant cells (or tissues) with regard to water movement depends on the surrounding solution.
- Depending on the concentration of solute, the solution can be

Isotonic	Hypotonic	Hypertonic
The external solution balances the osmotic pressure of cytoplasm.	The external solution is more dilute than the cytoplasm.	The external solution is more concentrated than cytoplasm.
	Cell swells	Cell shrinks

- Plasmolysis occurs when water moves out of the cell and the cell membrane of a plant cell shrinks away from its cell wall. It occurs in **hypertonic solution**.
- Water moves out first from cytoplasm and then to vacuole which causes shrinkage of protoplast from cell wall. When water flows into the cell and out of the cell and are in equilibrium, the cells are said to **flaccid**.
- The process of plasmolysis is usually reversible. When cells are placed in **hypotonic solution**, water diffuses into the cell causing the cytoplasm to build a pressure against the wall, that is called **turgor pressure**.
- As the cell becomes turgid, cell wall exerts an equal but opposite pressure to that of turgor pressure. This opposite pressure is called **wall pressure**.

4. Imbibition

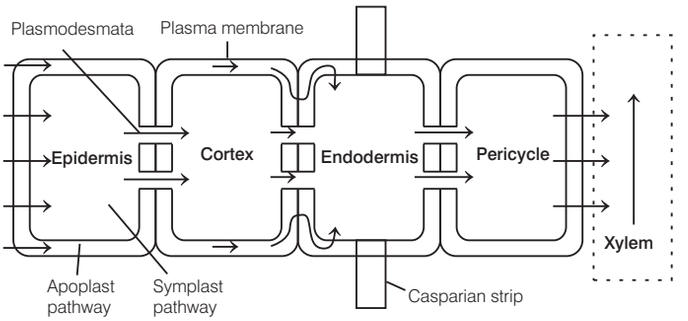
- It is a special type of diffusion when water is absorbed by solids-colloids causing them to increase in volume.
- For example, absorption of water by seeds and dry wood causes swelling due to the imbibition.
- Imbibition is significantly important because
  - It helps seedlings to come out from the soil.
  - In older times, the imbibition pressure was used for breaking the rocks and stones.
  - It acts as initial stage in germination of the seeds.

Long Distance Transport of Water

- In large and complex organisms, the sites of production or absorption are far away from the sites of storage.
- Due to this, substances have to follow the long path and have to move across very large distances to get transferred.
- The movement of water, minerals and food across long distances is generally done by a **mass** or **bulk flow system**, which operates due to the difference between the pressure of two points (i.e. the source and the sink).
- Bulk flow can be achieved either through a positive hydrostatic pressure gradient (e.g. a garden hose) or a negative hydrostatic pressure gradient (e.g. suction through a straw).
- The bulk movement of substances through the conducting or vascular tissues of plants is called **translocation**.

How do Plants Abrsorb Water?

- The absorption of water and minerals is the function of root hairs, purely by diffusion.
- Root hairs are thin-walled slender extensions of root, epidermal cells and largely increase the surface area for absorption. Once entering root hair, water follows two pathways
  - **Apoplast pathway** It is the system of adjacent cell wall that is continuous throughout the plant except at **Casparian strips** of the endodermis in the roots. The movement of water occurs exclusively through intercellular spaces and the walls of the cells. This movement is dependent on gradient (Apoplast pathway does not provide any barrier to water movement).
  - **Symplast pathway** It is the system of interconnected protoplasts. Neighbouring cells are connected through cytoplasmic strands that extend through **plasmodesmata**.
    Most water flow in the roots occurs through apoplast as it offers no resistance to water however, the inner boundary of cortex, i.e. the **endodermis**, is impervious to water because of a band of suberised matrix called **Casparian strip**. Water molecules are unable to penetrate the layer, so they are directed to wall regions that are not suberised into the cells properly through the membranes and water then moves through symplast. This pathway is slower than apoplast pathway and is helped by **cytoplasmic streaming** of cells.



Pathway of water movement

- Some plants have **mycorrhiza** (association of fungus with roots of higher plants) which provide a large surface area for absorption of mineral ions and water, e.g. *Pinus*.

Water Movement up a Plant

Plants absorb water from the soil and move it into the vascular tissues. Water is transported to various parts of the plant either through active transport or through passive transport.

Root Pressure

- As various ions from the soil are actively transported into the vascular tissues of the roots, water follows and increases the pressure inside roots. This positive pressure is called **root pressure**.
- This pressure is responsible for pushing up water to small heights in the stem.
- **Effect of root pressure or Guttation** It is the loss of water in liquid phase observable at night and early morning, when evaporation is low, excess water collects in the form of droplets around special openings of veins near the tip of grass blades and leaves of many herbaceous plants.

Transpiration Pull

- Most researchers agree that water is mainly 'pulled' through the plant and the driving force for this process is transpiration from leaves.
- In the plant body, there is a continuous column of water. It occurs from root through stem and leaves.
- This is referred to as the **cohesion-tension-transpiration pull model** of water transport.

Transpiration

- It is the evaporative loss of water by plants and occurs mainly through **stomata** in the leaves.

- Loss of water in the form of vapour occurs in transpiration.
- As the stomata open in daytime and close during night, this immediately causes opening or closing of stomata due to change in the turgidity of **guard cells**.
  Inner wall of each guard cell towards the pore or **stomatal aperture** is thick and elastic.
- 50-97% of transpiration occurs through stomata.
- The opening and closing of stomata can be understood by the following flowchart
  When turgidity increases within the two guard cells
  ↓
  Thin outer walls bulge out
  ↓
  Force inner walls into crescent shape
  ↓
  Stomata open
  ↓
  Guard cells loose turgor (due to water loss)
  ↓
  Elastic inner walls regain original shape
  ↓
  Guard cells become flaccid
  ↓
  Stomata close
- Transpiration is affected by **external factors** which include temperature, humidity, light and wind speed.

  Plant factors which include
  - **Number of stomata** Dorsiventral leaves (dicots) have greater number of stomata on lower surface. Isobilateral leaves (monocots) have equal number of stomata on both surfaces.
  - Distribution of stomata
  - Per cent of open stomata
  - Water status of plant
  - Canopy structure
- Transpiration driven ascent of xylem sap depends mainly on the following physical properties of water.
  - **Cohesion** Mutual attraction between water molecules.
  - **Adhesion** Attraction of water molecules to polar surfaces.
  - **Surface tension** Water molecules are attracted to each other in the liquid phase more than to water in the gas phase. It is responsible for capillarity in tracheids and vessels.
- These properties give water
  - **High tensile strength** Ability to resist a pulling force.
  - **High capillarity** Ability to rise in thin tubes.

Advantages of Transpiration

- Creates transpiration pull for absorption and transport in 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.
- Food in phloem sap can be transported in any required direction as long as there is a source of sugar and a sink which facilitates the use, storage or removal of the sugar.

Transpiration and Photosynthesis

- Availability of water is necessary for photosynthesis though some water is consumed in transpiration.
- C_4-plants are more efficient than C_3-plants in photosynthesis.
- In C_4-plants, there is reduction in the level of water loss and thus, these plants are capable of fixing more carbon to make sugars.

Uptake and Transport of Mineral Nutrients

- The nutritional requirement of the plant is obtained from water and minerals in the soil (except for carbon and oxygen which is taken from atmosphere).

Uptake of Mineral Ions

- This is done as minerals cannot be passively absorbed by roots because minerals are present in soil as charged particles (ions) which cannot move across cell membranes and the concentration of minerals in the soil is usually lower than the concentration of minerals in roots.
- Therefore, most minerals enter the root by **active absorption** into cytoplasm of epidermal cells, requiring energy in the form of ATP.
- Ions are absorbed from soil by both passive and active transport. Specific proteins in root hair cells actively pump ions from soil into the cytoplasm of epidermal cells. Minerals are translocated with the help of xylem.
- Water potential gradient is developed in roots by active uptake of ions which result in uptake of water by osmosis.

Translocation of Mineral Ions

- The quantity and types of solutes that enter xylem is regulated by transport proteins present in endodermal cells.
- Thus, endodermal cells act as control points. The apical and lateral meristems, developing flowers, young leaves, fruits and seeds, storage organs are chief sinks for mineral elements.
- The ions with the help of either active or passive uptake, or both reach the xylem of roots and are further transported to the whole plant body *via* transpiration stream.

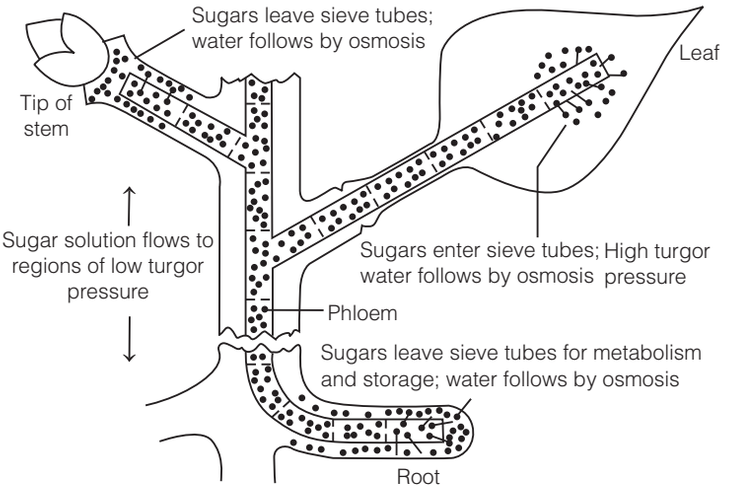
- The fine vein endings is where unloading of mineral ions takes place by diffusion or active uptake.

Phloem Transport : Flow from Source to Sink

- The leaves act as source, since food is manufactured there. Food, primarily sucrose, is transported by the vascular tissue phloem from a source to a sink.
- Sugar stored in roots may be mobilised to become a source of food in the early spring when the buds of trees act as sink (i.e. the part that needs energy for growth and development).
- Phloem sap is mainly water and sucrose but other than sugars, hormones and amino acids are also transported or translocated through phloem.
- According to the season and plant's need, source and sink areas get reversed and hence movement of nutrients may be unidirectional or bidirectional. In phloem, it is **bidirectional** while in xylem, it is always **unidirectional**.

Pressure Flow or Mass Flow Hypothesis

- This is the most accepted hypothesis for the translocation of sugars from the source to sink.
- Sugar is moved in the form of sucrose (a dissacharide) into the companion cells and then into the living phloem sieve tube cells by active transport.
- This process of loading at the source produces a hypertonic condition in the phloem.
- Movement of sugars begins at source, where sugars are loaded (actively transported) into a sieve tube. Loading of the phloem sets up a water potential gradient that facilitates the mass movement in the phloem.
- Osmotic pressure increases as water moves into phloem by osmosis. The phloem sap starts moving to regions of lower pressure which are the sinks. Here, active transport comes into action which moves sucrose out of phloem sap and finally into the cells. These cells would convert sugar to energy, starch or cellulose. This results in decrease in osmotic pressure of phloem which finally causes water to move out of phloem.



Mechanism of translocation

Mastering NCERT

MULTIPLE CHOICE QUESTIONS

TOPIC 1 ~ *Means of Transport*

1 Short distance transport of substances like nutrients, water, etc., in plants occurs through
(a) diffusion
(b) cytoplasmic streaming supplemented by active transport
(c) active transport only
(d) Both (a) and (b)

2 In plants, long distance transport of organic and inorganic substances occurs through
(a) simple permanent tissues
(b) complex permanent tissues
(c) meristematic tissues
(d) epithelial tissues

3 Which of the following is responsible for the transport of water and minerals from roots to stems, leaves, flowers and fruits in rooted plants?
(a) Xylem
(b) Phloem
(c) Cortex
(d) Both (a) and (b)

4 Transport of gases, hormones and organic solutes in plants is
(a) multidirectional
(b) unidirectional
(c) in two directions
(d) first unidirectional then divides to many directions

5 Movement of molecules, from a region of higher concentration to a region of lower concentration without expenditure of energy can be termed as
(a) osmosis (b) passive transport
(c) diffusion (d) active transport

6 The rate of diffusion of any substance is not affected by
(a) electrical charges of diffusing substances
(b) the presence of other substances in the solution
(c) molecular size of substances in a solution
(d) solubility to diffusing substance in lipids

7 What type of materials do not diffuse or find it difficult to pass through the membranes?
(a) Hydrophobic substances
(b) Hydrophilic substances
(c) Inorganic solutes
(d) Both hydrophilic and hydrophobic substances

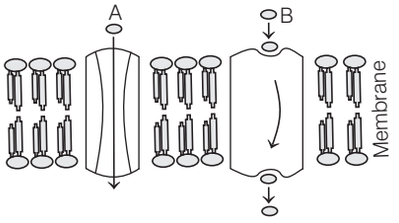
8 Which of the following affects the transport of molecules when carrier mediated facilitated diffusion is involved?
(a) Solubility of molecule in lipids
(b) Concentration gradient
(c) Availability of carrier molecule
(d) All of the above

9 What are the aquaporins in facilitated diffusion process?
(a) Lipids (b) Carrier proteins
(c) Channel proteins (d) Carrier lipids

10 Water channels are possessed by a membrane to facilitate the movement of hydrophilic substances. These channels are made up of
(a) eight similar types of aquaporin
(b) eight different types of aquaporin
(c) porin proteins
(d) None of the above

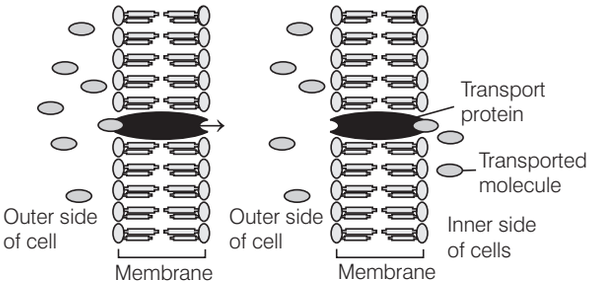
11 Carrier molecules, involved in facilitated diffusion
(a) increase the speed of transport across a membrane
(b) undergoes conformational change upon binding of solutes
(c) possess specific binding sites for the molecules to be transported
(d) All of the above

12 Consider the figure given below.



Identify *A* and *B*.
(a) A–Channel protein, B–Carrier protein
(b) A–Carrier protein, B–Channel protein
(c) Both A and B are Channel proteins
(d) Both A and B are Carrier proteins

13 Identify the following process and choose the correct option.

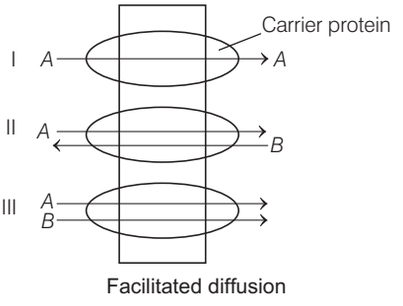


(a) Simple diffusion (b) Facilitated diffusion
(c) Osmosis (d) Deplasmolysis

14 Which of the following criteria does not pertain to facilitated transport? ***NEET 2013***
(a) Requirement of special membrane proteins
(b) High selectivity
(c) Transport saturation
(d) Uphill transport

15 Movement of two types of molecules in the same direction is
(a) symport (b) antiport
(c) uniport (d) Both (a) and (b)

16 The given diagram shows transport method of two molecules *A* and *B* together. Identify I, II and III and choose the correct option.



Facilitated diffusion

(a) I–Uniport, II–Symport, III–Antiport
(b) I–Uniport, II–Antiport, III–Symport
(c) I–Symport, II–Uniport, III–Antiport
(d) I–Antiport, II–Uniport, III–Uniport

17 What is required for the 'uphill transport' of substances through a membrane?
(a) Input of energy (b) Output of energy
(c) Pigments (d) Nothing is required

18 Which of the following is not a feature of active transport of solutes in plants? ***NEET (Odisha) 2019***

(a) Occurs against concentration gradient
(b) Non-selective
(c) Occurs through membranes
(d) Requires ATP

19 A group of students is studying transport of certain type of molecules in a cell and observe that transport slows down when the cells are treated with poison, i.e. a chemical which inhibits energy production. When under normal conditions, the process was repeated it was observed molecules are transported by

(a) osmosis (b) active transport
(c) facilitated diffusion (d) simple diffusion

20 Which of the following pairs is selective and specific mode of transport?

(a) Passive transport and active transport
(b) Passive transport and facilitated diffusion
(c) Facilitated diffusion and active transport
(d) Simple diffusion and facilitated diffusion

21 The main difference between active and passive transport across cell membrane is ***NEET (Odisha) 2019***

(a) passive transport is non-selective whereas active transport is selective
(b) passive transport requires a concentration gradient across a biological membrane whereas active transport requires energy to move solutes
(c) passive transport is confined to anionic carrier proteins whereas active transport is confined to cationic channel proteins
(d) active transport occurs more rapidly than passive transport

22 Compare the following processes of transport and choose the correct option.

S. No.	Property	Facilitated Diffusion	Active Transport	Simple Diffusion
I.	Highly specific	Yes, it is selective	Yes	No
II.	Use of energy as ATP	Yes	Yes	Yes
III.	Saturation point is reached when all carrier proteins are being used	Yes	No	Yes
IV.	Requires transport proteins	Yes	No	Yes

(a) Only II (b) Only III
(c) I, II, III and IV (d) Only I

TOPIC 2 ~ *Plant-Water Relation*

23 Two main components that determine water potential are

(a) pressure gradient minus water potential
(b) solute potential and pressure potential
(c) evaporation of water from stem and leaves
(d) the overall movement of solutes

24 The water potential of pure water is ***NEET 2017***

(a) zero
(b) less than zero
(c) more than zero, but less than one
(d) more than one

25 The water potential of pure water decreases on addition of

(a) solute (b) solvent
(c) Both (a) and (b) (d) None of these

26 Solute particles tend to …… the diffusion pressure of water.

(a) increase (b) decrease
(c) remain constant (d) become less than zero

27 Water tends to move into a cell that has

(a) high turgor pressure (b) high positive ψ_w
(c) more negative ψ_w (d) low turgor pressure

28 Water potential increases due to

(a) addition of solute
(b) evaporation
(c) addition of inorganic substances
(d) increase in pressure

29 Solute potential (ψ_s) is always

(a) positive (b) equal
(c) negative (d) None of these

30 The pressure exerted by the protoplast due to the entry of water against the rigid cell wall is termed as

(a) pressure potential (b) osmotic potential
(c) solute potential (d) water potential

31 The relationship between water potential, solute potential and pressure potential is

(a) $\psi_w = \psi_s - \psi_p$ (b) $\psi_w + \psi_s = \psi_p$
(c) $\psi_w = \psi_s + \psi_p$ (d) $\psi_w + \psi_p = \psi_s$

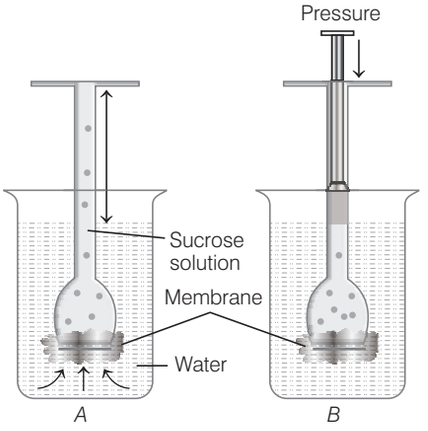
32 Cell *A* has ψ_w – 3 bars and cell *B* has ψ_w – 8 bars. The movement of water will be from

(a) cell *A* to cell *B*
(b) cell *B* to cell *A*
(c) data insufficient
(d) water cannot move in negative value of ψ_w

33 The process of osmosis depends upon
(a) concentration gradient (b) pressure gradient
(c) Both (a) and (b) (d) None of these

34 The osmotic expansion of a cell kept in water is chiefly regulated by
(a) mitochondria (b) vacuoles
(c) plastids (d) ribosomes

35 Identify the process taking place in the given experimental setup and choose the correct option.



(a) Osmosis (b) Plasmolysis
(c) Imbibition (d) Diffusion

36 In the thistle funnel experiment, what will happen if sugar solution is added to a beaker after the process of osmosis stops?
(a) The level of solution in thistle funnel will rise up
(b) The level of solution in thistle funnel will lower down
(c) The level of solution in beaker will drop
(d) The level of solution will remain unaffected in beaker

37 Prolonged addition of urea to a flowering plant causes
(a) endosmosis (b) exosmosis
(c) plasmolysis (d) diffusion

38 When a plant cell is placed in pure water, it
(a) expands until the osmotic pressure reaches that of water
(b) becomes less turgid until the osmotic potential reaches that of pure water
(c) becomes more turgid until the pressure potential of cell reaches its osmotic potential
(d) becomes more turgid until the osmotic potential reaches that of pure water

39 Cell *A* has osmotic potential of – 20 bars and pressure potential of 5 bars, whereas cell *B* has osmotic potential of –18 bars and pressure potential of 2 bars. The direction of flow of water will be ***AIIMS 2018***
(a) from cell *B* to cell *A* (b) from cell *A* to *B*
(c) no flow of water (d) in both the directions

40 The values of osmotic potential (π) and pressure potential (ρ) of cells *A, B, C* and *D* are given below.

Cell	π	ρ
A	– 1.0	0.5
B	– 0.6	0.3
C	– 1.2	0.6
D	– 0.8	0.4

Identify the option, which shows correct sequence of the path of movement of water.
(a) A → B → C → D (b) B → D → A → C
(c) B → C → D → A (d) D → A → B → C

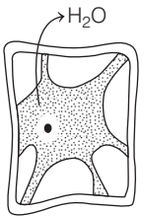
41 Numerically osmotic pressure is equivalent to
(a) osmotic potential (b) pressure gradient
(c) water potential (d) None of these

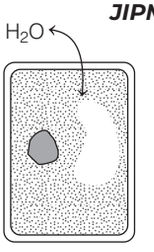
42 If the osmotic pressure of cytoplasm in a cell is balanced by external solution, the solution must be
(a) hypotonic (b) hypertonic
(c) atonic (d) isotonic

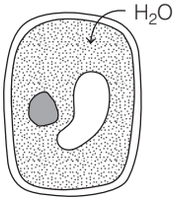
43 When the external solution is more …*A*…, it is called …*B*… solution.
Fill in the blanks with appropriate pair from the options given below.
(a) A–dilute; B–hypertonic
(b) A–concentrated; B–hypotonic
(c) A–dilute; B–isotonic
(d) A–concentrated; B–hypertonic

44 What will be the direction of flow of water when a plant cell is placed in a hypotonic solution? ***NEET (Odisha) 2019***
(a) Water will flow in both directions
(b) Water will flow out of the cell
(c) Water will flow into the cell
(d) No flow of water in any direction

45 Cell placed in hypertonic solution is shown by ***JIPMER 2019***

(a) 

(b) 

(c) 

(d) Both (a) and (b)

46 RBC and a plant cell are kept in distilled water. The solute concentration is same in both the cells. Observe the change in both the cells.
(a) Both plant cell and RBC would not undergo any change
(b) The RBC would increase in size and burst, while the plant cell would remain about the same size
(c) The plant cell would increase in size and burst, while the RBC would remain about the same size
(d) Both plant cell and RBC would decrease in size and collapse

47 …*A*… occurs when the water moves out of the cell and the …*B*… of a plant cell shrinks away from the cell wall.

Fill in the blanks by choosing the correct pair of words from the options given below.
(a) A–Reverse osmosis; B–protoplasm
(b) A–Imbibition; B–nucleus
(c) A–Translocation; B–ER
(d) A–Plasmolysis; B–cell membrane

48 Which among the following represents the correct relationship for a plasmolysed cell?
(a) $\psi_w = \psi_s + \psi_p$ (b) $\psi_s = \psi_w + \psi_p$
(c) $\psi_w = \psi_s$ (d) $\psi_w = \psi_p$

49 The space between the plasma membrane and the cell wall of plasmolysed cell surrounded by a hypertonic solution is occupied by
(a) hypertonic solution (b) hypotonic solution
(c) isotonic solution (d) water

50 A leaf peeling of *Tradescantia* is kept in a medium having 10% NaCl. After a few minutes, if we observe the leaf peel under the microscope, we are likely to see
(a) entry of water into the cell
(b) the cells bursting out
(c) diffusion of NaCl into the cell
(d) exit of water from the cell

51 What will happen, if a large amount of water enters in a plant cell?
(a) TP of cell gets reduced
(b) TP opposes the entry of water
(c) Water potential of the cell becomes more negative
(d) Water potential of the cell increases simultaneously

52 If sugars are actively moving into a cell, what will happen to the turgor pressure of the cell?
(a) TP increases due to the entry of water
(b) TP decreases because water exits
(c) TP increases as sugar concentration affects it directly
(d) No effect of sugar concentration on turgidity hence, no change

53 A special type of diffusion when water is absorbed by solids-colloids causing them to increase in volume is
(a) absorption (b) imbibition
(c) active transport (d) osmosis and diffusion

54 Study the following conditions.
I. Wooden doors swell-up and get stuck during rainy season.
II. Rocks and boulders were split using a phenomenon by prehistoric man.
III. Pressure build-up which helps seedlings emerge out of soil.

Which one of the following phenomenon is responsible for above condition?
(a) Imbibition (b) Osmosis
(c) Diffusion (d) Endosmosis

55 Why seeds imbibe and swell after keeping in water?
(a) OP inside the seed is low
(b) OP of water is high
(c) Water potential gradient develops between the seed coat and water
(d) Diffusion pressure deficit of seed is very high

56 The pre-requisite for any substance to imbibe any liquid is
(a) affinity between absorbant and liquid
(b) affinity between adsorbant and liquid
(c) affinity between absorbant and seed
(d) affinity between adsorbant and seed

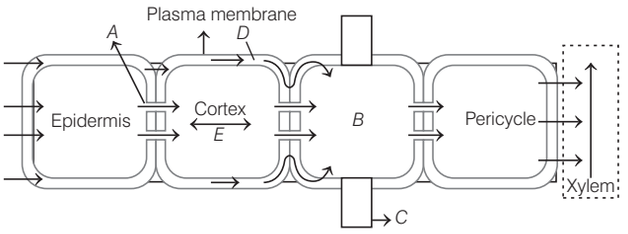
57 Imbibition is always accompanied by swelling or increase in the volume of the imbibant. However, the increase in the volume of the imbibant is
(a) more than the volume of water imbibed
(b) same as the volume of the water imbibed
(c) less than the volume of the water imbibed
(d) depend upon the type of imbibant

TOPIC 3 ~ *Long Distance Transport of Water*

58 Transport of different types of solute substances over long distances takes place by
(a) bulk flow system
(b) combined response
(c) facilitated diffusion
(d) pressured transport

59 Examples of bulk flow by a positive hydrostatic pressure gradient and a negative hydrostatic pressure gradient are
(a) suction through straw and swelling of wood, respectively
(b) imbibition and a garden hose
(c) garden hose and suction through a straw, respectively
(d) swelling of wood and imbibition, respectively

60 In the given flowchart, the pathway of water movement is shown from soil to xylem. Identify *A-E* and choose the correct option.



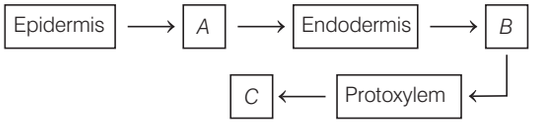
(a) A–Stomatal pore, B–Endodermis, C–Casparian strip, D–Symplast, E–Apoplast
(b) A–Plasmodesmata, B–Palisade, C–Medullary rays, D–Symplast, E–Apoplast
(c) A–Plasmodesmata, B–Endodermis, C–Casparian strip, D–Apoplast, E–Symplast
(d) A–Stomatal pore, B–Guard cell, C–Medullary rays, D–Apoplast, E–Symplast

61 In which of the following paths, flow of water occurs from cell to cell through their protoplasm?
(a) Apoplast pathway
(b) Symplast pathway
(c) Both (a) and (b)
(d) Transmembrane pathway

62 Which of the following pathways occurs through cell wall? ***AIIMS 2018***
(a) Apoplast pathway
(b) Vascular pathway
(c) Symplast pathway
(d) Non-vacuolar pathway

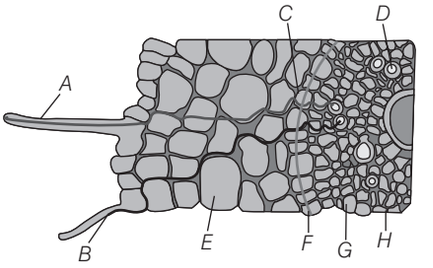
63 Which one of the following acts as a barrier in the apoplastic pathway?
(a) Epidermis
(b) Plasmodesmata
(c) Casparian strips
(d) Metaxylem

64 In the given schematic diagram, pathway of water movement inside the root is shown from soil to xylem. Identify the tissue involved in the steps *A-C* and choose the correct option accordingly.



(a) A–Hypodermis, B–Medullary rays, C–Metaxylem
(b) A–Cortex, B–Pericycle, C–Metaxylem
(c) A–Pericycle, B–Cortex, C–Metaxylem
(d) A–Hypodermis, B–Cortex, C–Vascular tissues

65 A portion of transverse section of root is shown in the diagram. Identify *A-H* in the given diagram and choose the correct option.



(a) A–Apoplastic path; B–Symplastic path; C–Endodermis; D–Phloem; E–Cortex; F–Casparian strip; G–Pericycle; H–Xylem
(b) A–Symplastic path; B–Apoplastic path; C–Xylem; D–Phloem; E–Endodermis; F–Cortex; G–Casparian strip; H–Pericycle
(c) A–Symplastic path; B–Apoplastic path; C–Endodermis; D–Xylem; E–Cortex; F–Casparian strip; G–Pericycle; H–Phloem
(d) A–Apoplastic path; B–Symplastic path; C–Endodermis; D–Cortex; E–Casparian strip; F–Xylem; G–Phloem; H–Stele

66 Pathway of water conduction from soil to xylem is
(a) soil → root hair → cortex → pericycle → endodermis → metaxylem → protoxylem
(b) soil → root hair → cortex → endodermis → pericycle → protoxylem → metaxylem
(c) soil → root hair → epidermis → endodermis → phloem → xylem
(d) soil → root hair → epidermis → cortex → phloem → xylem

67 The fungus part in mycorrhizal association provides to plant
(a) sugar (b) minerals and water
(c) N-containing compounds (d) carbohydrates

68 Root hair zone in plants is a specialised structure for water absorption. They do not perform photosynthesis and so are incapable of
(a) mineral uptake (b) water uptake
(c) CO_2 uptake (d) O_2 uptake

69 The positive pressure responsible for pushing up water to small heights is called
(a) root pressure (b) stem pressure
(c) guttation (d) osmosis

70 The pressure responsible for oozing of solution through cut stem near base of a soft stemmed plant on early morning of a humid day is
(a) turgor pressure (b) root pressure
(c) osmotic pressure (d) None of these

71 Root pressure
(a) is insufficient to rise water above ground level
(b) is positive in all except the tallest trees
(c) acts as the driving force for the mass flow of sugar
(d) is unable to push water up to small height in the stem

72 Root hair absorbs water from soil with the help of
(a) suction pressure (b) turgor pressure
(c) osmotic pressure (d) None of these

73 During water absorption from the soil, the water potential of the root cell is ..... than the soil.
(a) higher (b) lower
(c) slightly higher (d) slightly lower

74 A thin layer of water held by the soil particles under the influence of internal attractive force, is known as
(a) hygroscopic water (b) gravitational water
(c) ground water (d) capillary water

75 Loss of water in liquid phase (in form of droplets) from the margin of leaves in many herbaceous plants is
(a) guttation (b) root pressure
(c) transpiration (d) transpiration pull

76 During guttation
(a) water is driven out during night
(b) water is excreted in impure form
(c) water is excreted in liquid phase
(d) All of the above

77 Loss of water in liquid phase by guttation takes place through a specialised structure called
(a) sunken stomata (b) cuticle
(c) hydathode (d) bark

78 Which one is false about guttation?
(a) It occurs in herbaceous plants when root pressure is low and transpiration is high
(b) It occurs in plants growing under conditions of high soil moisture and low humidity
(c) Both (a) and (b)
(d) Guttation is not related with transpiration

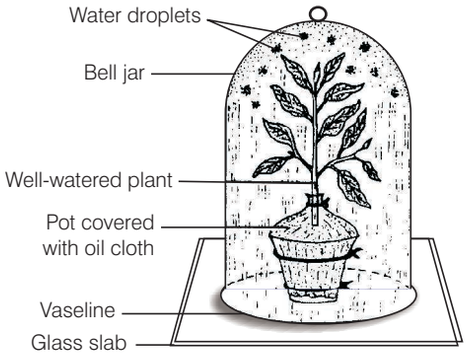
79 The force responsible for the water movement against gravity even up to a 130 m of tall tree comes from
(a) root pressure (b) transpiration pull
(c) diffusion pressure (d) pulsation

TOPIC 4~ *Transpiration*

80 Transpiration is the loss of water from aerial parts of plants in the
(a) solid form (b) liquid form
(c) vapour form (d) Both (b) and (c)

81 Transpiration is important for plants as
(a) it creates transpiration pull for transport
(b) supplies water for photosynthesis
(c) maintains shape of plant
(d) All of the above

82 What is depicted by the diagram given below?



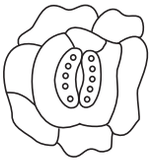
(a) Measuring the rate of transpiration
(b) Demonstration of ascent of sap
(c) Demonstration of transpiration
(d) Both (a) and (c)

83 Cobalt chloride paper is used to study which phenomenon in plants?
(a) Osmosis (b) Diffusion
(c) Transpiration (d) Guttation

84 The opening and closing of stomata is due to change in
(a) osmolarity (b) turgidity
(c) transpiration (d) None of these

85 Which one gives the most valid and recent explanation for stomatal movements?
CBSE-AIPMT 2015
(a) Transpiration
(b) Potassium influx and efflux
(c) Starch hydrolysis
(d) Guard cell photosynthesis

86 The given figure of stomata demonstrates which condition?

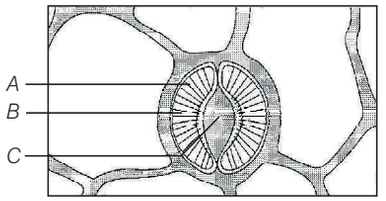


(a) Guard cell with higher water content
(b) Guard cell with lower water content
(c) Guard cell with no water content
(d) Guard cell with medium water content

87 If concentration of solute has decreased in guard cells, what change can be observed in it?
(a) Osmotic pressure increases
(b) Water potential increases
(c) Water potential decreases
(d) Both (b) and (c)

88 Stomatal opening is affected by
(a) nitrogen concentration, carbon dioxide concentration and light
(b) carbon dioxide concentration, temperature and light
(c) nitrogen concentration, light and temperature
(d) carbon dioxide concentration, nitrogen concentration and temperature

89 Choose the correct option for label *A*-*C* in the given diagram of stomatal apparatus.



	A	B	C
(a)	Stomatal aperture	Subsidiary cell	Guard cell
(b)	Microfibril	Guard cell	Stomatal aperture
(c)	Stomatal aperture	Guard cell	Epidermal cell
(d)	Stomatal aperture	Guard cell	Cellulosic microfibril

90 Isobilateral leaf is an
(a) amphistomatic leaf (b) monostomatic leaf
(c) bistomatic leaf (d) Both (b) and (c)

91 Which of the following factors is most important in the regulation of transpiration?
(a) Light (b) Temperature
(c) Relative humidity (d) Wind speed

92 Transpiration and root pressure cause water to rise in plants by ***CBSE-AIPMT 2015***
(a) pulling it upward
(b) pulling and pushing it, respectively
(c) pushing it upward
(d) pushing and pulling it, respectively

93 Plants growing on hills are likely to show
(a) higher rates of transpiration
(b) lower rates of transpiration
(c) same rate of transpiration as in plains
(d) lower rates of transpiration provided by the sunken stomata

94 Cohesion is
(a) attraction between water and leaf surface
(b) attraction between water molecules
(c) attraction of water molecules to polar surfaces
(d) attraction of water molecules to non-polar surfaces

95 Adhesion is caused by
(a) formation of hydrogen bond between water molecules
(b) transpiration pull
(c) higher surface tension
(d) attraction of water molecules to polar surface

96 Which theory is considered best to explain ascent of sap?
(a) Bulk flow system (b) Transpiration pull
(c) Transpiration (d) Root pressure theory

97 Ascent of sap is
(a) active and requires energy expenditure by the soil
(b) passive and no requirement of energy by the plants
(c) active and requires energy expenditure by the plants
(d) passive unless soil is dry

98 According to the transpiration-cohesion theory, the upward pull of water is transmitted to other water molecules by cohesion, which is caused by
(a) hydrogen bond (b) hydrophilic cell walls
(c) turgor pressure (d) osmosis

99 No rupture and fraction occur in water column of vessels and tracheids during ascent of sap. It is due to
(a) they are lignified thick walls
(b) they have weak gravitational pull
(c) cohesion and adhesion
(d) transpiration pull

100 Which one of the following does not play a major role in upward movement of xylem sap in tall trees?
(a) Transpiration
(b) Tension
(c) Cohesion and adhesion
(d) Plasmodesmeta

101 A student has taken a twig from a plant. She/he observes a droplet of fluid exuding from the cut surface of twig. What is this fluid?
(a) Plant latex (b) Phloem sap
(c) Xylem sap (d) Both (b) and (c)

102 The ability to resist a pulling force is
(a) capillarity (b) cohesion
(c) adhesion (d) tensile strength

103 Which is not the function of transpiration?
(a) Cools leaf surface
(b) Maintains shape and structure of plant
(c) Helps in translocation of sugars from source to sink
(d) Provides water for photosynthesis

104 A twig having fresh flower and buds is kept in minute amount of water containing salt. It remains fresh for a longer period due to
(a) exosmosis
(b) absorption of more water
(c) electrolyte balance
(d) decrease in transpiration rate

TOPIC 5 ~ *Uptake and Transport of Mineral Nutrients*

105 Choose the correct option for uptake of mineral ions.
(a) Unlike water, all minerals cannot be passively absorbed by roots
(b) Most of the minerals enter the root by active transport
(c) Ions are absorbed from soil by both passive and active transport
(d) All of the above

106 Which one of the following has a significant role in solvent transport?
(a) Diffusion (b) Active transport
(c) Osmosis (d) Surface tension

107 The concentration of minerals in the soil is usually …… than/to the concentration of minerals in the roots.
(a) greater (b) equal
(c) lower (d) Both (a) and (b)

108 Transport of minerals through xylem is
(a) active and energy is provided by ATP
(b) passive and energy is not required
(c) active and no requirement of energy
(d) passive and energy is provided by ATP

109 Xylem sap is made up of
(a) water alone (b) water and minerals
(c) minerals alone (d) sugar and water

110 Root pressure develops due to ***CBSE-AIPMT 2015***
(a) active absorption (b) low osmotic potential in soil
(c) passive absorption (d) increase in transpiration

111 The chief sinks for the mineral elements are
(a) the growing regions of the plants like apical meristem and lateral meristem
(b) young leaves
(c) developing flowers, fruit and seeds
(d) All of the above

112 During mineral translocation, elements most readily mobilised are
(a) phosphorus and sulphur
(b) nitrogen and potassium
(c) oxygen and carbon
(d) Both (a) and (b)

113 Some elements like calcium are not remobilised because they are
(a) structural components (b) heavy metals
(c) less charged (d) macromolecules

TOPIC 6 ~ *Phloem Transport : Flow from Source to Sink*

114 Phloem sap is made up of
(a) water and minerals (b) water and sucrose
(c) water and glucose (d) Both (b) and (c)

115 In plants, which of the following are translocated through phloem?
(a) Hormones (b) Amino acids
(c) Sugars (d) All of these

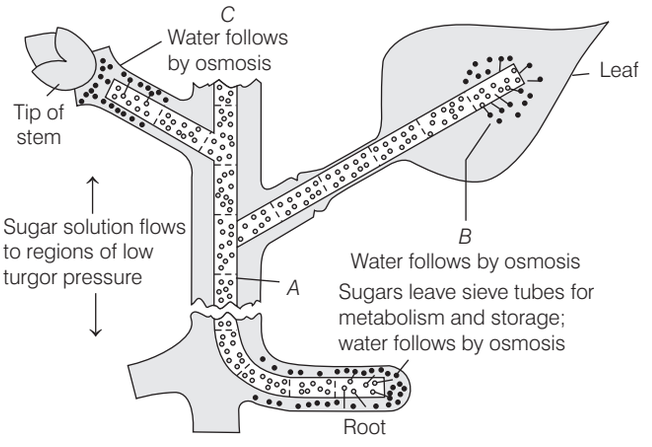
116 Pressure flow hypothesis is for
(a) translocation of sugars
(b) translocation of water
(c) translocation of minerals
(d) None of these

117 The accepted mechanism used for the translocation of sugars from source to sink is
(a) root flow hypothesis (b) pressure flow hypothesis
(c) transpirational pull (d) stem flow hypothesis

118 Loading of phloem sets up a …… that facilitates mass movement in phloem.
(a) concentration gradient
(b) pressure gradient
(c) water potential gradient
(d) Both (a) and (b)

119 When sugars enter sieve tubes, water flows by osmosis, resulting in
(a) water potential
(b) osmotic gradient
(c) turgor pressure
(d) DPD

120 In the given diagram, identify the marked phenomenon/part and choose the correct option.



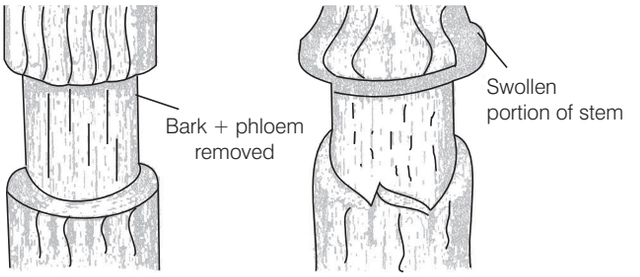
(a) A–Phloem, B–Sugar leaves sieve tube, C–Sugar enters sieve tube
(b) A–Xylem, B–Sugar leaves sieve tube, C–Sugar enters sieve tube
(c) A–Phloem, B–Sugar enters sieve tube, C–Sugars leave sieve tubes
(d) A–Xylem, B–Sugar enters sieve tube, C–Sugars leave sieve tubes

121 Sugar is loaded into sieve tube by
(a) simple diffusion (b) active transport
(c) facilitated transport (d) passive transport

122 If you are given a task to analyse phloem sap chemical, which of the following will be present in least concentration?
(a) Water (b) Sugar
(c) Minerals and nitrogen (d) Hormones

123 Why the transport of organic food through phloem is bidirectional?
(a) Roots serve as source, while leaves are the sink region
(b) Source and sink regions are irreversible
(c) The relationship between the two regions (source and sink) is variable
(d) Translocation of organic solute is regulated by energy

124 The diagram given below represents the simple ringing or girdling experiment. Bark containing phloem is removed. This experiment proves and justify that phloem is the path for translocation of food. In the given diagram, swollen part of stem has been indicated.



Choose the correct option for the formation of the swollen part of stem.
(a) Accumulation of food material just above the ringing space
(b) Accumulation of minerals and water just above the ringing space
(c) Due to a repairing mechanism
(d) Injured part undergoes turgor change

NEET

SPECIAL TYPES QUESTIONS

I. Assertion and Reason

■ **Direction** (Q. No. 125-133) *In each of the following questions, a statement of Assertion* (A) *is given by corresponding statement of Reason* (R). *Of the statements, mark the correct answer as*
(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true, but R is not the correct explanation of A
(c) If A is true, but R is false
(d) If A is false, but R is true

125 **Assertion** (A) No energy expenditure takes place in the process of diffusion.

Reason (R) Diffusion occurs along the concentration gradient, i.e. from a region of higher concentration to a region of lower concentration.

126 **Assertion** (A) In washed beet root slices, kept in cold water, β-cyanin does not diffuse outside of the cell.

Reason (R) Membrane is not permeable to the pigment β-cyanin.

127 **Assertion** (A) When dried seeds of pea are placed in a tin and water is added up to their upper level and then a lid is put tightly over it, within an hour, the lid will blow off.

Reason (R) The lid of tin will blow due to rapid division in pea seeds.

128 **Assertion** (A) During rainy season, wooden doors get stuck and become difficult to open and shut properly.

Reason (R) Due to the process of imbibition volume of wooden items increases, when they come in contact of water.

129 **Assertion** (A) Unidirectional flow of water, mineral and nitrogen occurs through xylem.

Reason (R) Direction of flow of organic and inorganic substances is unidirectional and occurs through phloem.

130 **Assertion** (A) Cohesion force is also called as tensile strength.

Reason (R) Attraction of water molecules to polar surface or hydrophilic wall of the xylem tube causes adhesion force.

131 **Assertion** (A) Transpiration facilitates supply of water for photosynthesis, maintains shape and structure of plant and also transports minerals from the soil to other parts of the plant.

Reason (R) Process of transpiration helps in translocation of inorganic and sugar molecules from the source to sink.

132 **Assertion** (A) In phloem, sugar is translocated in non-reducing form.

Reason (R) Non-reducing sugars are the most reactive sugars.

133 **Assertion** (A) In the ringing experiment, a narrow continuous band of tissue external to the xylem is removed.

Reason (R) Ringing experiment proves the transport of solutes by phloem.

II. Statement Based Questions

134 Which of the following statements distinguish between the method of transport between xylem and phloem?

(a) Active transport moves xylem, but not phloem sap
(b) Transport in xylem is unidirectional and saps move upward, while in phloem transport is bidirectional
(c) Transpiration does not move xylem sap, but it moves phloem sap
(d) Transport of substances takes place from source to sink by both the tissues

135 Which of the following statements is incorrect for the movement of water?

(a) Water is pumped up in the plant by roots
(b) Water is pulled up the plant by evaporation of water from the leaf surfaces
(c) Water has a strong tendency to be evaporated into the air
(d) Continuous column of water in xylem tissue resists breaking even when exposed to the forces of evaporation and gravity

136 Some cells are placed in a solution of glucose to measure the rate of diffusion. As the concentration of glucose solution is being increased, the diffusion rate increases simultaneously. However, when the concentration of glucose solution reaches above 10 m, the diffusion rate no longer increases.

Which statement best defines the mechanism of glucose transport in the cells?

(a) Transport of hydrophilic substances along the concentration gradient through fixed membrane transport protein without the involvement of energy expenditure
(b) Transport of hydrophilic substances along and against the concentration gradient *via* carrier proteins
(c) Active transport *via* transporter proteins
(d) Facilitated diffusion without carrier proteins

137 Following statements are related with the diffusion of coloured molecules across a membrane. Select the correct statement which shows the fastest rate of diffusion.

(a) An internal concentration of 15% and external concentration of 10%
(b) An internal concentration of 25% and external concentration of 50%
(c) An internal concentration of 50% and external concentration of 25%
(d) Both (b) and (c) show fastest rate of diffusion

138 Choose true and false statements from the following and select the correct option.

I. Diffusion is an important process of transport in plants since, it is the only means for gaseous movement within the plant body.
II. In active transport, pumps are proteins that use energy to carry substances across the cell membrane against concentration gradient.
III. In facilitated diffusion, special proteins help hydrophilic substances to be transported across the membrane.
IV. In diffusion, molecules move against concentration gradient in a random manner.
V. Facilitated diffusion is faster than active transport.

(a) I, II, III and IV all are true
(b) I, II, III are true, while IV and V are false
(c) IV and V are true, while I, II and III are false
(d) II, III, IV are true, while I and V are false

139 Read the following statements regarding porins and select the correct option given below.

I. Porins are transport proteins.
II. Channel proteins are a type of transport protein, which are usually gated.
III. Carrier protein binds the particular solute to be transported.
IV. Particular solute is delivered to the other side of the membrane by carrier proteins.

(a) I, II and III (b) I, III and IV
(c) I, II, III and IV (d) I and IV

140 Which statement can be shared by facilitated diffusion and active transport?

(a) Both need carrier transporter, which are sensitive to inhibitors that react with protein's side chains
(b) Energy is required by both the processes
(c) No energy expenditure in these processes
(d) Both use carbohydrates to move molecules across the membrane

141 Consider the following statements and choose the correct statements.

I. Carrier proteins are needed by both facilitated diffusion and active transport and are sensitive to inhibitors that react with protein's side chain.
II. Different types of proteins present in the membrane play a major role in both active as well as passive transport.
III. The carrier proteins needed by facilitated and active transport are specific.
IV. There is no need of energy to pump molecule against a concentration in active transport.
V. Transport rate reaches to saturation point, when all the active proteins are used.

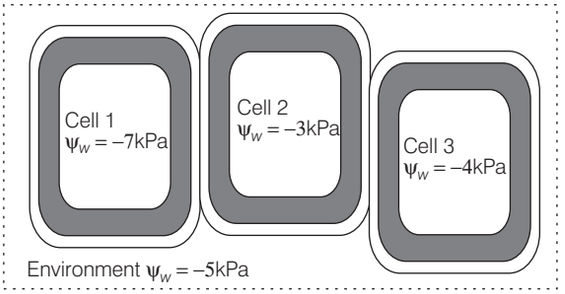
Choose the correct option.

(a) I, II, II, IV and V
(b) I, II and III
(c) V, IV and I
(d) I, II, III and V

142 Some statements are given regarding active transport in plants.
Choose the incorrect statement.

(a) Active transport needs energy to pump molecules against the concentration gradient
(b) It is carried out with the help of membrane proteins
(c) Due to more concentration of charged particles in soil than the concentration in roots, active absorption of minerals takes place
(d) All of the above

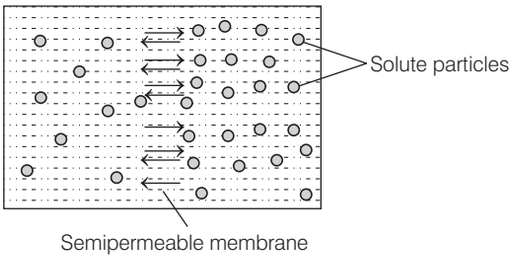
143 The diagram shows the water potential (ψ_w) in some plant cells and their environment.



Which statement describes the movement of water between these cells and their environment?

(a) All three cells are turgid, so no water moves
(b) Water moves from cell 1, cell 3 and the environment into cell 2
(c) Water moves from cell 3 to the environment and from the environment to cell 1
(d) Water moves from the environment into cells 1, 2 and 3

144 Study the following picture and the statements given below and choose the incorrect option.



(a) The above diagram shows the net movement of water from the dilute to concentrated solution
(b) The two solutions are separated by a differentially permeable membrane
(c) Water molecule strikes the membrane randomly on both the sides and passes through the same
(d) Diffusion of water does not occur from its lower chemical potential to higher chemical potential

145 Choose the correct option for the following statements.

I. Movement of substances through diffusion is active as well as passive.
II. Water potential (Ψ_w) of a solution equals the solute potential at the atmospheric pressure.
III. Inward movement of water makes the cell flaccid and *vice versa*.

(a) I, II are true, but III is false
(b) III, II are true, but I is false
(c) II is true, but I, III are false
(d) All are false statements

146 Choose the correct option in accordance to the statements given below.

I. Wall pressure is exerted to prevent any increase in protoplasm size.
II. Osmosis is the movement of substances, which takes place along a diffusion gradient.

(a) Both statements I and II are correct
(b) Both statements I and II are incorrect
(c) Statement I is correct and II is incorrect
(d) Statement I is incorrect and II is correct

147 Select the correct statement for net direction and rate of osmosis from the following.

(a) Only the net direction of osmosis, not the rate of osmosis depends on both the pressure gradient and concentration gradient

(b) The rate of osmosis depends only on pressure gradient

(c) The net direction and rate of osmosis depend upon both the pressure gradient and concentration gradient

(d) The net direction and rate of osmosis do not depend on the pressure gradient and concentration gradient

148 Read the following statements and choose the correct one from the codes given below.

I. The apoplastic movement of water takes place exclusively through intercellular spaces and cell wall without crossing any membrane.

II. Symplastic movement occurs from cell to cell through plasmodesmata, i.e. adjacent cells are connected through plasmodesmata.

III. Permeability of a membrane depends on its composition and chemical nature of the solute.

IV. Solutes present in a cell increase the free energy of the water or water potential.

(a) I, II and III (b) I, II and IV

(c) II and IV (d) I and IV

149 Choose the correct statement regarding Casparian strips.

I. It surrounds pericycle.

II. It is made up of lignosuberin.

III. It limits the pathway available to water solutes, forcing them to enter the symplast.

(a) I and III (b) I, II and III

(c) I and II (d) None of these

150 Consider the following statements.

I. *Pinus* seeds cannot germinate and establish without the presence of mycorrhizae.

II. Mycorrhizal association between fungus and root of plant (*Pinus*) is often obligate.

Choose the correct option.

(a) Statment I is true, but II is false

(b) Statement II is true, but I is false

(c) Both the statements I and II are true

(d) Both the statements I and II are false

151 Read the following statements and choose the correct answer from the options given below.

(a) In the absence of Casparian strips, plants are unable to control amount of water and solute it absorbs

(b) Guttation generally occurs during high atmospheric humidity and plentiful soil water

(c) Translocation of sugars from source to sink is called pressure flow hypothesis

(d) All statements are correct

152 Read the following statements.

I. *Hydrilla* leaf cells show the cytoplasmic streaming.

II. Mycorrhiza has fungal and algal association with roots, which is found in the roots of *Cycas* and *Pinus*.

III. Innermost layer of cortex of root and stem is the layer called endodermis.

Select the appropriate option(s).

(a) Only statement I is true

(b) Statements I and III are true

(c) All statements are true

(d) None of the statements is true

153 Consider the following statements and choose the correct answer from the options given below.

I. A dry alive seed still contains water.

II. A mature maize plant absorbs about 3 L water per day.

III. A mustard plant takes up water equal to its weight in about five hours.

IV. Water is not considered as the limiting factor for plant growth and productivity.

(a) I, II, III and IV (b) IV and II

(c) I, II and III (d) Only IV

154 Choose the correct statements regarding guttation and pick the correct option form the codes given below.

I. It occurs through specialised pore called hydathode.

II. Hydathodes can be located on margin and tips of leaves.

III. It occurs in plants growing under condition of low soil moisture and high humidity.

IV. It occurs in herbaceous plants when root presssure is low and transpiration is high.

(a) I and II (b) III and IV

(c) I, II, III and IV (d) I, II and IV

155 Water vapour comes out from the plant leaf through the stomatal opening. Through the same stomatal opening carbon dioxide diffuses into the plant during photosynthesis. Reason out the above statements using the following options. ***NEET 2016***

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

(b) The above processes happen only during night time

(c) One process occurs during daytime and the other at night

(d) Both processes cannot happen simultaneously

156 Read the following statements and choose the correct option.

I. Most of the transpiration takes place through surface/margin of leaves.

II. A little amount of water is lost through stem, this is referred to cauline transpiration.

III. Transpiration is comparatively a slow process than evaporation.

IV. Transpiration driven ascent of sap does not depend on cohesion, adhesion and surface tension properties of water.

(a) I, II, III and IV (b) I, II and III
(c) I, II and IV (d) II, III and IV

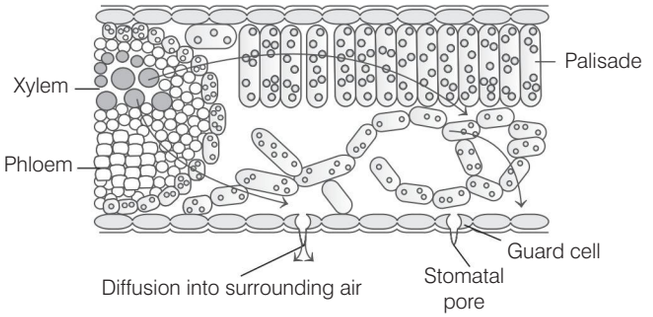
157 Consider the following statements.

I. Cohesion, adhesion and surface tension are the physical properties of water.
II. These properties give water high tensile strength and high capillarity.

Choose the correct option.

(a) Statement I is true, but II is false
(b) Statement I is false, but II is true
(c) Both statements I and II are true
(d) Both statements I and II are false

158 Read the following statements about the figure given below and choose the correct statement.



(a) The figure shows the movement of water in the leaf
(b) Stomatal transpiration causes the pulling of water molecules into the leaf from xylem
(c) Lower water vapour in the atmosphere causes transpiration pull
(d) All of the above

159 Consider the following statements.

I. Most minerals enter the root by active transport.
II. Minerals present in the soil are charged particles (ions).

Choose the correct option.

(a) I is true, but II is false (b) II is true, but I is false
(c) Both I and II are true (d) Both I and II are false

160 Consider the following statements for analysis of the xylem exudates. It indicates that

I. Some of the inorganic nitrogen travel in the organic form as amino acid and related organic compounds, much of it is carried as inorganic ions.
II. Small amount of phosphorus and sulphur carried as organic compound.

Choose the correct option.

(a) Statement I is true, but II is false
(b) Statement II is true, but I is false
(c) Both statements I and II are true
(d) Both statements I and II are false

161 Choose the option for the correct statements.

I. Ions are absorbed from the soil by both active and passive transport.
II. Specific proteins in the membranes of root hair cells actively pump ions from the soil into the cytoplasm of epidermal cells.
III. Transport proteins of endodermal cells are control points, where a plant adjusts the quantity and types of solutes that reach the xylem.
IV. Root endodermis because of the layer of suberin has the ability to actively transport ions in one direction only.

(a) I, II and III (b) II and IV
(c) III and IV (d) I, II, III and IV

162 Which of the following statements is/are correct regarding pressure flow model for translocation?

I. Sugar is transported through phloem as glucose.
II. Movement of sugar is carried out through sieve tube near the source region.
III. Concentration of sugar is always highest near the sink region.
IV. Water from the adjacent xylem moves into phloem by osmosis.

(a) II and IV (b) II and III
(c) I, II and III (d) Only IV

163 Identify true and false statements and select the correct option from the codes given below.

I. As suction pressure increases, water absorption also increases, which in turn increases the absorption of ions.
II. Absorption of ions is affected by transpiration pull.
III. Large amount of charged particles is absorbed along with absorption of water.
IV. Pressure flow hypothesis depends entirely on the existence of mechanism for loading sugars into phloem at the source region and unloading of it at the sink.
V. Contents in the sieve tube move unidirectionally.

(a) I, II, III and IV are true, while V is false
(b) I, III, IV and V are true, while II is false
(c) I, II, IV and V are true, while III is false
(d) II, III, IV and V are true, while I is false

164 Arrange the following events of mass flow of organic material in sequence.

I. Sugars are transported from cell to cell in the leaf.
II. Food is synthesised in the form of glucose by leaf cells.
III. Movement of water takes place into sieve tube elements.
IV. Downward movement of sugar occurs in the stem.
V. Solutes are actively transported into the sieve elements.

(a) I, II, III, V, IV (b) II, I, V, III, IV
(c) II, III, I, V, IV (d) I, II, V, IV, III

165 Choose the incorrect statement.

(a) If bark of tree is girdled from main stem, the plant dies because ascent of sap is stopped

(b) If xylem is girdled from main stem, wilting of leaves takes place

(c) In the flowering plant, food is transported in the form of disaccharide sucrose

(d) In girdling experiment in a plant, root dies first

III. Matching Type Questions

166 Match the following columns.

	Column I		Column II
A.	Water potential of 10% salt solution	1.	Positive
B.	Pressure potential in a normal cell	2.	Negative
C.	Pressure potential in a plasmolysed cell	3.	Zero
D.	Metric potential on the surface of the wood		

Codes

	A	B	C	D
(a)	1	2	3	1
(b)	3	2	1	2
(c)	2	3	2	1
(d)	2	3	1	2

167 Match the following columns.

	Column I		Column II
A.	Hypotonic	1.	Water
B.	Hypertonic	2.	Sucrose
C.	Solute	3.	Lower tonicity
D.	Solvent	4.	Higher tonicity

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	4	2	1	3
(c)	3	4	2	1
(d)	3	1	2	4

168 Match the following columns.

	Column I (Surrounding Medium)		Column II (Cells)
A.	Hypotonic	1.	No net flow of water
B.	Hypertonic	2.	Water moves into the cell
C.	Isotonic	3.	Water moves out of the cell

Codes

	A	B	C
(a)	2	3	1
(b)	3	2	1
(c)	1	2	3
(d)	2	1	3

169 Match the following columns.

	Column I		Column II
A.	Semipermeable membrane	1.	Dixon and Jolly
B.	Transpiration pull	2.	Holard
C.	Pulsation theory	3.	JC Bose
D.	Whole water content in soil	4.	Osmosis

Codes

	A	B	C	D
(a)	2	1	4	3
(b)	4	1	3	2
(c)	3	4	1	2
(d)	1	5	2	4

170 Match the following columns.

	Column I (Cells)		Column II (Location)
A.	Bulliform cells	1.	Stomata
B.	Guard cells	2.	Aerating pore
C.	Lenticel	3.	Accessory cells
D.	Subsidiary cells	4.	Isobilateral leaf

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	1	4	2	3
(c)	4	2	3	1
(d)	4	1	2	3

171 Match the following columns.

	Column I		Column II
A.	Manometer	1.	Transpiration
B.	Potometer	2.	Osmosis
C.	Stomata	3.	Root pressure
D.	Leaves	4.	Stomatal opening
E.	Porometer	5.	Micrometry

Codes

	A	B	C	D	E
(a)	4	1	1	2	3
(b)	2	3	4	1	5
(c)	1	5	2	3	4
(d)	3	2	1	5	4

NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

NCERT

172 What are the factors affecting the rate of diffusion?
(a) Permeability of membrane
(b) Temperature
(c) Pressure
(d) All of the above

173 What are porins?
(a) Enzymes (b) Specialised cells
(c) Proteins (d) None of these

NCERT Exemplar

174 Which of the following statements does not apply to reverse osmosis?
(a) It is used for water purification
(b) In this technique, pressure greater than osmotic pressure is applied to the system
(c) It is a passive process
(d) It is an active process

175 The lower surface of leaf will have more number of stomata in a/an
(a) dorsiventral leaf (b) isobilateral leaf
(c) Both (a) and (b) (d) None of these

176 When a plant undergoes senescence, the nutrients may be
(a) accumulated (b) bound to cell wall
(c) translocated (d) None of these

177 Which one of the following will not directly affect transpiration?
(a) Temperature (b) Light
(c) Wind speed (d) Chlorophyll content of leaves

178 The form of sugar transported through phloem is
(a) glucose (b) fructose
(c) sucrose (d) ribose

179 The process of guttation takes place
(a) when the root pressure is high and the rate of transpiration is low
(b) when the root pressure is low and the rate of transpiration is high
(c) when the root pressure equals the rate of transpiration
(d) when the root pressure as well as rate of transpiration are high

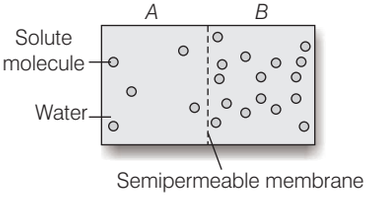
180 Which of the following is an example of imbibition?
(a) Uptake of water by root hair
(b) Exchange of gases in stomata
(c) Swelling of seed when put in soil
(d) Opening of stomata

181 Water potential of pure water at standard temperature is equal to
(a) 10 (b) 20 (c) zero (d) None of these

182 Choose the correct option.
Mycorrhiza is a symbiotic association of fungus with root system which helps in
I. absorption of water II. mineral nutrition
III. translocation IV. gaseous exchange
Codes
(a) Only I (b) Only II (c) I and II (d) II and III

183 Mark the mismatched pair.
(a) Amyloplasts–Store protein granule
(b) Elaioplasts–Store oils or fats
(c) Chloroplasts–Contain chlorophyll pigments
(d) Chromoplasts–Contain coloured pigments other than chlorophyll

184 Based on the figure given below, which of the following statements is not correct?



(a) Movement of solvent molecules will take place from chamber *A* to *B*
(b) Movement of solute will take place from *A* to *B*
(c) The presence of a semipermeable membrane is a prerequisite for this process to occur
(d) The direction and rate of osmosis depend on both the pressure gradient and concentration gradient

185 Match the following columns and choose the correct option.

	Column I		Column II
A.	Leaves	1.	Antitranspirant
B.	Seed	2.	Transpiration
C.	Roots	3.	Negative osmotic potential
D.	Aspirin	4.	Imbibition
E.	Plasmolysed cell	5.	Absorption

Codes

	A	B	C	D	E
(a)	2	4	5	1	3
(b)	3	2	4	1	5
(c)	1	2	3	4	5
(d)	5	4	3	2	1

Answers

Mastering NCERT with MCQs

1 (d)	2 (b)	3 (a)	4 (a)	5 (c)	6 (b)	7 (b)	8 (d)	9 (c)	10 (b)	11 (d)	12 (a)	13 (b)	14 (d)	15 (a)
16 (b)	17 (a)	18 (b)	19 (b)	20 (c)	21 (b)	22 (d)	23 (b)	24 (a)	25 (a)	26 (b)	27 (c)	28 (d)	29 (c)	30 (a)
31 (c)	32 (a)	33 (c)	34 (b)	35 (a)	36 (b)	37 (b)	38 (c)	39 (b)	40 (b)	41 (a)	42 (d)	43 (d)	44 (c)	45 (a)
46 (b)	47 (d)	48 (c)	49 (a)	50 (d)	51 (b)	52 (a)	53 (b)	54 (a)	55 (c)	56 (b)	57 (c)	58 (a)	59 (c)	60 (c)
61 (b)	62 (a)	63 (c)	64 (b)	65 (c)	66 (b)	67 (b)	68 (c)	69 (a)	70 (b)	71 (b)	72 (a)	73 (b)	74 (a)	75 (a)
76 (d)	77 (c)	78 (a)	79 (b)	80 (c)	81 (d)	82 (c)	83 (c)	84 (b)	85 (b)	86 (a)	87 (b)	88 (b)	89 (b)	90 (a)
91 (c)	92 (b)	93 (a)	94 (b)	95 (d)	96 (b)	97 (b)	98 (a)	99 (c)	100 (d)	101 (b)	102 (d)	103 (c)	104 (d)	105 (d)
106 (c)	107 (c)	108 (a)	109 (b)	110 (a)	111 (d)	112 (d)	113 (a)	114 (b)	115 (d)	116 (a)	117 (b)	118 (c)	119 (a)	120 (c)
121 (b)	122 (c)	123 (c)	124 (a)											

NEET Special Types Questions

125 (b)	126 (a)	127 (c)	128 (a)	129 (c)	130 (b)	131 (c)	132 (c)	133 (a)	134 (b)	135 (a)	136 (a)	137 (d)	138 (b)	139 (c)
140 (a)	141 (d)	142 (c)	143 (c)	144 (c)	145 (c)	146 (a)	147 (c)	148 (a)	149 (b)	150 (c)	151 (d)	152 (b)	153 (c)	154 (a)
155 (a)	156 (b)	157 (c)	158 (d)	159 (c)	160 (b)	161 (d)	162 (d)	163 (a)	164 (b)	165 (a)	166 (c)	167 (c)	168 (a)	169 (b)
170 (d)	171 (d)													

NCERT & NCERT Exemplar Questions

172 (d)	173 (c)	174 (d)	175 (a)	176 (c)	177 (d)	178 (c)	179 (a)	180 (c)	181 (c)	182 (c)	183 (a)	184 (b)	185 (a)

Answers & Explanations

1 (*d*) Short distance transport of substances like nutrients, water, gases, minerals and hormones occurs through diffusion and by cytoplasmic streaming supplemented by active transport.

2 (*b*) Long distance transport of organic and inorganic substances in plants occurs through the vascular system consisting of complex permanent tissues, i.e. xylem and phloem. This is known as translocation.

3 (*a*) In rooted plants, transport of water and minerals from roots to stem, leaves, flowers and fruits, occurs through xylem.

4 (*a*) The direction of translocation, i.e. transport of organic substances and mineral nutrients is multidirectional. However, it is unidirectional in case of water and minerals.

5 (*c*) Diffusion is the process in which movement of molecules occurs along the concentration gradient, i.e. movement of molecules takes place from its higher concentration to lower concentration without the expenditure of energy.

6 (*b*) The presence of other substances does not affect the rate of diffusion. In diffusion, electrical charges of diffusing substance, can affect the rate of diffusion. Channel protein allows diffusion of solute or substance of appropriate size, i.e. rate of diffusion is also affected by molecular size of diffused materials and solubility of diffusing substances in lipids.

7 (*b*) Lipid soluble molecules (hydrophobic) can easily pass through the cell membranes, while hydrophilic (water loving) substances face difficulty to pass through these membranes.

8 (*d*) In facilitated diffusion, the rate of diffusion is affected by the solubility of molecules in lipids, concentration gradient, molecular size of the molecules, etc. Availability of carrier molecules also affects the rate of transport in facilitated diffusion.

9 (*c*) Aquaporins are proteins present in cell membranes. They facilitate the transport of water soluble substances. Aquaporins are also known as channel proteins.

10 (*b*) For the transport of hydrophilic substances, cell membranes possess aquaporins or water channels. These water channels are made up of eight different types of aquaporins.

11 (*d*) All options are correct for carrier proteins involved in facilitated diffusion, as these facilitate the diffusion of hydrophilic substances through biological membrane. These are specific and allow the cells to select the solute of an appropriate size. Carrier proteins can increase the rate of diffusion and may undergo changes on binding with solutes.

13 (*b*) The given figure indicates facilitated diffusion. The diffusion of hydrophilic substances along the concentration gradient through fixed membrane transport proteins without involving energy expenditure, is called facilitated diffusion.

14 (*d*) Uphill transport criteria does not pertain to facilitated diffusion. Uphill transport is the process in which diffusion of a component occurs from a less concentrated stream to a more concentrated permeable stream. Facilitated transport is a form of passive transport in which materials are moved across the plasma membrane by a transport protein down their concentration gradient.

15 (*a*) When carrier proteins allow movement of two types of molecules together, it is termed as cotransport. It can be further divided into two types; symport and antiport. In symport, two types of molecules are transported in the same direction.

16 (*b*) In the given diagrams, I is uniport, II is antiport and III is symport.

- Uniport occurs when a molecule moves across a membrane independent of other molecules.
- Antiport occurs when the two types of molecules move in opposite directions.
- Symport occurs when the two types of molecules cross the membrane in same direction.

18 (*b*) Option (b) is not a feature of active transport of solutes in plants. Active transport of solutes in plants is carried out by membrane proteins. Like enzymes, the carrier proteins are very specific (i.e. selective) in what they carry across the membranes. Active transport, i.e. the uphill transport of molecules uses energy (ATP) to pump molecules against a concentration gradient.

19 (*b*) In active transport, the movement of solutes occurs against the concentration gradient or chemical potential gradient with the expenditure of energy. Thus, the active transport process will be slowed down when treated with a chemical that inhibits energy production.

20 (*c*) Facilitated diffusion and active transport are two important processes for the movement of substances, into and out of the cells are selective and specific. This is because both the processes enable the transport of only a few selected materials which do not react with the side chains of the protein transporters involved.

21 (*b*) The main difference between active and passive transport across the cell is that passive transport requires a concentration gradient across the biological membrane involved.

Whereas during active transport, the movement of molecules is from lower concentration to higher concentration that means they move against the concentration gradient by using ATP.

22 (*d*) Only option (d) is correct. Rest of the columns are incorrect and can be corrected as

Property	Facilitated Transport	Active Transport	Simple Diffusion
Requires special membrane proteins	Yes	Yes	No
Saturation point is reached when all carrier proteins are being used	Yes	Yes	No
Use of energy ATP	No	Yes	No

23 (*b*) Water potential is the free energy of one mole of water at NTP. It is the fundamental concept to understand water movement. Solute potential and pressure potential are two main components which determine water potential.

24 (*a*) Water potential of pure water at standard temperature, which is not under any pressure is taken to be zero.

26 (*b*) Pure water has maximum diffusion pressure. If solute particles are added in pure water, its diffusion pressure decreases.

27 (*c*) Water tends to move into a cell that has more negative ψ_w. Water potential of pure water is zero and it is negative when the concentration of water in a solution is less. Therefore, movement of water is from an area of its higher water potential (or less negative) to area where there is lower water potential (or more negative).

28 (*d*) Water potential increases due to increase in pressure. If a pressure greater than atmospheric pressure is applied to pure water or a solution, its water potential increases.

29 (*c*) Solute potential is always negative. The more the solute molecules, the lower (more negative) is the solute potential.

31 (*c*) Water potential of a cell is affected by both solute and pressure potential. The relationship between water potential, solute potential and pressure potential is

$$\psi_w = \psi_s + \psi_p$$

32 (*a*) The movement of water will be from cell A to cell B. We know that water moves from the area of its less negative or high water potential to the area of its more negative or less water potential.

Therefore water will move from

Cell A having a pressure potential of – 3 bars to cell B having a pressure potential of – 8 bars.

34 (*b*) The osmotic expansion of a cell kept in water is chiefly regulated by vacuoles. This is because, vacuoles have single membraned tonoplast and act as a semipermeable membrane, allowing selective entry and exit of water.

35 (*a*) The process taking place in the given experimental setup is osmosis. This is because it depicts the movement of water molecules from the region of its high concentration to lower concentration through a semipermeable membrane.

36 (*b*) In thistle funnel experiment, when sugar solution is added to a beaker after the process of osmosis stops, the solution of beaker will become hypertonic and as a result exosmosis will occur. Hence, the level of solution in thistle funnel will get lowered.

38 (*c*) When a plant is placed in pure water, the water will move into the cell due to endosmosis until the pressure potential and osmotic potential of the cell become equal. Thus, as a result the cell will become more turgid.

39 (*b*) We know that, Water potential (ψ_w) = Solute or osmotic potential (ψ_s) + Pressure potential (ψ_p).

The water potential $(\psi_w) = \psi_s + \psi_p$

$\therefore$ ψ_w of cell $A = -20 + 5 = -15$

ψ_w of cell $B = -18 + 2 = -16$

Since, water moves from higher water potential to lower potential thus, the flow of water will be from cell *A* to *B*.

40 (*b*)

Cell	**Water Potential** (osmotic potential + pressure potential)
A	$-1+0.5=-0.5$
B	$-0.6+0.3=-0.3$
C	$-1.2+0.6=-0.6$
D	$-0.8+0.4=-0.4$

As water moves from higher ψ_w to lower ψ_w so, the correct sequence of the path of movement of water is $B \rightarrow D \rightarrow A \rightarrow C$.

41 (*a*) Numerically osmotic pressure is equivalent to the osmotic potential, but with an opposite sign. Osmotic pressure is positive, while osmotic potential is negative.

42 (*d*) If an external solution balances the osmotic pressure of the cytoplasm, then it is known as isotonic solution. When the cells are placed in isotonic solution, there is no net flow of water.

44 (*c*) The behaviour of plant cells with regards to water movement depends on the surrounding solution. Thus, when a plant cell is placed in hypotonic solution, the water will flow into the cell and the cell will swell.

45 (*a*) Cell placed in hypertonic solution is correctly shown by figure (a). The figure given in option (a) depicts that the movement of water is outside the cell and the cell is plasmolysed, i.e. the cell membrane has got shrinked, these observations signify that the cell is placed in a hypertonic solution.

46 (*b*) When RBC and a plant cell are placed in distilled water, endosmosis takes place. Thus, as a result, RBC would increase in size and burst, while the plant cell would remain about the same size because of the presence of rigid cell wall made of cellulose and hemicellulose.

48 (*c*) The equation of water potential is

$$\psi_w = \psi_s + \psi_p$$

Where ψ_s = Solute potential

ψ_p = Pressure potential

ψ_w = Water potential

In a plasmolysed cell, pressure potential is zero, i.e. there is no movement of water outside due to the cell being in a plasmolysed state.

Thus, the relationship for a plasmolysed cell can be given as,

$$\therefore \quad \psi_w = \psi_s + 0$$

$$\psi_w = \psi_s$$

49 (*a*) When a cell is placed in a hypertonic solution, the protoplasm shrinks and leaves the cell wall due to exosmosis and the cell becomes plasmolysed. The space between the plasma membrane and the cell wall of plasmolysed cell is occupied by a hypertonic solution or water.

50 (*d*) When a leaf peeling of *Tradescantia* is kept in a medium having 10% NaCl solution, the cells shrink in size as water moves out of the cell. This is followed by the separation of protoplast from cell wall due to exosmosis. This phenomenon is called plasmolysis.

51 (*b*) Being a positive force, turgor pressure opposes the entry of water if a large amount of water enters in a plant cell.

52 (*a*) When sugars actively move into a cell, the turgor pressure of the cell increases as the water moves into the cell.

53 (*b*) Imbibition is a special type of diffusion when water is absorbed by solids-colloids causing them to increase in volume. The classical examples of imbibition are absorption of water by seeds and dry wood.

55 (*c*) The seeds imbibe and swell after being kept in water as water potential gradient develops between the seed coat and water. The imbibants have negative water potential. As a result when they come in contact with water, a steep water potential is established between the imbibant (seed coat) and imbibate (water).

58 (*a*) Transport of substances over longer distances through vascular tissue is termed as translocation. It occurs through a mass or bulk flow system.

59 (*c*) A characteristic of mass flow is that substances, whether in solution or in suspension, are swept along at the same pace, as in flowing river. Bulk flow can be achieved either through a positive hydrostatic pressure gradient (e.g. a garden hose) or a negative hydrostatic pressure gradient (e.g. suction through a straw).

61 (*b*) In symplastic movement, the flow of water occurs from cell to cell through their protoplasm. In this pathway, the adjacent cells are connected through plasmodesmata.

62 (*a*) The apoplastic movement of water occurs exclusively through the intercellular spaces and the walls of the cells. Apoplast pathway, inside the roots provides the least resistance to the movements of water.

63 (*c*) Water molecules in apoplast pathway are unable to penetrate the layer/bond of suberised matrix called the Casparian strip. It occurs in the endodermis of the root and acts as a barrier in the apoplastic pathway.

66 (*b*) The pathway of water conduction from soil to xylem is Soil → root hair → cortex → endodermis → pericyle → protoxylem → metaxylem

68 (*c*) Root hair zone (cell differentiation zone) in plants is a specialised structure for water absorption. It is the most efficient water absorption region in roots. Inspite of water absorption, root hair zone or root cells are incapable for photosynthesis because of the absence of chlorophyll and do not uptake CO_2.

71 (*b*) Root pressure, a manifestation of active water absorption is a positive pressure, which develops in the sap of xylem of root of small plant, but it is not applicable to tall trees.

72 (*a*) The net force, which is responsible for water absorption into a cell or root hair is known as suction pressure.

73 (*b*) During water absorption from the soil, the water potential of the root cells is lower than that of the soil. The water movement between the two systems takes place from the system having higher water potential or more energy to the system containing lower water potential or low energy.

74 (*a*) The water held by the soil particles as thin films is known as hygroscopic water. This is held between the soil particles under influence of internal molecular attractive forces (cohesive forces).

76 (*d*) Guttation occurs usually from the tips and margin of leaves during early morning or night time. It is the process of excretion or loss of water in liquid phase (droplet) from the tip of leaves and injured parts of plants. The droplets of water coming out through guttation is impure, consisting of both organic and inorganic substances. Thus, all options are correct.

78 (*a*) Option (a) is incorrect about guttation and can be corrected as

Guttation occurs when root pressure is high and transpiration is low.

Rest of the options are correct.

82 (*c*) The diagram demonstrates the process of transpiration by bell jar experiment. In this experiment, a potted plant is placed on a slab and a dry bell jar is inverted over it. The edge of jar is sealed with wax or vaseline and the whole apparatus is left undisturbed. After sometime the inner surface of bell jar became misty due to transpiration by plant.

83 (*c*) Cobalt chloride paper is used to study the phenomenon of transpiration in plants. Dry cobalt chloride paper that is blue in colour turns pink when it comes in contact with water. Using this property of cobalt chloride paper we can demonstrate water loss during transpiration. We can measure the rate of transpiration by using the time taken for the paper to change its colour from blue to pink.

84 (*b*) The opening and closing of stomata is due to change in the turgidity of the guard cells.

85 (*b*) Levitt in 1954 proposed active potassium transport theory, which is the most valid and recent explanation for stomatal movements. It proves that the accumulation of K^+ ion brings the opening of stomata and loss of K^+ ions, the closing of stomata.

87 (*b*) If the concentration of solute decreases in guard cells of stomata, the water potential will increase. This causes exosmosis, which in turn decreases the turgidity of guard cells. Thus, closing of stomata takes place.

88 (*b*) Stomatal opening can be affected by CO_2 concentration, light and temperature. Carbon dioxide is an effective antitranspirant. A little rise in CO_2 concentration induces partial closure of stomata. Its higher concentration results in complete closure of stomata.

Light affects the rate of transpiration in two ways, firstly by controlling the stomatal opening and secondly by affecting the temperature.

Increase in temperature increases the rate of transpiration.

90 (*a*) Amphistomatic leaves are those leaves which have stomata on both surfaces and isobilateral leaves have equal number of stomata on both surfaces. Thus, isobilateral leaf is an amphistomatic leaf.

91 (*c*) Relative humidity is most important in the regulation of transpiration. Rate of transpiration is inversely proportional to relative humidity.

92 (*b*) Transpiration causes water to rise in plants by pulling through xylem elements. Root pressure causes water to rise in plants by pushing water in xylem components. So, the rise of water in plants is done by pulling and pushing *via* transpiration and root pressure, respectively.

93 (*a*) Plants growing on hills show higher rates of transpiration because of low atmospheric pressure which permits more rapid diffusion of water.

95 (*d*) Adhesion is caused by attraction of water molecules to the polar surfaces. Movement of water inside the roots from soil to xylem and then in most of the plant parts takes place by transpiration forces, which provide both energy and necessary pull. Force between tracheary wall and water molecule produces surface tension, which accounts for high capillarity through tracheary elements, which is called as adhesion force. These forces help to ensure the continuity of water column in xylem.

96 (*b*) Transpiration pull theory is considered the best to explain ascent of sap. Excessive loss of water from the aerial parts of plants causes a tension in whole water column of the plant. As this tension develops due to transpiration, it is also called as transpirational pull.

97 (*b*) Ascent of sap is passive and occurs along the concentration gradient. Hence, there is no need of energy in this process.

98 (*a*) According to the transpiration pull or transpiration cohesion theory, the upward pull of water is transmitted to other water molecules by cohesion, which is caused by hydrogen bond. Water is a polar molecule and forms hydrogen bonds between the positively charged hydrogen atoms and negatively charged oxygen atom. Hydrogen bonds make water molecules stick together.

99 (*c*) No rupture and fraction occur in water column of vessels and tracheids during ascent of sap due to cohesion and adhesion.

Conduction of water in vertical direction from root to aerial parts of the plant is known as ascent of sap.
The molecules remain joined to each other in water column due to the force of cohesion. The force between the walls of tracheary elements and water molecule is called as adhesion force. These two forces ensure the continuity of water column in xylem.

100 (*d*) Plasmodesmata does not play a major role in upward water movement. These are bridge-like structures, which join adjacent cells in symplastic movement of water. While transpiration pull, tension and cohesion and adhesion of water molecule are those factors which play an important role in upward movement of xylem sap in plants.

101 (*b*) A newly detached twig from a plant exudates a fluid of organic food of plant like sugar from the detached part/cut part. The fluid is known as phloem sap.

103 (*c*) Option (c) is not the function of transpiration. This process plays an important role in the cooling effect by evaporating water, turgidity, which maintains the shape and structure of the plant, supplies water for photosynthesis, helps in absorption of water and mineral salts.

But translocation of organic food like sugar from source to sink is not facilitated by transpiration.

104 (*d*) On addition of little salt into water, the gradient of water becomes more negative, which in turn decreases the rate of transpiration. Hence, the cut twig or flower remains fresh for a longer period.

106 (*c*) In osmosis, only solvents move from a higher concentration to lower concentration. So, osmosis has a significant role in solvent transportation.

108 (*a*) Transport of minerals through xylem from soil takes place by active transport because the ions are transported against concentration gradient. So, there is a requirement of energy, which is provided by ATP.

110 (*a*) Root pressure is the positive pressure that develops in the roots of plants by the active absorption of nutrients from the soil.

111 (*d*) The chief sinks for the mineral elements are the growing regions of the plant, such as the apical and lateral meristems, young leaves, developing flowers, fruits and seeds and the storage organs. Unloading of mineral ions occurs at the fine vein endings through diffusion and active uptake by the cells of these regions.

113 (*a*) Mineral ions are frequently remobilised, particularly from older, senescing parts to younger leaves. Elements that are most readily mobilised are phosphorus, sulphur, nitrogen and potassium. Some elements that are structural components, like calcium, are not remobilised.

118 (*c*) The movement of sugars in the phloem begins at the source, where sugars are loaded (actively transported) into a sieve tube. Loading of the phloem sets up a water potential gradient that facilitates mass movement in the phloem.

123 (*c*) Long distance transport of the substances takes place through bulk flow system. Organic nutrients are supplied over long distance transport by phloem tissue from source to sink region. The direction of transport of these organic nutrients can be upward or downward, i.e. bidirectional. This is due to the variable relationship between synthesis region or source site and sink or utilisation region.

124 (*a*) Option (a) is correct. In girdling or ringing experiment, the path of organic nutrients in the stem of plant is represented, which is carried out by phloem. In the experiment, a ring of bark along with phloem is cut from the stem.

Due to the absence of phloem in the ringing part, translocation of food does not take place and gets accumulated above the ring. Bark also swells up and may rise to adventitious roots. Ascent of sap in plants can be demonstrated by girdling experiment.

125 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

Process of diffusion is the net transport of solute or solvent from a region of higher concentration to lower concentration area where ion, atoms or molecules move randomly.

It is a passive process and does not require the expenditure of energy.

126 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Process of diffusion can be summarised easily as the movement of uncharged ions, atoms or molecules through a biological membrane. It depends upon the permeability of the biological membrane. Here, the membrane is impermeable to pigment β-cyanin. That is why pigment β-cyanin is unable to colour the water.

127 (*c*) Assertion is true, but Reason is false and it can be corrected as

Air dried seeds of pea on coming in contact with water can develop an imbibition pressure**.** This leads to changes in the volume of each seed. Thus, the lid tightly put over a tin containing seeds with water will be blown off after a while due to swelling of seeds.

128 (*a*) Both Assertion are Reason are true and Reason is the correct explanation of Assertion.

Wooden doors get stuck and become difficult to open and shut as they swell up due to imbibition. Imbibition is a process in which water is absorbed by solid (colloids) causing them to enormously increase in volume.

129 (*c*) Assertion is true, but Reason is false and it can be corrected as

Unidirectional flow of water, mineral and nitrogen occurs through xylem. The direction of flow of organic and inorganic substances is multidirectional, which occurs through phloem.

130 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

The force, which is responsible to join water molecules to each other in water column is cohesion force. On the account of cohesion force, water column can bear a pull or tension up to 100 atm.

Therefore, it is also known as tensile strength, while the force between the wall of tracheary elements and water molecule is called as adhesion force, which produces surface tension and accounts for high capillarity through tracheids and vessels.

131 (*c*) Assertion is true, but Reason is false and it can be corrected as

Transpiration plays an important role in the supply of water during photosynthesis and is regarded as a price paid for photosynthesis. It also helps in maintaining the turgidity of cells and causes transpiration pull in the water column of xylem tissue. However, translocation of organic molecules like sugar takes place through phloem.

132 (*c*) Assertion is true, but Reason is false and it can be corrected as

Sucrose is a non-reducing and translocating form of sugar in phloem. This is less reactive than other sugars.

133 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

In ringing experiment, a continuous band of tissue, external to the xylem is removed. When such plant is placed in the light, after some time, the tissue above the ring becomes swollen due to the accumulation of solutes. This experiment proves that transport of solutes occurs by phloem.

134 (*b*) The statement in option (b) is correct method of transport to distinguish between xylem and phloem.

Transport of water and minerals in xylem is unidirectional and sap moves upwards due to transpirational pull, while transport in phloem is bidirectional and multidirectional. Transport of organic food by phloem takes place from the source to sink.

135 (*a*) The statement in option (a) is incorrect. It can be corrected as

The movement of water or pumping up of water is through xylem tissue not by root.

Rest of the statements are correct.

136 (*a*) The statement in option (a) best defines the mechanism of glucose transport occurring in the cell, i.e. facilitated diffusion. When there is a gradient already present and there is a need to transport hydrophilic substance along the concentration gradient. This is done through fixed membrane transport protein without the involvement of energy expenditure.

137 (*d*) Both options (b) and (c) are correct for the process of diffusion of coloured molecules. This is because in both options (b) and (c), there is maximum difference in concentration of molecules in between internal and external solution. Thus, the rate of diffusion will be equally fast in both are cases. We know that diffusion process takes place between concentration of molecules of solution, i.e. the movement of molecules (solute) from their high concentration to low concentration.

138 (*b*) Statements I, II and III are true and statements IV and V are false. These can be corrected as

- Facilitated diffusion is comparatively a slow process than active transport.
- Transport of molecules occurs along the concentration gradient in diffusion.

140 (*a*) The statement in option (a) can be shown by facilitated diffusion and active transport.

In both, facilitated diffusion and active transport, there is an involvement of carrier transporter or transporter proteins. These are highly specific and show sensitivity to inhibitors.

Rest of the statements are incorrect and can be corrected as

- Facilitated (transport) diffusion does not involve expenditure of energy.
- Active transport involves energy expenditure.
- Both processes use transport proteins to move molecules across the membrane.

141 (*d*) Statements I, II, III and V are correct and statement IV is incorrect. It can be corrected as

In active transport, energy is required to pump molecule against a concentration gradient.

142 (*c*) The statement in option (c) is incorrect and can be corrected as

Due to more concentration of charged particles in soil than the concentration in roots, facilitated diffusion of minerals takes place.

Rest of the statements are correct.

143 (*c*) The statement in option (c) describes the movement of water with respect to water between these cells and their environment. Water potential (ψ_w) of pure water is zero. As we add solute in water, the water potential decreases, i.e. becomes negative of the solution.

We know that movement of water takes place from its high concentration to low concentration.

Thus, the movement of water will be

$$\underset{\psi=-3kPa}{\text{Cell 2}} \longrightarrow \underset{\psi=-4kPa}{\text{Cell 3}} \longrightarrow \underset{\psi=-5kPa}{\text{Environment}} \longrightarrow \underset{\psi=-7kPa}{\text{Cell 1}}$$

144 (*c*) The statement in option (c) is incorrect and it can be corrected as

The given diagram represents the process of osmosis, i.e. the movement of water from its higher concentration to lower concentration through a selectively permeable membrane.

Rest of the statements are correct.

145 (*c*) Statement II is true, but statements I and III are false. It can be corrected as

- The movement of substances through diffusion is passive not active.
- Inward movement of water makes the cell turgid and *vice-versa*.

147 (*c*) The statement in option (c) is correct.

The net direction and rate of osmosis depends on both the pressure gradient and concentration gradient.

148 (*a*) Statements I, II and III are correct. Statement IV is incorrect and can be corrected as

Addition of solutes in a system or cell decreases the energy of water. Pure water has the maximum diffusion pressure.

152 (*b*) Statement I and III are correct. Statement II is incorrect and can be corrected as

Mycorrhiza has fungal not algal association with roots of *Pinus* and orchids.

153 (*c*) Statement I, II and III are correct. Statement IV is incorrect and can be corrected as

A dry alive seed contains around 10-15% water of its weight. Water is the major component of life, which is generally absorbed by plants in variable quantity according to their metabolic requirement. A mature maize plant absorbs about 3 L water/day, while a mustard plant can absorb as the water equal to its weight in only 5 hrs. Hence, water is considered as the limiting factor for plant life, growth and development.

154 (*a*) Statements I and II are correct. Statements III and IV are incorrect and can be corrected as

- It occurs in plants growing under conditions of high soil moisture and high humidity.
- It occurs in herbaceous plants when root pressure and transpiration both are high.

155 (*a*) The statement in option (a) is the correct reason. Rest of the statements are incorrect and can be corrected as

The water vapour from the plant leaf is released through stomatal opening and diffusion of carbon dioxide into the plant through same stomatal opening can happen together bacause diffusion coefficient of water and CO_2 is different.

Normally, stomata are open during the day and closed during night. So, statements in options (b) and (c) are incorrect. Statement in option (d) is also incorrect because both processes can happen together.

156 (*b*) Statements I, II and III are correct. Statement IV is incorrect and can be corrected as

Ascent of sap in conducting tissues of plant is affected by cohesion, adhesion and properties of water.

160 (*b*) Statement II is true, but I is false and it can be corrected as

An analysis of the xylem exudates shows that though some of the nitrogen travels as inorganic ions, much of it is carried in the organic form as amino acids and related compounds. Similarly, small amounts of phosphorus and sulphur are carried as organic compounds.

162 (*d*) Statement IV is correct. Other statements, statements I, II and III are incorrect and can be corrected as

- Sugar is transported through phloem as sucrose.
- Movement of sugar is carried out through companion cells.
- Concentration of sugar is always highest near the source region.

163 (*a*) Statements I, II, III and IV are true. Statement V is false and it can be corrected as

Contents in the sieve tube move bidirectionally.

164 (*b*) The sequence of events of mass flow of organic substances materials is II $\rightarrow$ I $\rightarrow$ V $\rightarrow$ III $\rightarrow$ IV.

According to Munch flow model or pressure flow hypothesis, the correct sequence of transport of organic nutrients from source to sink is that first of all food material synthesis takes place then it is transported from cell to cell in the leaves (mesophyll cell). It is passed into the sieve tube through their companion cells by an active transport.

Now, sieve tube shows high osmotic concentration and absorbs water from the adjacent xylem. Having absorbed water, they became turgid and organic nutrients are transported from a region of higher turgor pressure to a region of lower turgor pressure.

165 (*a*) The statement in option (a) is incorrect and it can be corrected as

In a ringing or girdling experiment, the ring of bark along with phloem is cut from the stem to represent the path of organic nutrients by phloem tissue. If phloem is not removed along with bark, supply of organic food will continue and plant will survive. If xylem is girdled from main stem, supply of minerals and salt is stopped in the leaves and upper part of girdling site.

Rest of the statements are correct.

172 (*d*) Diffusion rates are affected by the concentration gradient, the permeability of the membrane separating them, temperature and pressure.

173 (*c*) The porins are proteins which 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.

174 (*d*) Reverse osmosis is not an active process. A process (in organisms) is considered active when its completion requires energy in the form of ATP. And as reverse osmosis does not consume ATP and does not occurs along the concentration gradient, it is a passive process.

175 (*a*) In dorsiventral leaf, the number of stomata will be more on lower surface.

176 (*c*) Senescence is the programmed death of a plant. Translocation of nutrients to different parts of the plant is done at the time of senescence.

178 (*c*) Sucrose, a disaccharide sugar is transported through phloem.

179 (*a*) Guttation occurs when root pressure is high and rate of transpiration is low and there is high humidity in the air.

The other given conditions do not favour guttation.

180 (*c*) Swelling of seed in soil is an example of imbibition. Imbibition is a type of diffusion process along the concentration gradient enabling the solid to absorb water and increase in volume.

Out of the other options, i.e. uptake of water by root hair is an example of absorption, exchange in/of gases, stomata is an example of diffusion and opening of stomata is an example of turgor pressure or turgidity.

181 (*c*) Water potential of pure water at standard temperature is zero. It is the highest value of water potential.

182 (*c*) Option (c) is correct. Mycorrhiza associated with roots of plants helps in both absorption of water and mineral nutrition from the soil. Mycorrhiza does not help in translocation and gaseous exchange.

183 (*a*) Option (a) is mismatched pair and it can be corrected as

Amyloplasts are the colourless plastids, which store starch, but not the protein granules.

Other pairs are correctly matched.

184 (*b*) Statement in option (b) is incorrect and it can be corrected as

Movement of water will take place from chamber *A* to *B*. It is not the solute, which will move from chamber *A* to *B*.

This is because osmosis is a process in which solvent molecules move from a region of higher concentration to a region of lower concentration through a semipermeable membrane.

Rest of the statements are correct.