# NCERT Solutions for Class-XI Biology

# Chapter-11

**1.** What are the factors affecting the rate of diffusion?

**1.** Factors affecting the rate of diffusion are :

- Density – Rate of diffusion of a substance is inversely proportional to square root of its relative density (Graham's Law).
- Permeability of medium – Rate of diffusion decreases with density of the medium.
- Temperature – A rise in temperature increases the rate of diffusion with Q10 = 1.2 -1.3. Because of it sugar crystals do not dissolve easily in ice cold water while they do so easily in warm water.
- Diffusion pressure gradient – Rate of diffusion is directly proportional to the difference of diffusion pressure at the two ends of a system and inversely proportional to the distance between the two.

**2.** What are porins? What role do they play in diffusion?

**2.** Porins are types of proteins which form pores of large sizes in the outer membranes of plastids such as chloroplast, mitochondria and the membranes in bacteria. They help in facilitating the passive transport of small-sized protein molecules.

**3.** Describe the role played by protein pumps during active transport in plants.

**3.** Active transport uses energy to pump molecules against a concentration gradient. Active transport is carried out by membrane play a major role in both active as well as passive transport. Pumps are proteins that use energy to carry substances across the cell membrane. These pumps can transport substances from a low concentration to a high concentration ('uphill' transport). E.g.,$H^+$ pump, $K^+$ pump, Cl – pump, $Na^+$ – K pump. The pumps operate with the help of ATP.$K^+$ – $H^+$ exchange pump occurs in guard cells. $Na^+$ – $K^+$ exchange pump operates across many animal membranes. Transport rate reaches a maximum when all the protein transporters or pumps are being used or are saturated. Like enzymes these carrier proteins are very specific in what they carry across the membrane. These proteins are sensitive to inhibitors that react with protein side chains.

**4.** Explain why pure water has the maximum water potential.

**4.** Water potential quantifies the tendency of water to move from one part to the other during various cellular processes. It is denoted by the Greek letter Psi or Ψ. The water potential of pure water is always taken as zero at standard temperature and pressure. It can be explained in terms of the kinetic energy possessed by water molecules. When water is in liquid form, the movement of its molecules is rapid and constant. Pure water has the highest concentration of water molecules. Therefore, it has the highest water potential. When some solute is dissolved in water, the water potential of pure water decreases.

**5.** Differentiate between the following:

(a) Diffusion and Osmosis

(b) Transpiration and Evaporation

(c) Osmotic Pressure and Osmotic Potential

(d) Imbibition and Diffusion

(e) Apoplast and Symplast pathways of movement of water in plants.

(f) Guttation and Transpiration.

**5.** (a) Diffusion and Osmosis

| **Diffusion** | **Osmosis** |
|---|---|
| It refers to the passive movement of particles, ions, and molecules along the concentration gradient | The process of movement of a solvent across a semipermeable membrane |
| Semi-permeable membrane not required. | Semi-permeable membrane required. |

(b) Transpiration and Evaporation

| **Transpiration** | **Evaporation** |
|---|---|
| Transpiration is a physiological process | Evaporation is a physical process |
| It occurs through stomatal pores | It occurs through any surface of the plant |
| It is controlled by environmental as well as physiological factors | It is controlled by environmental factors only |

(c) Osmotic Pressure and Osmotic Potential

| **Osmotic pressure** | **Osmotic potential** |
|---|---|
| Osmotic pressure is the positive pressure | Osmotic potential is the negative pressure |
| It is numerically expressed in bars with a positive sign | It is expressed in bars with a negative sign |

(d) Imbibition and Diffusion

| Imbibition | Diffusion |
|---|---|
| Imbibition is a special type of diffusion when water is absorbed by solid colloids causing them to increase in volume.<br>For example absorption of water by seeds and dry woods. | Diffusion refers to the movement of solute molecules along a concentration gradient |

(e) Apoplast and Symplast pathways of movement of water in plants.

| **Apoplast pathway** | **Symplast pathway** |
|---|---|
| It consists of nonliving parts of the plant's body such as cell walls and intercellular spaces. | It consists of living parts of the plant body such as protoplast connected to plasmodesmata. |
| There is little resistance in the movement of water | Some resistance occurs in the movement of water. |
| The metabolic state of the root does not affect the apoplast pathway | The metabolic state of the root directly affects the symplast pathway. |

(f) Guttation and Transpiration.

| **Guttation** | **Transpiration** |
|---|---|
| Water is lost from the leaves in the form of liquid droplets during the night. | Water is lost from the leaves in the form of water vapors usually during the day. |
| It is an uncontrolled process. | It is a controlled process. |

**6.** Briefly describe water potential. What are the factors affecting it?

**6.** Water potential quantifies the tendency of water to move from one part to the other during various cellular processes such as diffusion, osmosis, etc. It is denoted by the Greek letter Psi or Ψ and is expressed in Pascals (Pa). The water potential of pure water is always taken as zero at standard temperature and pressure. Water potential ($\Psi_w$) is expressed as the sum of solute potential ($\Psi_s$) and pressure potential ($\Psi_p$).

$\Psi_w = \Psi_s + \Psi_p$

When some solute is dissolved in water, the water potential of pure water decreases. This is termed as solute potential ($\Psi_s$), which is always negative. For a solution at atmospheric pressure, $\Psi_w = \Psi_s$.

The water potential of pure water or a solution increases on the application of pressure values more than atmospheric pressure. It is termed as pressure potential. It is denoted by $\Psi_p$ and has a positive value, although a negative pressure potential is present in the xylem. This pressure potential plays a major role in the ascent of water through the stem.

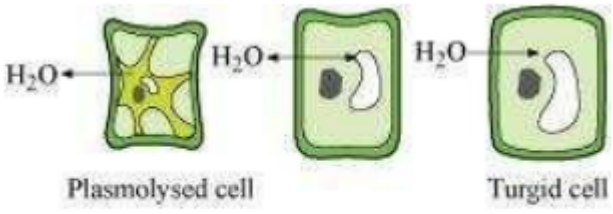
**7.** What happens when a pressure greater than the atmospheric pressure is applied to pure water or a solution?

**7.** If a pressure greater than atmospheric pressure is applied to pure water or a solution, its water potential increases. It is equivalent to pumping water from one place to another. Pressure can build up in a plant system when water enters a plant cell due to diffusion causing a pressure built up against the cell wall, it makes the cell turgid.

**8.** (a) With the help of well-labelled diagrams, describe the process of plasmolysis in plants, giving appropriate examples.

(b) Explain what will happen to a plant cell if it is kept in a solution having higher water potential.

**8.** (a) Plasmolysis can be defined as the shrinkage of the cytoplasm of a plant cell, away from its cell wall and toward the centre. It occurs because of the movement of water from the intracellular space to the outer-cellular space. This happens when the plant cell is placed in a hypertonic solution (i.e., a solution having more solute concentration than the cell cytoplasm). This causes the water to move out of the cell and toward the solution. The cytoplasm of the cell shrinks and the cell is said to be plasmolysed. This process can be observed in an onion peel kept in a highly concentrated salt solution.




Process of plasmolysis

(b) When a plant cell is placed in a hypertonic solution or a solution having higher water potential, the water diffuses into the cell (i.e., movement is observed from higher to lower water pressure region). The entry of water in the plant cell exerts pressure on the rigid cell wall. This is called turgor pressure. As a result of its rigid cell wall, the plant cell does not burst.

**9.** How is the mycorrhizal association helpful in absorption of water and minerals in plants?

**9.** Some plants have additional structures associated with them that help in water (and mineral) absorption. A mycorrhiza is a symbiotic association of a,fungus with a root system. The fungal filaments form a network around the young root or they penetrate the root cells. The hyphae have a very large surface area that absorb mineral ions and water from the soil from a much larger volume of soil that perhaps a root cannot do. The fungus provides minerals and water to the roots, in turn the roots provide sugars and N-containing compounds to the mycorrhizae. Some plants have an obligate association with the mycorrhizae. For example Pinus seeds cannot germinate and establish without the presence of mycorrhizae.

**10.** What role does root pressure play in water movement in plants?

**10.** Root pressure is the positive pressure that develops in the roots of plants by the active absorption of nutrients from the soil. When the nutrients are actively absorbed by root hairs, water (along with minerals) increases the pressure in the xylem. This pressure pushes the water up to small heights. Root pressure can be observed experimentally by cutting the stem of a well-watered plant on a humid day. When the stem is cut, the solution oozes from the cut end.

Root pressure is also linked to the phenomenon of guttation, i.e., the loss of water in the form of liquid droplets from the vein endings of certain herbaceous plants.

Root pressure is only able to transport water up to small heights. However, it helps in re-establishing the continuous chains of water molecules in the xylem.

Transpirational pull maintains the flow of water molecules from the roots to the shoots.

**11.** Describe transpiration pull model of water transport in plants. What are the factors influencing transpiration? How is it useful to plants?

**11.** Transpiration pull or cohesion-tension theory was originally proposed by Dixon and Joly in 1894 and further improved by Dixon in 1914. According to this theory, a continuous column of water is present in the xylem channels of plant. The continuity of water column is maintained in the plant because of cohesive force of water molecules. There is another force of adhesion which holds water tp the walls of xylem vessels. During transpiration in plants, water is lost, in form of water vapour, from the mesophyll cells to exterior, through stomata. As a result, the turgor pressure of these cells decreases and the diffusion pressure deficit (DPD) increases. Now these cells take water from adjoining cells and the turgor of those adjoining cells decreases. This process is repeated and ultimately water is absorbed from nearest xylem vessels of leaf. As there is a continuous water column inside the xylem elements, a tension or pull is

transmitted down and finally transmitted to root, resulting in the upward movement of water.

Factors affecting transpiration include both environmental and internal factors.
Environmental factors:

(i) Relative humidity – The rate of transpiration is inversely proportional to the relative humidity, i.e., the rate of transpiration is higher when the relative humidity is lower and lower when the relative humidity is higher.

(ii) Atmospheric temperature – A high temperature opens stomata even in darkness. Besides producing a heating effect, it lowers the relative humidity of the air and increases vapour pressure inside transpiring organ. Consequently, rate of transpiration increases.

(iii) Light – Because most of the transpiration occurs through stomata, the rate of transpiration is quite high is light. It falls down appreciably in the darkness.

(iv) Air movements – Transpiration is lower in the still air because water vapours accumulate around the transpiring organs and reduce the DPD of the air. The movement of the air increases the rate of transpiration by removing the saturated air around the leaves.

(v) Atmospheric pressure – Low atmospheric pressure enhances evaporation, produces air currents and increases the rate of transpiration.

(vi) Availability of water – The rate of transpiration depends upon the rate of absorption of soil water by roots. This is further influenced by a number of soil factors like soil water, soil particles, soil temperature, soil air, etc.

Internal or plant factors :

(i) Leaf area (transpiring area) – A plant with large leaf area will show more transpiration than another plant with less leaf area.

(ii) Leaf structure – Leaf structure affects transpiration in following ways:

(a) Cuticular transpiration decreases with the thickness of cuticle and cutinisation of epidermal walls.

(b) Because most of the transpiration takes place through the stomata, their number and position influences the rate of transpiration.

(c) The sunken stomata are device to reduce the rate of transpiration by providing an area where little air movement occurs.

(iii) Root/shoot ratio – A low root/shoot ratio decreases the rate of transpiration while a high ratio increases the rate of transpiration.

(iv) Mucilage and solutes – They decrease the rate of transpiration by holding water tenaciously.

Transpiration is useful to plants in the following ways:

(i) Removal of excess water – It has been held that plants absorb far more amount of water than is actually required by them. Transpiration, therefore, removes the excess of water.

(ii) Root system – Transpiration helps in better development of root system which is required for support and absorption of mineral salts.

(iii) Quality of fruits – The ash and sugar content of the fruit increases with the increase in transpiration.

(iv) Temperature maintenance – Transpiration prevents overheating of leaves. However, plants growing in areas where transpiration is meagre do not show over–heating. Some succulents can endure a temperature of 60°C without any apparent damage.
(v) Pole in ascent of sap and turgidity – Ascent of sap mostly occurs due to transpiration pull exerted by transpiration of water. This pull is important in the absorption of water. Further, transpiration maintains the shape and structure of plant parts by keeping cells turgid.
(vi) Distribution of mineral salts- Mineral are mostly distributed by rising column of sap.
(vii) Photosynthesis – Transpiration supplies water for photosynthesis.

**12.** Discuss the factors responsible for ascent of xylem sap in plants.

**12.** Transpirational pull is responsible for the ascent of water in the xylem. This ascent of water is dependent on the following physical factors:

- Cohesion – Mutual attraction between water molecules
- Surface tension – Responsible for the greater attraction between water molecules in liquid phase than in gaseous phase
- Adhesion – Attraction of water molecules to polar surfaces
- Capillarity –Ability of water to rise in thin tubes

These physical properties of water allow it to move against gravity in the xylem.

**13.** What essential role does the root endodermis play during mineral absorption in plants?

**13.** Like all cells, the endodermal cells have many transport proteins embedded in their plasma membrane; they let some solutes cross the membrane, but not others. Transport proteins of endodermal cells are control points, where a plant adjusts the quantity and types of solutes that reach the xylem. Because of the layer of suberin, the root endodermis has the ability to actively transport ions in one direction only.

**14.** Explain why xylem transport is unidirectional and phloem transport bi-directional.

**14.** During the growth of a plant, its leaves act as the source of food as they carry out photosynthesis. The phloem conducts the food from the source to the sink (the part of the plant requiring or storing food). During spring, this process is reversed as the food stored in the sink is mobilised toward the growing buds of the plant, through the phloem. Thus, the movement of food in the phloem is bidirectional (i.e., upward and downward). The transport of water in the xylem takes place only from the roots to the leaves. Therefore, the movement of water and nutrients in the xylem is unidirectional.

**15.** Explain pressure flow hypothesis of translocation of sugars in plants.

**15.** The accepted mechanism used for the translocation of sugars from source to sink is called the pressure flow hypothesis. As glucose is prepared at the source i.e., in leaves, (by photosynthesis) it is converted to sucrose (a dissacharide). The sugar is then moved in the form of sucrose into adjacent companion cells and then into the living phloem i.e., in sieve tube cells by active transport. This process of loading at the source produces a hypertonic conditions in the phloem. Water in the adjacent xylem moves

into the phloem by osmosis. As osmotic pressure builds up, the phloem sap will move to areas of lower pressure. At the sink, osmotic pressure must be reduced. Again active transport is necessary to move the sucrose out of the phloem sap and into the cells which will use the sugar converting it into energy, starch, or cellulose. As sugars are removed, the osmotic pressure of the phloem decreases and water moves out of the phloem

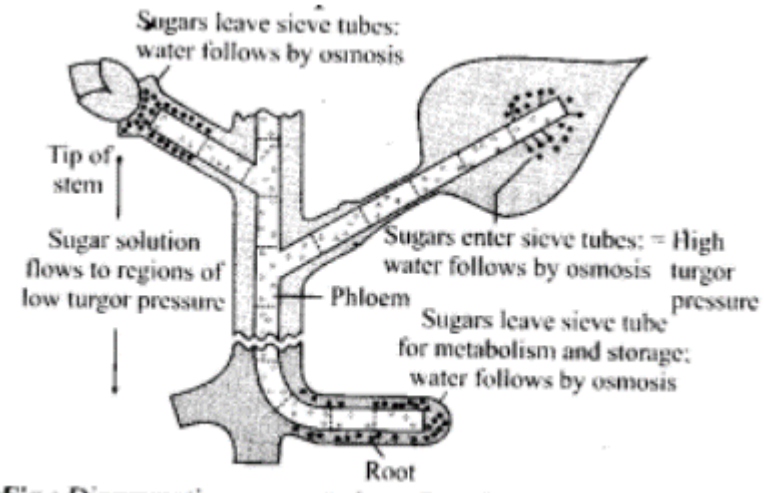



**Fig.:** Diagramatic representation of mechanism of translocation.

**16.** What causes the opening and closing of guard cells of stomata during transpiration?

**16.** The tiny pores present on the surfaces of leaves, called stomata, help in the exchange of gases. Each stoma consists of bean-shaped or dumbbell-shaped guard cells. The epidermal cells surrounding the guard cells are modified to form subsidiary cells. The opening and closing of the guard cells is caused by a change in their turgidity. The inner walls of the guard cells are thick and elastic, while the outer walls are thin. The numerous microfibrils present in the guard cells facilitate the opening and closing of the guard cells. At the time of the opening of the stomata, the turgidity of the guard cells increases. As a result, the outer walls bulge and the inner walls become crescent-shaped. The stomatal opening is facilitated by the radial arrangement of the microfibrils.

At the time of the closing of the stomata, the guard cells lose their turgidity, the outer and inner walls retain their original shapes, and the microfibrils get arranged longitudinally.