

**SAMPLE CONTENT**



**Precise**

# **BIOLOGY Vol. I**

**As per the new textbook prescribed  
by Maharashtra State Board**

#### **Phenotypic variations:**

Phenotypic variation is the variability in phenotypes that exists in a population. Phenotypic variation can be caused by differences in the genotypes, environmental factors, or both. Different combinations of genes are responsible for variations in coat colour of dogs of same breed.



**Std. XII Sci.**

**Target** Publications® Pvt. Ltd.

**Written as per the latest textbook prescribed by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune.**

**Precise**  
**BIOLOGY (Vol. I)**  
**Std. XII Sci.**

**Salient Features**

- ☞ Written as per the new textbook
- ☞ Subtopic-wise segregation for powerful conceptual building
- ☞ Complete coverage of Textual Exercise Questions
- ☞ Extensive coverage of New Type Questions
- ☞ ‘Quick Review’ at the end of every chapter facilitates quick revision
- ☞ Reading Between the Lines is designed to impart holistic education
- ☞ Video/PDF links provided via QR codes for boosting conceptual retention

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## PREFACE

**Precise Biology Std. XII, Vol. I** is intended for every Maharashtra State Board aspirant of Std. XII, Science. The scope, sequence, and level of the book are designed to match the new textbook issued by the Maharashtra State board.

Biological systems are the supreme complex chemical systems on Earth, and their functions are both controlled and determined by the principles/laws of chemistry and physics.

We understand that Board Examinations can be daunting and the stress of cracking the examination can often leave students struggling to make sense of the curriculum.

With the examination in focus, the **Precise Series** has been specifically designed to make preparation easier, by providing a methodical and organized perspective of the curriculum, thus greatly improving the chances of scoring well.

In order to make sure that students fully grasp the nub of the subject, it is important to present such concepts meaningfully and in an easy to read format. In this vein, the Precise Biology book is being crafted to provide an **exam-centric approach** to the curriculum, while **retaining the essence** of the subject. Each chapter is thus structured to provide a conceptual foundation.

The scope of the book also offers a plethora of Multiple Choice Questions (MCQ) in order to familiarize the students with the pattern of competitive examinations.

We believe that the study of Biology helps in the understanding of many fascinating and important phenomena. In this vein, we have put an effort to relate Biology to real-world events in order to show students that Biology is a vibrant, constantly evolving science that has relevance in our modern world. We hope this book becomes a valuable tool for you and helps you to understand the concepts of Biology.

Please write to us on: mail@targetpublications.org

*A book affects eternity; one can never tell where its influence stops.*

*Best of luck to all the aspirants!*

From,  
Publisher

**Edition:** First

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## FEATURES

### 1.1 Asexual Reproduction

**Q.1.** Write a short note on asexual reproduction in lower organisms.

**Ans:**

- i. **Asexual reproduction:** It is a process of reproduction which results in production of genetically identical progeny from a single organism and inherits the gene of the parent.
- ii. Asexual reproduction in lower organisms occurs by following methods:

### Sub-topic wise Segregation

Every chapter is segregated sub-topic wise. A subtopic encompasses textual content in the format of Question-Answers. *Textual exercise questions* are placed aptly amongst various additional questions in accordance with the flow of subtopic.

*This is our attempt to elaborate a simulation of concepts and lay stress on reading for understanding as well as writing answers in exam.*

### Reading between the lines

**Reading between the lines** provides elaboration or missing fragments of the concept which is essential for complete understanding of the concept.

*This is our attempt to help students to understand the underlying concept behind an answer.*

### Reading between the lines



*Types of chromosomes based on position of centromere*

**Metacentric:** Centromere is in the middle of the chromosome and hence, the two arms are nearly equal.

*Chromosome looks 'V-shaped' in anaphase.*

### QR Code

**QR code** provides access to a video/PDF in order to boost understanding of a concept or activity.

*This is our attempt to facilitate learning through visual aids.*

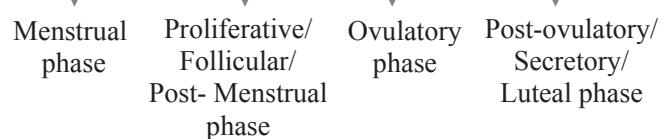
### Quick Review

**Quick review** includes tables/ flow charts to summarize the key points in a chapter.

*This is our attempt to help students to reinforce key concepts.*

### Quick Review

#### Menstrual cycle



## FEATURES

### Multiple Choice Questions

1. Gemmule formation takes place in \_\_\_\_\_.  
(A) *Hydra*      (B) *Spongilla*  
(C) *Planaria*      (D) *Amoeba*
2. *Hydra* multiplies asexually by \_\_\_\_\_.  
(A) budding      (B) gemmule formation  
(C) regeneration      (D) both (A) and (B)

### Multiple Choice Questions

**Multiple Choice Question** includes textual as well as additional MCQs.

*This is our attempt to give students practice of MCQs and prepare them thoroughly for board examination.*

### Exercise

**Exercise** includes subtopic-wise additional questions and problems.

*This is our attempt to provide additional practice to students to gauge their preparation.*

### Exercise

#### 3.1 Chromosome and Mechanism of Inheritance

1. What do we mean by heredity?  
**Ans:** Ref. Q.2

2. Make a list of phenotypes that were studied by Mendel in pea plant.  
**Ans:** Ref. Q.3

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[Reference: Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04]

**Note:** 1. \* mark represents Textual question.

2.  symbol represents textual questions that need external reference for an answer.

## Contents and Concepts

- |  |  |
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| 6.1 Properties of water<br>6.2 Water absorbing organ<br>6.3 Water available to roots for absorption<br>6.4 Absorption of water by roots from soil<br>6.5 Water Potential ( $\Psi$ )<br>6.6 Plasmolysis | 6.7 Path of water across the root (i.e. from epiblema upto xylem in the stelar region)<br>6.8 Mechanism of absorption of water<br>6.9 Translocation of water<br>6.10 Transport of minerals<br>6.11 Transport of food<br>6.12 Transpiration<br>6.13 Structure of stomatal apparatus |
|--|--|

**6.1 Properties of Water**

**Q.1.** Enlist the properties of water which makes it a significant molecule that connects physical world with biological processes.

**Ans:** **Properties of water:**

- Water is in the liquid form at room temperature and is the **best solvent** for most of the solutes.
- In pure form, it is inert inorganic compound with **neutral pH**. Due to this, water is the **best transporting medium** for dissolved minerals and food molecules.
- It is **best aqueous medium** for all biochemical reactions occurring in the cells.
- It is an **essential raw material** for photosynthesis.
- Water has high specific heat, high heat of vaporization and high heat of fusion. Due to this, it acts as **thermal buffer**.
- Water molecules have good **adhesive and cohesive forces** of attraction.
- Due to **high surface tension**, high adhesive and cohesive force, it can easily rise in the capillaries.

These properties of water make it a significant molecule that connects physical world with biological processes.

**6.2 Water absorbing organ**

**Q.2.** How epiphytic plants absorb water?

**Ans:** Epiphytic plants like orchids absorb water vapours from air with the help of epiphytic roots having special tissue called velamen.

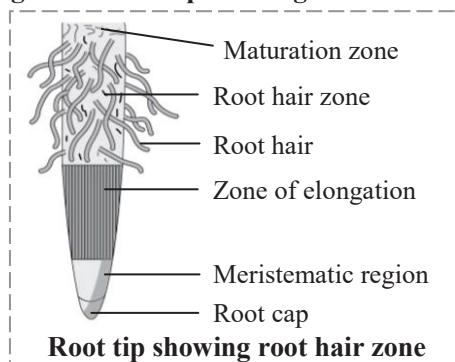
**Q.3.** Name the four regions of a typical root.

**Ans:** Four regions of a typical root:

Zone of maturation, zone of absorption (root hair region), zone of elongation and meristematic region.

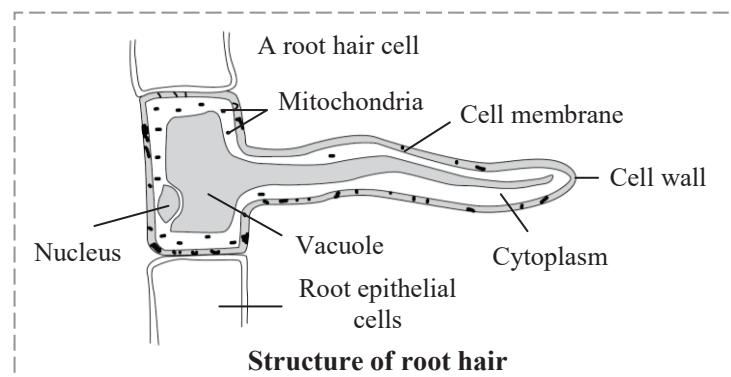
**Q.4.** Draw the neat and labelled diagram of root tip showing root hair zone.

**Ans:**



\*Q.5. Describe structure of root hair.

**Ans:** Structure of root hair:



- Root hair is cytoplasmic extension (prolongation) of epiblema cell.
- Each root hair may be approximately 1 to 10 mm long and tube like structure.
- It is colourless, unbranched, short-lived (ephemeral) and very delicate.
- It has a large central vacuole surrounded by thin film of cytoplasm, plasma membrane and thin cell wall, which is two layered.
- Outer layer is composed of pectin and inner layer is made up of cellulose.
- Cell wall of a root hair is freely permeable but plasma membrane is selectively permeable.

### 6.3 Water available to roots for absorption

**Q.6. Classify the various types of water present in soil.**

**Ans:** The types of water present in soil can be classified as:

- Gravitational water:** The water which percolates deep into soil, due to the gravity is called 'gravitational water'. This water goes beyond the reach of roots of most of the plants, thus is not available to plants for absorption.
- Hygroscopic water:** Fine soil particles inhibit adsorb water and hold it very tightly. This is called 'hygroscopic water'. Roots cannot absorb it.
- Combined water:** Water present in the form of hydrated oxides of silicon, aluminium, etc., is called 'combined water'. It is also unavailable to plants for absorption.
- Capillary water:** Some amount of water is held in pores present between the neighbouring soil particles, due to capillarity. This is called capillary water which is available for absorption.

### 6.4 Absorption of water by roots from soil

**Q.7. Name the three processes involved in absorption of water from soil.**

**Ans:** The three processes involved in absorption of water from soil are:

Imbibition, diffusion and osmosis.

**Q.8. Write a short note on Imbibition.**

**Ans:** **Imbibition:**

i. Imbibition is swelling up of hydrophilic colloids due to adsorption of water.

**OR**

The adsorption of water by hydrophilic compounds is called imbibition.

- Substance that adsorbs water / liquid is called as **imbibant** and water/ liquid that gets imbibed is called as **imbibate**.
- The root hair cell wall is made up of pectic compounds and cellulose which are hydrophilic colloids.
- During imbibition, water molecules get tightly adsorbed without the formation of solution.
- Imbibition continues till the equilibrium is reached. In other words, water moves along the concentration gradient.
- Imbibition is significant in soaking of seeds, swelling up of dried raisins, kneading of flour etc.

**Q.9. Use your brain power (Textbook page no. 120)**

Why do the wooden doors become very hard to close and open in rainy season?

**Ans:**

- During rainy season, wooden doors swell due to the adsorption of water by hydrophilic compounds (like cellulose and pectic compounds) through a process known as **imbibition**.
- The water molecules get tightly adsorbed on the surface of compounds without forming a solution.
- Due to imbibition, these compounds show swelling.

Thus, wooden doors become very hard to close and open in rainy season.

**Q.10. What is diffusion? Write its significance to plants.**

**Ans:**

- Diffusion:**
  - Diffusion means to disperse.
  - Diffusion can be defined as the movement of ions/ atoms/ molecules of a substance from the region of their higher concentration to the region of their lower concentration till equilibrium is reached.
  - The movement is due to the kinetic energy of the molecules.
  - Water passes into the cell by diffusion through a freely permeable cell wall.
- Significance of diffusion to plants:** In plants, diffusion plays significant role absorption of water, minerals, conduction of water against the gravity, exchange of gases and transport and distribution of food.

**Q.11. What is Diffusion Pressure?**

**Ans: Diffusion Pressure:**

Diffusion pressure is a result of diffusion. It is directly proportional to the number of diffusing particles.

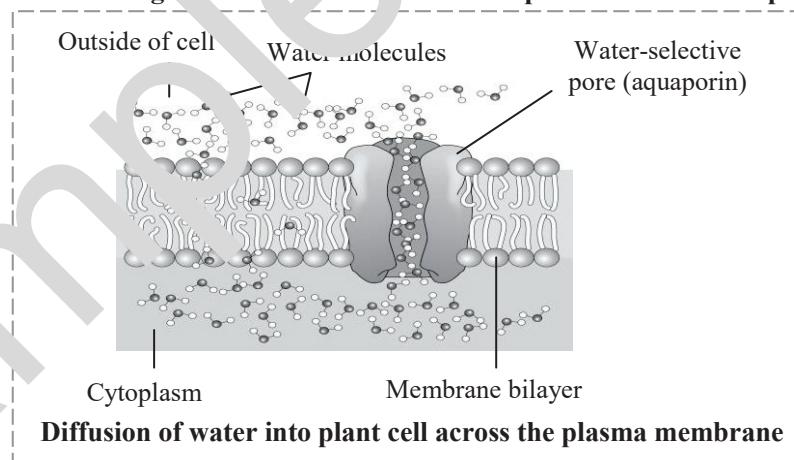
**Q.12. Explain the term DPD.**

**Ans: DPD (Diffusion Pressure Deficit):**

- Diffusion pressure of pure solvent (pure water) is always more than the diffusion pressure of solvent in a solution. The difference in the diffusion pressure of pure solvent and the solvent in a solution is called **Diffusion Pressure Deficit (DPD)** or Suction Pressure (SP).
- The term DPD was coined by B.S. Meyer (1938). No longer days. Term **water potential** is used for DPD.
- In colloquial language, the term DPD is actually the thirst of a cell with which it absorbs water from the surroundings.
- Water around cell wall has more diffusion pressure than cell sap. Due to this, water moves in the cell by diffusion.

**Q.13. Draw neat and labelled diagram of diffusion of water into plant cell across the plasma membrane.**

**Ans:**

**Q.14. Explain the term osmosis.**

**Ans:**

- Osmosis is a special type of diffusion of solvent through a semipermeable membrane.

**OR**

- It is defined as the diffusion of water or solvent from a solution of lower concentration to the solution of higher concentration through semipermeable membrane.
- It is a process by which water enters into the cytoplasm of the root hair cell.
  - The cytoplasm of root hair cell contains minerals, sugars, etc. Thus it is more concentrated (stronger) than outside the cell (weaker).
  - Therefore, solvent from weaker solution enters into cytoplasm (i.e. to stronger solution) of cell through a semipermeable plasma membrane. This migration of solvent is called osmosis.

**\*Q.15. Distinguish between diffusion and osmosis.****Ans: Diffusion and Osmosis:**

No.	Diffusion	Osmosis
i.	It takes place in solid, gas or liquid medium.	It takes place only in liquid medium.
ii.	It does not require presence of semi-permeable membrane.	It requires presence of semi-permeable membrane.
iii.	In diffusion, the movement of ions/atoms/molecules from region of higher concentration to the region of lower concentration takes place.	In osmosis, diffusion of only solvent from lower concentration of solution to higher concentration of solution occurs.
iv.	It is influenced by the diffusion pressure.	It is only influenced by the turgor pressure

**Q.16. Define the following terms:**

- i. Hypotonic solution      ii. Hypertonic solution      iii. Isotonic solution

**Ans:**

- i. **Hypotonic solution:** It is a solution (weak solution or strong solvent) having low osmotic concentration.  
 ii. **Hypertonic solution:** It is a solution (strong solution or weak solvent) having high osmotic concentration.  
 iii. **Isotonic solution:** It is a solution having such a concentration where there is neither gain nor loss of water in an osmotic system. In other words, concentration outside and inside the cell is same.

**Q.17. Define osmosis. What are the types of osmosis?****Ans:**

- i. **Osmosis:** Refer Q.14 (i)  
 ii. **Types of osmosis:**
  - a. **Exo-osmosis:** It is the migration of solvent from the cell to outside. It causes flaccidity of cell.
  - b. **Endo-osmosis:** It is the migration of the solvent into the cell from outside. This makes the cell turgid.

**Q.18. Define turgor pressure (T.P) and wall pressure (W.P). How T.P is related to DPD and W.P?****Ans:**

- i. **Turgor pressure (T.P)** is the pressure exerted by turgid cell sap on to the cell membrane and cell wall.  
 ii. Cell wall being thick and rigid, exerts a counter pressure on the cell sap. This is called **Wall pressure (W. P.)**.  
 iii. In a fully turgid cell, DPD is zero.  
 iv. In a fully turgid cell, T. P. = W. P., but operating in opposite direction.

**\*Q.19. What is osmotic pressure?****Ans:**

- i. The pressure exerted due to osmosis is called osmotic pressure.  
 ii. Osmotic pressure is a pressure of the solution which is required in opposite direction, so as to stop the entry of solvent molecules into the cell.

Osmotic pressure of a solution is equivalent to the pressure which must be exerted upon it to prevent flow of solvent across a semipermeable membrane.

**Q.20. Write the formula used to calculate cell DPD.**

**Ans:** The formula used to calculate cell DPD is  $DPD = OP - TP$

**Q.21. Why is turgor pressure important?**

**Ans:** Turgor pressure is important because;

- i. It keeps walls and organelles stretched.  
 ii. It provides support to the non-woody tissues.  
 iii. It is essential for cell enlargement during growth.  
 iv. It maintains shape of cell and facilitates opening and closing of stoma.

**Q.22. Distinguish between Osmotic pressure and Turgor pressure.****Ans:**

	Osmotic pressure	Turgor pressure
1.	Osmotic pressure is a pressure of the solution, which is required in opposite direction, so as to stop the entry of solvent molecules into the cell.	Turgor pressure is the pressure exerted by turgid cell sap on to the cell membrane and cell wall.

**Q.23. Write significance of osmosis in plants.**

**Ans:** **Significance of osmosis in plants:**

- i. It is responsible for absorption of water into root.  
 ii. It maintains turgidity of cell.



- iii. It facilitates cell to cell movement of water.
- iv. It offers resistance to drought, frost, etc.
- v. It also helps in the drooping of leaflets and leaves in vicinity of “touch me not” plant.

**Q.24. Write a short note on facilitated diffusion.**

**Ans:** Facilitated diffusion:

- i. The passive absorption of solutes when mediated by a carrier it is called as facilitated diffusion.
- ii. Particles that are lipid soluble can easily diffuse through lipoproteinous cell membrane.
- iii. The diffusion of hydrophilic solutes (water soluble) has to be facilitated because their diffusion across the membrane is difficult.
- iv. Membrane proteins provide such sites for facilitated diffusion.
- v. These proteins are aquaporins and ion-channels.
- vi. These proteins help move substances across membranes without the expenditure of energy.
- vii. Concentration gradient must be present for the molecules to be diffused through facilitated diffusion.

## 6.5 Water potential ( $\psi$ )

**Q.25. Define chemical potential.**

**Ans:** Free energy per molecule in a chemical system is called its chemical potential.

**Q.26. Explain in brief the concept of water potential.**

**Ans:** Water potential:

- i. Chemical potential of water is called water potential.
- ii. It is represented by Greek letter psi ( $\psi$ ).
- iii. The unit of measurement of water potential is bars / pascals/ atmospheres.
- iv. Water potential of protoplasm is equal but opposite in sign to DP. It has negative value.
- v. Water potential of pure water is always zero. Addition of any solute in it decreases its psi ( $\psi$ ) value. Therefore, it has negative value.
- vi. Difference between water potential of the adjacent cells decides movement of water through plasmodesmata across the cells.
- vii. Water always flows from less negative potential to more negative water potential (i.e. from high water potential area to low water potential area).

**Q.27. What happens when a pressure greater than the atmospheric pressure is applied to pure water or a solution? [NCERT]**

**Ans:** When a pressure greater than the atmospheric pressure is applied to pure water or a solution, its water potential increases.

**Q.28. Enlist the factors affecting water absorption.**

**Ans:** Factors affecting water absorption:

- i. Presence of capillary water is essential for water absorption.
- ii. Rate of water absorption is maximum at soil temperature between 20° to 30°C.
- iii. High concentration of solutes in soil water reduced the rate of absorption of water.
- iv. Poorly aerated soil shows poor absorption rate.
- v. Increase in respiration accelerates the rate of absorption of water in the irrigated soil.

## 6.6 Plasmolysis

**Q.29. Name the condition in which protoplast of the cell shrinks.**

**Ans:** Plasmolysis

**Q.30. What is plasmolysis?**

**Ans:** Plasmolysis:

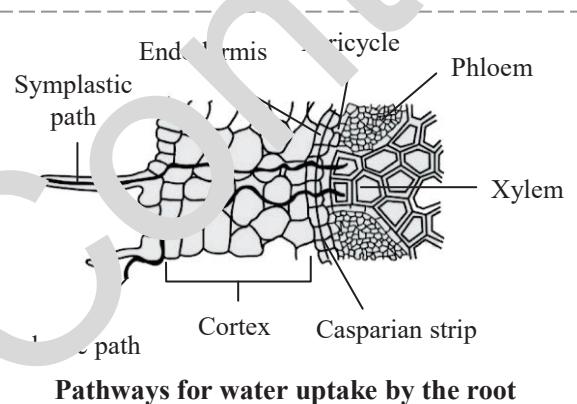
- i. When a living cell is placed in hypertonic solution, exo-osmosis occurs. This is called as plasmolysis.
- ii. During plasmolysis, protoplast of cell shrinks and recedes from cell wall due to which cell becomes flaccid. Such cell is called plasmolysed cell.
- iii. In a plasmolysed cell, a gap is developed between cell wall and the protoplast. This gap is filled up by outer solution.

**Q.31. How a plasmolysed cell can be deplasmolysed?****Ans:**

- In a plasmolysed cell, turgor pressure is always zero.
- When plasmolysed cell is placed in hypotonic solution, endo-osmosis occurs.
- Due to this cell becomes turgid. This is called deplasmolysis and such cell is called deplasmolysed cell.

**\*Q.32. Which type of solution will bring about deplasmolysis?****Ans:** Hypotonic solution can bring about deplasmolysis.**Q.33. If in a fully turgid cell,  $T.P = O.P$ , then what will be its DPD?****Ans:** If in a fully turgid cell,  $T.P = O.P$ , then its DPD will be zero. (As,  $DPD = O.P - T.P$ )**6.7 Path of water across the root (i.e. from epiblema upto xylem in the stellar region)****\*Q.34. Write on journey of water from soil to xylem in roots.****OR****Explain movement of water in root.****Ans:** **Journey of water from soil to xylem in roots (from epiblema upto xylem in the stellar region):**

- Water is absorbed by root hair cell through the processes like imbibition, diffusion, osmosis which occur sequentially.
- Water passes through epidermal cell (epiblema), cortex, endodermis, caspary strip, pericycle and then to protoxylem.
- When root hair cell absorbs water it becomes turgid. Its turgor pressure increases, but its DPD value decreases.
- However, the immediately adjacent cortical cell inner to it, has more DPD value, because its O. P. is more.
- Therefore, cortical cell will absorb water from the turgid root hair cell. It then becomes turgid.
- The flaccid root hair cell now absorbs water from oil.
- Water from the turgid cortical cell is absorbed by inner cortical cell and the process goes on.
- Thus, a gradient of suction pressure ( $\Delta PL$ ) developed from cells of epiblema to the cortex of the root.
- Consequently water moves rapidly across the root through loosely arranged living cells of cortex, followed by passage cells of endodermis and finally into the cell of pericycle.
- Protoxylem is in the close proximity with pericycle.
- It is due to root pressure, water from pericycle is forced into the xylem.
- Pathway of water across the root occurs in two types: **Apoplast pathway** and **Symplast pathway**
- Apoplast pathway:** When some amount of water passes across the root through the cell wall and the intercellular spaces of cortical cells of root, it is then called apoplast pathway. This pathway occurs up to endodermis.
- Symplast pathway:** When water passes across from one living cell to other living cell through plasmodesmata, then it is called symplast pathway. It is also called trans-membrane pathway.

**Pathways for water uptake by the root****Q.35. What is symplast pathway?****Ans:** Refer Q.3 (xiv)**Q.36. Differentiate between Apoplast pathway and Symplast pathway.**

[NCERT]

**Ans:**

	<b>Apoplast pathway</b>	<b>Symplast pathway</b>
i.	In apoplast pathway, water moves from interconnecting cell walls and intercellular spaces.	In symplast pathway, water moves from one cell to another through cytoplasmic bridges called plasmodesmata.
ii.	The movement of water is non-osmotic.	The movement of water occurs due to osmosis.
iii.	Movement of water is fast.	Movement of water is slow.
iv.	Obstructed in endodermis due to presence of caspary strip.	Can be followed through endodermis and pericycle as caspary strip does not obstruct the pathway.



**Q.37. Explain the term root pressure. Name the instrument used to measure root pressure.**

**Ans: Root pressure:**

- During absorption of water the continuous flow of water develops hydrostatic pressure in living cells of root. This is called root pressure.
- Root pressure causes water to flow from pericycle into the xylem. It also causes upward conduction of water against the gravity.
- Manometer is used to measure the root pressure.

**Q.38. Explain the additional apoplasm pathway that bypasses the casparyan strip without entering into the symplast pathway.**

**Ans:**

- The apoplastic (non-living) pathway provides a route towards the vascular stele through free spaces and cell walls of the epidermis and cortex.
- An additional apoplastic route that allows direct access to the xylem and phloem is along the margin of secondary roots.
- Secondary roots develop from the pericycle, a cell layer just inside the endodermis.
- The endodermis is characterized by the Casparyan strip, a suberized layer that keeps all the space in the symplast in order to enter the vascular system.
- Since secondary roots grow through the endodermis, a direct pathway to the xylem and phloem is available that bypasses the Casparyan strip and allows to enter the vascular system without moving into the symplast (living tissue).

## 6.8 Mechanism of absorption of water

**\*Q.39. Describe mechanism for absorption of water.**

**Ans: Mechanism for absorption of water:**

- In plants, water is absorbed mainly by two processes: **Passive absorption and Active absorption**
- Passive absorption:**
  - About 98% of the total water absorbed in plants occurs passively.
  - In passive absorption, living cells of root do not play any important role in water absorption.
  - The driving force is transpiration pull and it thus proceeds through DPD gradient.
  - There is no expenditure of energy (ATP) as water moves in accordance to the concentration gradient. Hence, it is passive absorption.
  - Passive absorption occurs during day time when transpiration is in progress. It stops at night when transpiration stops.
  - Rapid transpiration creates a tension in the xylem vessel due to negative water potential. This tension is transmitted to xylem in the root. Consequently water is pulled upwards passively.
  - During passive absorption, no ATP is utilized. Thus, the rate of respiration is not affected.
- Active absorption:**
  - In this water is absorbed due to activity of roots.
  - Root cells play active role in the absorption of water.
  - The driving force is the root pressure developed in the living cells of root.
  - Active absorption occurs usually at night when transpiration stops due to closure of stomata.
  - As water absorption is against the DPD gradient, there is expenditure of ATP (energy) generated through the respiratory activity of cells.

**Q.40. Explain in detail osmotic and non-osmotic absorption.**

**Ans: Active absorption of water can be of two types: Osmotic and non-osmotic absorption.**

**i. Osmotic absorption:**

- Atkins and Priestly (1922) proposed that water is absorbed from soil into xylem of the root according to the osmotic gradient.
- To create osmotic conditions, there is an expenditure of energy. But such absorption does not directly require an expenditure of energy.
- A gradient of DPD develops from cell of epiblema to pericycle due to activity of living cells of root.
- As the process is continuous, a hydrostatic pressure, called root pressure is developed in root cells.
- This root pressure forces water from pericycle to xylem and then upwards to the stem.

**ii. Non-osmotic absorption:**

- Kramer and Thimann (1959) proposed non-osmotic absorption theory.
- Sometimes, water is absorbed from soil against the concentration gradient.

- c. Such absorption requires an expenditure of energy released during respiration.
- d. Poor supply of oxygen retards water absorption.
- e. Moreover low temperature retards water uptake because of decrease in the rate of respiration.
- f. Use of metabolic inhibitors also retards the rate of respiration and thus the water uptake.

## 6.9 Translocation of water

### Q.41. Define ascent of sap.

**Ans:** The transport of water with dissolved minerals from root to other aerial parts like stem and leaves, against the gravity, is called translocation or ascent of sap.

### \*Q.42. Discuss theories of water translocation.

#### **Ans: Theories of water translocation:**

- i. Various theories have been put forth to explain the mechanism of translocation of water. These theories include Vital force theory, Relay pump theory, Physical force theory, Root pressure theory, etc.
- ii. **Root Pressure Theory (Vital Theory):** This theory was proposed by J. Priestley. According to this theory, the activity of living cells of root is responsible for translocation of water.
- iii. **Capillarity theory (physical force theory):** This theory was put forth by P. Lehmann in 1863. According to this theory, physical forces and dead cells are responsible for ascent of sap.
- iv. **Cohesion-tension theory (Transpiration pull theory):** This theory was put forth by Dixon and Jolly (1894). This is presently widely accepted theory explaining ascent of sap in plants. This theory is based on two principles i.e. Cohesion and adhesion, and transpiration pull.

### Q.43. Draw figure of experimental set up to demonstrate root pressure and explain root pressure theory in detail.

#### **Ans: Root Pressure Theory (Vital Theory):**

- i. This theory was proposed by J. Priestley.
- ii. According to this theory, the activity of living cells of root is responsible for translocation of water.
- iii. When a stem of potted plant is cut few inches above the soil by a sharp knife, xylem sap is seen flowing out oozing out through the cut end.
- iv. This exudation at the cut end of stem is good proof for the existence of root pressure.
- v. As water absorption by roots is constant and continuous process, a hydrostatic pressure is developed in the living cells of cortex of root. This is termed as root pressure (coined by S. Hales).
- vi. It is due to root pressure water along with dissolved minerals is not only forced into xylem but it is also conducted upwards against the gravity.
- vii. Root pressure seems to be largely an osmotic phenomenon and its development is an active process.
- viii. The value of root pressure is +1 to +2 bars which is enough to pump water to a height of 10 to 20 meters.
- ix. The factors like oxygen, moisture, temperature of soil, salt contents, etc. influence the root pressure.

### Q.44. Root pressure is not the sole mechanism explaining the ascent of sap in all plants of varying heights. Give reason.

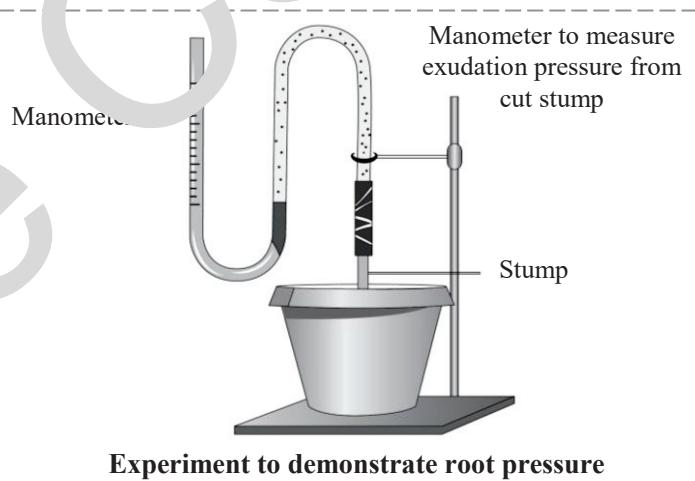
#### **OR**

#### **Write limitations of root pressure theory.**

Although, ascent of sap takes place due to root pressure, there are certain objections raised, such as;

- i. It is not applicable to plants taller than 20 meters.
- ii. Ascent of sap can also occur even in the absence of root system.
- iii. Root pressure value is almost nearly zero in taller gymnosperm trees.
- iv. In actively transpiring plants, no root pressure is developed.
- v. Xylem sap under normal condition is under tension i.e. it shows negative hydrostatic pressure or high osmotic pressure.

Thus, root pressure is not the sole mechanism explaining the ascent of sap in all plants of varying heights.



**Experiment to demonstrate root pressure**

**\*Q.45. Which type of plants have negative root pressure?**

**Ans:** The plants in which transpiration occurs rapidly especially during midsummer shows negative root pressure.

**\*Q.46. Explain capillarity theory of water translocation.**

**Ans: Capillarity theory of water translocation:**

- i. This theory was put forth by Boehm in (1863).
- ii. According to this theory, physical forces and dead cells are responsible for ascent of sap.  
For e.g. Wick dipped in an oil lamp, shows capillarity due to which oil is raised upwards. The conduction of water in a straw dipped in water is raised to a certain height because of capillarity. The height to which water is raised depends on the diameter of the straw.
- iii. Capillarity is because of surface tension, and forces of cohesion (attraction between like molecules) and adhesion (attraction between unlike molecules).
- iv. Xylem vessel/ tracheid with its lumen can be compared with straw.
- v. Water column exist because of combined cohesive and adhesive forces of water and xylem wall, due to capillarity.
- vi. Due to capillarity, water is raised or conducted upwards against the gravity, to few centimetres only.

**Q.47. Write objections/ Limitations of capillarity theory:**

**Ans: Objections/ Limitations of capillarity theory:**

- i. Capillary tube (xylem) must be continuously and completely hollow from one end to the other end but tracheids in the xylem show closed end-walls.
- ii. The lower end of capillary tube i.e. xylem must be in direct contact with soil water. However, there exists a barrier of root cortex between xylem and soil water.
- iii. Narrower the capillary tube, greater is the height to which water column is raised. Thus, taller trees should show xylem vessels with very narrow bore (diameter). However, in nature the tall trees show xylem vessels having wider bore.

**\*Q.48. Explain cohesion theory for translocation of water.**

**Ans: Cohesion theory (Transpiration pull theory) for translocation of water:**

- i. This theory was put forth by Dixon and Jolly (1894).
- ii. This is presently widely accepted theory explaining ascent of sap in plants.
- iii. This theory is based on two principles i.e. Cohesion and adhesion, and transpiration pull.

**v. Cohesion and adhesion:**

- a. A strong force of attraction between water molecules is called **cohesive force**.
- b. While a strong force of attraction between water molecules and lignified wall of lumen of xylem vessel, is called **adhesive force**.
- c. Due to combined cohesive and adhesive forces a continuous water column is developed (formed) in the xylem right from root upto the tip of the topmost leaf in the plant.

**v. Transpiration pull:**

- a. The transpiration pull developed in the leaf vessel is transmitted down to root and thus accounts for the ascent of sap.
- b. Excess water is lost in the form of vapour, mainly through the stomata found on leaf.
- c. This water loss increases D.P.D. of mesophyll cells. These cells withdraw water ultimately from xylem in the leaf.
- d. In other words, due to continuous transpiration, a gradient of suction pressure (i.e. D.P.D.) is developed right from guard cells up to the xylem in the leaf. This will create a tension (called negative pull or transpiration pull) in the xylem.
- e. Consequently, water column is pulled out of xylem. Thus, water is pulled upwards passively against the gravity leading to the ascent of sap.

**\*Q.49. Write objections/ limitations of cohesion theory for translocation of water.**

**Ans:**

- i. For transpiration pull to operate, water column should be unbroken and continuous. However, due to temperature fluctuations during day and night, gas bubbles may enter in water column breaking the continuity.
- ii. This mechanism assumes that tracheids are more efficient than the vessels, as their end walls support water column. However, vessels are more evolved than tracheids and are more efficient.
- iii. If plant is smeared with vaseline in order to stop transpiration, even then ascent of sap occurs.
- iv. Ascent of sap also occurs in deciduous plants that have shed all of their leaves.

**\*Q.50. In which conditions transpiration pull will be affected?**

**Ans:** Refer Q.49 (i)

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To see complete chapter buy **Target Notes** or **Target E-Notes**

**Q.73. Write significance of Transpiration.****Ans: Significance of Transpiration:**

- i. It removes excess of water.
- ii. It helps in the passive absorption of water and minerals from soil.
- iii. It helps in the ascent of sap.
- iv. As stomata are open, gaseous exchange required for photosynthesis and respiration, is facilitated.
- v. It maintains turgor of the cells.
- vi. Transpiration helps in reducing the temperature of leaf and in imparting cooling effect.

**Q.74. Write disadvantage of transpiration.****Ans:** Excessive transpiration leads to wilting and injury in the plant. It may also lead to the death of the plant.**\*Q.75. What is transpiration ? Explain role of transpiration.****Ans:**

- i. **Transpiration:** Refer Q.64 (i)
- ii. **Role of transpiration:** Refer Q.73

**\*Q.76. What is significance of transpiration? Explain root pressure theory and its limitations.****Ans:**

- i. **Significance of transpiration:** Refer Q.73
- ii. **Root pressure theory and its limitations:** Refer Q.43, Q.44

**\*Q.77. Why transpiration is called necessary evil?****Ans:** Curtis (1926) regarded transpiration as 'a necessary evil', because;

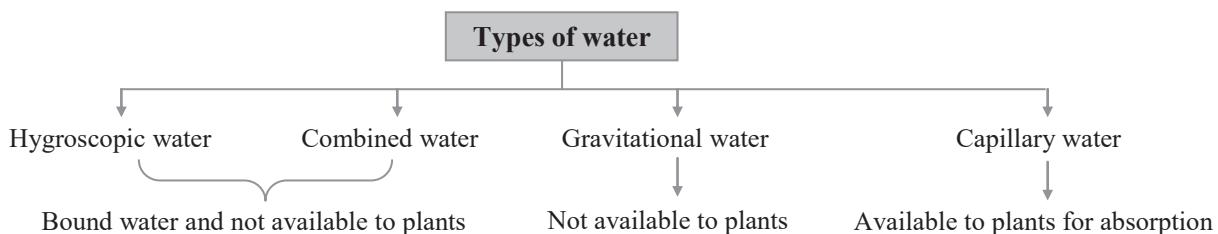
- i. For stomatal transpiration to occur, stoma must remain open, during day time.
- ii. When stomata are open then only the gaseous exchange needed for respiration and photosynthesis, will take place.
- iii. If stomatal transpiration stops, it will directly affect productivity of plant through the loss of photosynthetic and respiratory activity.
- iv. Hence for productivity, stomata must remain open.
- v. Consequently transpiration cannot be avoided.

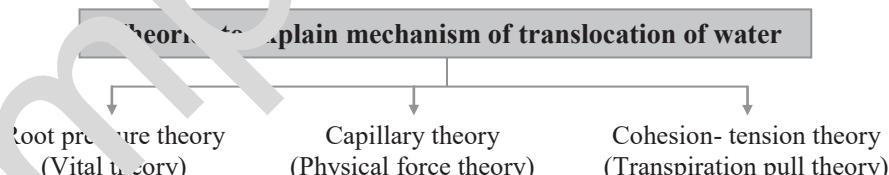
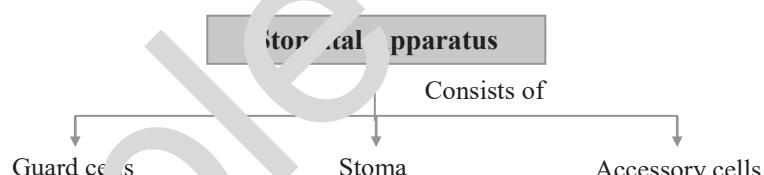
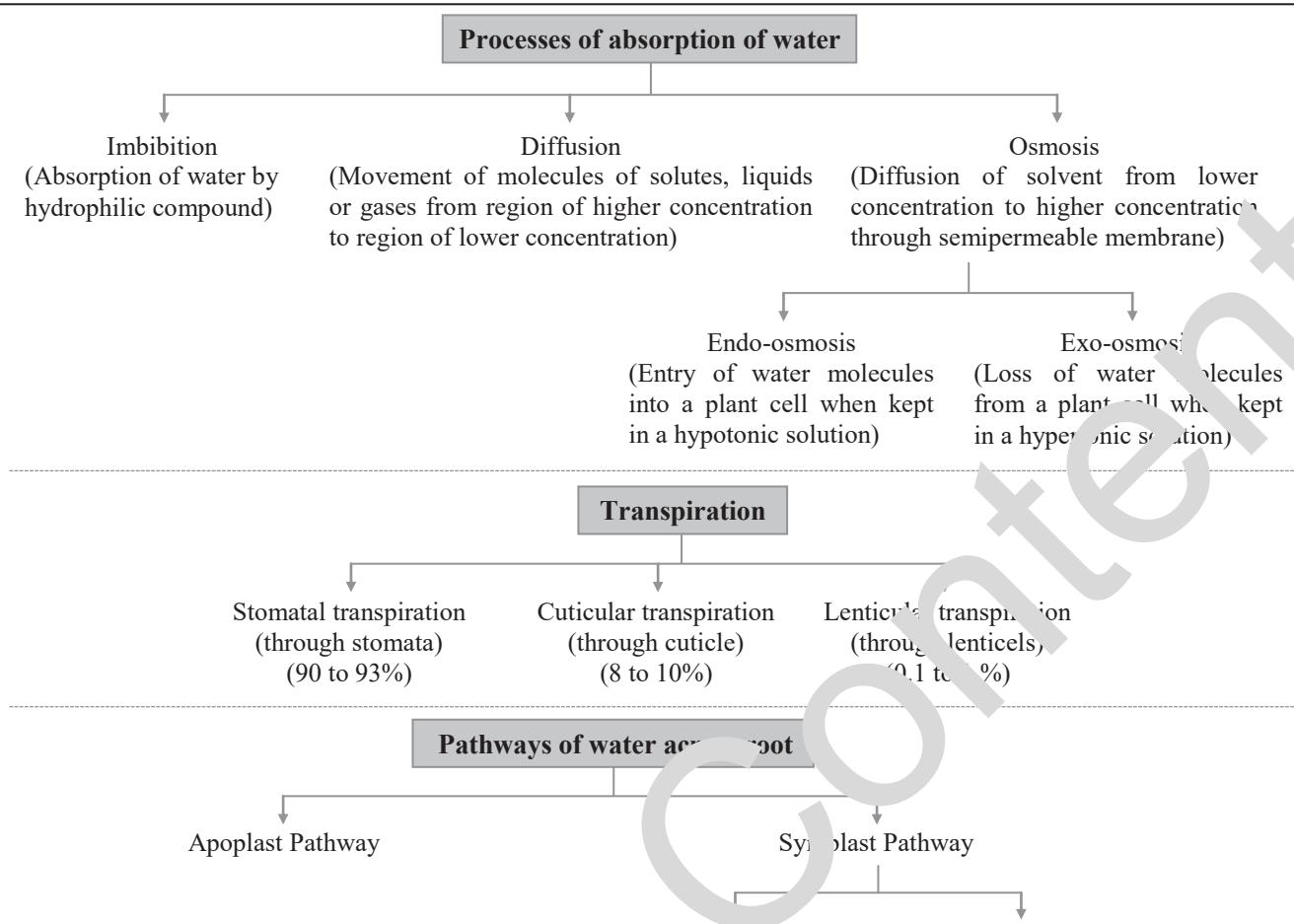
**\*Q.78. Define and or explain the terms:**

- |                     |                    |                     |                         |
|---------------------|--------------------|---------------------|-------------------------|
| i. Osmosis          | ii. Diffusion      | iii. Plasmolysis    | iv. Imbibition          |
| v. Guttation        | vi. Transpiration  | vii. Ascent of sap  | viii. Active absorption |
| ix. DPD             | x. Turgor pressure | xi. Water potential | xii. Wall pressure      |
| xiii. Root pressure |                    |                     |                         |

**Ans:**

- |  |   |
|--|---|
| i. <b>Osmosis:</b> Refer Q.14          | ii. <b>Diffusion:</b> Refer Q.10                |
| iii. <b>Plasmolysis:</b> Refer Q.30    | iv. <b>Imbibition:</b> Refer Q.8                |
| v. <b>Guttation:</b> Refer Q.63        | vi. <b>Transpiration:</b> Refer Q.64            |
| vii. <b>Ascent of sap:</b> Refer Q.41  | viii. <b>Active absorption:</b> Refer Q.39(iii) |
| ix. <b>DPD:</b> Refer Q.12             | x. <b>Turgor pressure:</b> Refer Q.18(i)        |
| xi. <b>Water potential:</b> Refer Q.36 | xii. <b>Wall pressure:</b> Refer Q.18(ii)       |
| xiii. <b>Root pressure:</b> Refer Q.37 |   |

**Practical / Project****\*Q.79. Prepare power point presentation for different types of transpiration.****Ans:** Refer Q.65*[Note: Students are expected to collect more information about different types of transpiration]***Quick Review**



## Exercise

### 6.1 Properties of water

1. What are the properties of water?

**Ans:** Refer Q.1

### 6.2 Water absorbing organ

2. Which are the four regions of a typical root?

**Ans:** Refer Q.3

3. Name the region of a root which possesses root hair.

**Ans:** Refer Q.3

### 6.3 Water available to roots for absorption

4. i. Which are the four types of water?  
ii. Which type of water is available for plants to absorb?

**Ans:** i. Refer Q.6  
ii. Refer Q.6 (iv)

### 6.4 Absorption of water by roots from soil

5. Explain the term Imbibition.

**Ans:** Refer Q.8

6. Give examples of Imbibition.

**Ans:** Refer Q.8 (vi), Q.9 (i)



7. What is DPD?
- Ans:** Refer Q.12
8. Name the types of solutions based on concentration and osmotic migration.
- Ans:** Refer Q.16
9. Define turgor pressure and wall pressure.
- Ans:** Refer Q.18 (i, ii)
10. Why is osmosis important to plants?
- Ans:** Refer Q.23

### 6.5 Water Potential ( $\Psi$ )

11. Write a short note on water potential.
- Ans:** Refer Q.26
12. What is the unit to measure water potential?
- Ans:** Refer Q.26 (iii)

### 6.6 Plasmolysis

13. What is turgor pressure of plasmolysed cell?
- Ans:** Refer Q.31 (i)
14. Define Plasmolysis.
- Ans:** Refer Q.30 (i)

### 6.7 Path of water across the root (i.e. from epiblema upto xylem)

15. Which are the two pathways of water across the roots?
- Ans:** Refer Q.34 (xiii, xiv)
16. Draw neat and labelled diagram of pathways of water uptake by the root.
- Ans:** Refer Q.34 (Diagram)
17. Define root pressure.
- Ans:** Refer Q.37 (i)

### 6.8 Mechanism of absorption of water

18. Explain in detail passive and active absorption of water.
- Ans:** Refer Q.39
19. Write a short note on osmotic absorption.
- Ans:** Refer Q.40 (i)

### 6.9 Translocation of water

20. Who put forth the cohesion tension theory?
- Ans:** Refer Q.40 (iv)
21. Explain in detail root pressure theory.
- Ans:** Refer Q.43
22. Write limitations of root pressure theory.
- Ans:** Refer Q.44
23. Write objections of capillarity theory.
- Ans:** Refer Q.47
24. Describe transpiration pull model of water transport in plants. [NCERT]
- Ans:** Refer Q.48

### 6.10 Transport of mineral ions

25. Write about active absorption of minerals.
- Ans:** Refer Q.52
26. Enlist micronutrients and macronutrients in plants.
- Ans:** Refer Q.53

### 6.11 Transport of food

27. Explain the pressure flow hypothesis of translocation of sugar in plants. [NCERT]
- Ans:** Refer Q.61(iii)
28. Explain the Munch's pressure flow theory/ Mass flow hypothesis.
- Ans:** Refer Q.61
29. Explain the terms source and sink with respect to transport of food in plants.
- Ans:** Refer Q.57 (i)

### 6.12 Transpiration

30. Define guttation.
- Ans:** Refer Q.63 (i)
31. Which are the three types of transpiration?
- Ans:** Refer Q.65 (i)
32. Write a short note on stomatal transpiration.
- Ans:** Refer Q.65 (iv)

### 6.13 Structure of stomatal apparatus

33. With the help of neat and labelled diagram explain the stomatal apparatus.
- Ans:** Refer Q.67
34. What is stoma? Write its function.
- Ans:** Refer Q.67(iii)
35. Explain in detail mechanism of opening and closing of stomata.
- Ans:** Refer Q.70
36. Transpiration is called as necessary evil. Give reason.
- Ans:** Refer Q.77
37. What causes the opening and closing of guard cells of stomata during transpiration? [NCERT]
- Ans:** Refer Q.70

### Multiple Choice Questions

- \*1. In soil, water available for absorption by root is
- gravitational water
  - capillary water
  - hygroscopic water
  - combined water
- \*2. Water absorption takes place through
- lateral roots
  - root cap
  - root hair
  - primary root



3. Which of the following is the first step in water absorption?  
 (A) Imbibition  
 (B) Active Absorption  
 (C) Passive absorption  
 (D) Osmosis
- \*4. During rainy season wooden doors warp and become difficult to open or to close because of  
 (A) plasmolysis      (B) imbibition  
 (C) osmosis           (D) diffusion
5. Diffusion is significant in plants in  
 (A) absorption of minerals  
 (B) exchange of gases  
 (C) absorption of water  
 (D) all of these
- \*6. Water movement between the cells is due to  
 (A) T. P.  
 (B) W. P.  
 (C) DPD  
 (D) incipient plasmolysis
7. Osmotic movement of water is on the basis of  
 (A) free energy      (B) entropy  
 (C) translocation    (D) imbibition
- \*8. Osmosis is a property of  
 (A) solute            (B) solvent  
 (C) solution          (D) membrane
- \*9. Which of the following type of solution has lower level of solutes than the solution?  
 (A) Isotonic          (B) Hypotonic  
 (C) Hypertonic       (D) An isotonic
10. In a fully turgid cell, DPD is  
 (A) always one       (B) zero  
 (C) always negative   (D) both (B) and (C)
11. In a flaccid cell, if  $\Delta P$  is zero,  
 (A) DPD is equal to C<sub>s</sub>  
 (B) DPD is greater than C<sub>s</sub>  
 (C) O.P. is greater than DPD  
 (D) DPD is also zero
12. Select the incorrect statement from the following.  
 (A) DPD is termed as water potential.  
 (B) O.P. is termed as osmotic potential.  
 (C) T. P. has always positive value.  
 (D) Water potential of pure water is always negative.
13. Plasmolysis occurs in plant cells when outer solution is  
 (A) isotonic           (B) hypertonic  
 (C) hypotonic        (D) mesotonic
14. In symplast pathway, water passes across  
 (A) Cell wall  
 (B) intercellular spaces
- (C) plasmodesmata  
 (D) both (A) and (B)
15. Select the incorrect statement with respect to passive absorption of water.  
 (A) No ATP is utilized.  
 (B) The rate of respiration is not affected.  
 (C) There is expenditure of energy generated through respiratory activity of cells.  
 (D) Occurs during day time when transpiration is in progress.
- \*16. The most widely accepted theory for ascent of sap is  
 (A) capillarity theory  
 (B) root pressure theory  
 (C) diffusion  
 (D) transpiration pull theory
- \*17. Surface tension due to  
 (A) diffusion          (B) osmosis  
 (C) gravitational force (D) cohesion
- \*18. In guard cells when sugar is converted into starch in the stomatal pore  
 (A) closes almost completely  
 (B) opens partially  
 (C) opens fully  
 (D) remains unchanged
- \*19. Due to low atmospheric pressure the rate of transpiration will  
 (A) increase           (B) decrease rapidly  
 (C) decrease slowly   (D) remain unaffected
20. Guttation takes place through special glands called  
 (A) xylem            (B) water stomata  
 (C) hydathodes      (D) both (B) and (C)
21. Maximum transpiration occurs through  
 (A) stomata          (B) cuticle  
 (C) lenticels        (D) bark
22. Opening and closing of stomata is mainly due to the  
 (A) hormonal change in guard cells  
 (B) change in turgor pressure of guard cells  
 (C) gaseous exchange  
 (D) respiration
23. In fully opened stomata, guard cells are  
 (A) plasmolysed      (B) shrunken  
 (C) turgid            (D) flaccid

### Answers to Multiple Choice Questions

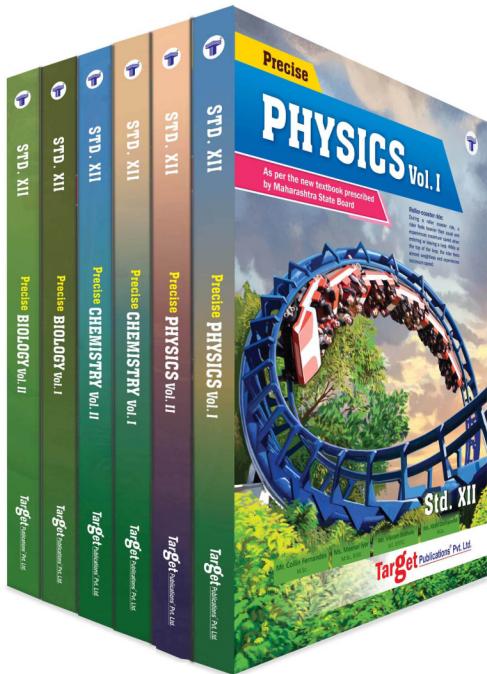
- |         |         |         |         |
|---------|---------|---------|---------|
| 1. (B)  | 2. (C)  | 3. (A)  | 4. (B)  |
| 5. (D)  | 6. (C)  | 7. (A)  | 8. (B)  |
| 9. (B)  | 10. (B) | 11. (A) | 12. (D) |
| 13. (B) | 14. (C) | 15. (C) | 16. (D) |
| 17. (D) | 18. (A) | 19. (A) | 20. (D) |
| 21. (A) | 22. (B) | 23. (C) |         |



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