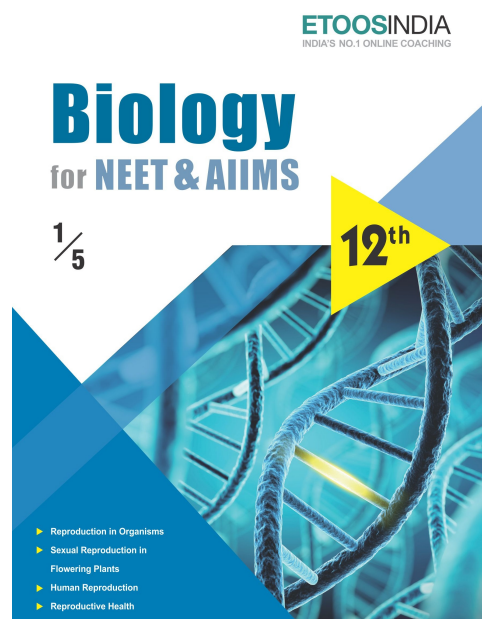
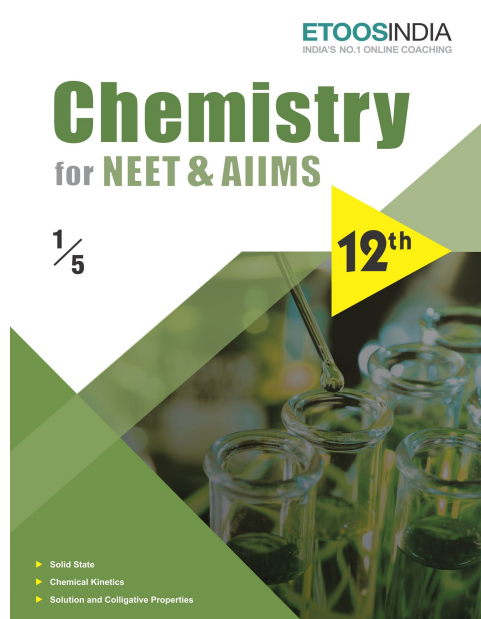
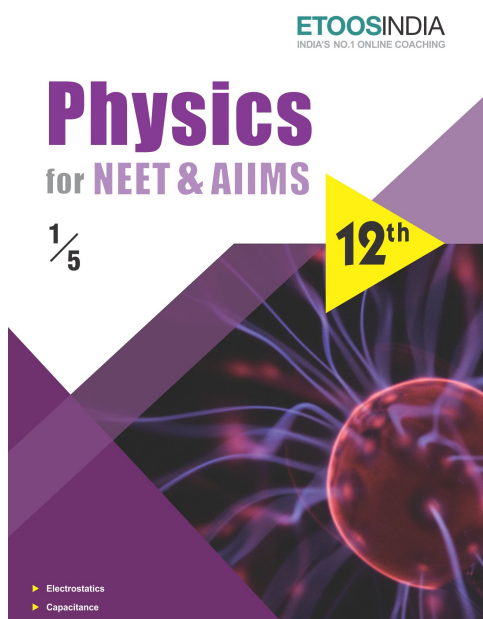
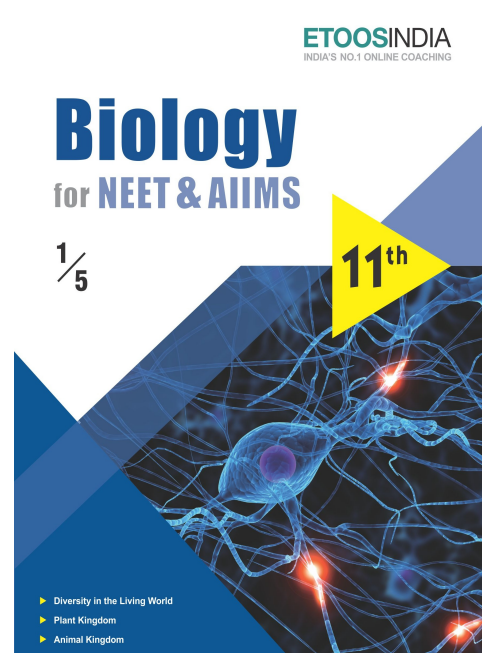
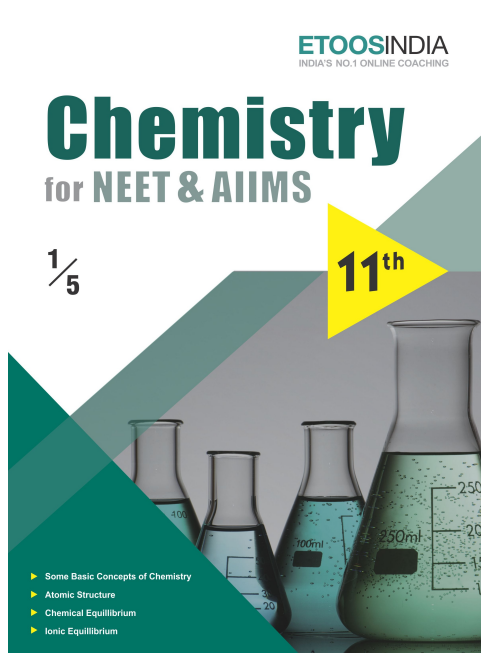
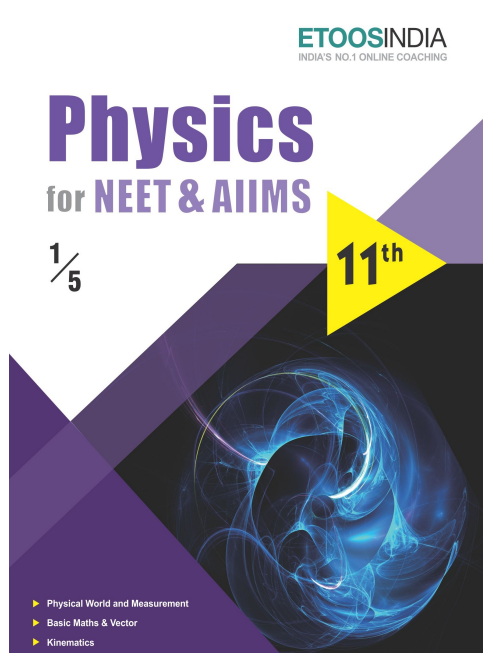


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# TRANSPORT IN PLANTS

*“For each of us who appear to have had a successful experiment there are many to whom their own experiments seem barren and negative.”*

“MELVIN CALVIN (1911-1997)”

## INTRODUCTION

**I**t is a matter of wonderment that how water reaches the top of tall trees. How and why substances move from one cell to the other or whether all substances move in a similar way? To understand some of the transport processes that take place in plants, one needs to know that plants need to move molecules over very long distances, much more than animals do; they also do not have a circulatory system in place. Water taken up by the roots reaches each and every part of the plant up to the tip of growing. When we talk of the movement of substances we need to first define what kind of movement we are talking about, also what substances we are looking at. In the flowering plants the substances that would need to be transported are water, mineral nutrients, organic nutrients and plant growth regulators. Over small distances substances move by diffusion and by cytoplasmic streaming supplemented by active transport while their longer distance transport occurs through the vascular system, i.e., xylem, phloem and is called **Translocation**.

## Transport in Plants

### Introduction –

- The study of metabolism and various vital activities of plants is known as **plant physiology**.
- **Stephan Hales** is known as father of plant physiology.
- **J.C. Bose** is known as **father of Indian plant physiology**.
- Plants grow in soil
- It absorb water and minerals, which are available in soil.
- Water has great importance for plant. Water forms 80-90% of fresh weight of plant body. The method or technique, plant cells obtain water, comes under the heading of **water relations**.

### INTRODUCTION (TRANSPORT IN PLANTS)

Did you ever noticed that how water reaches the top of big or tall trees and for that how and why substance travel from one cell to the other. Also, how substance are moving in similar way in the same direction.

In flowering plants, substances that would require to be transported are water, organic and mineral nutrients & plant growth hormone / regulators. Transport over longer distances proceeds through the vascular system (xylem and phloem) and is called as **Translocation**. The small distance transport means transport within the cell or across the membrane or from cell to cell in a tissue which occurs by diffusion, facilitated diffusion (Passive transport) and by active transport.

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. Transport in phloem, means transport of organic compounds synthesized in the photosynthetic leaves which is bidirectional (from leaves to storage organs and later from storage organs to other growing parts).

**Means of transport:-** Transport in plants is of two types-

- a. Short distance transport
- b. Long distance transport

### DIFFUSION

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

- The diffusion continues till the dynamic equilibrium is not established. At this stage the net movement of molecules is equal in both directions.
- The kinetic energy, which is present in the molecules of material is distributed equally in their available space by their nature.

Diffusion rate  $\propto$  Gas > Liquid > Solid

- Diffusion is a slow process
- Diffusion does not depend on living system.
- Diffusion rates are affected by gradient of concentration, the permeability of the membrane, temperature and pressure.
- It is very important for plants as it is only means for gaseous movement within the plant body.
- Molecules or ions which are diffused exert a pressure, on the substance or medium in which diffusion takes place, is known as diffusion pressure.

*Etoos Tips & Formulas*

- Over small distances substances move by diffusion and cytoplasmic streaming .
- Long distance transport is called TRANSLOCATION
- Organic substances move - Multidirectional
- Inorganic substances & H<sub>2</sub>O → Unidirectional
- Diffusion - passive, random slow and not dependent on living system .
- Gaseous exchange-is due to diffusion
- Diffusion rate depends on concentration gradient, permeability, temperature & pressure.
- Facilitated diffusion → Carried out for those substances having hydrophilic moiety
- Gradient required, carrier mediated, without energy
- Water channels made up of aquaporins
- Active transport → Uphill transport, energy & carrier proteins both required.
- Common features to Facilitated and Active transport → saturation, selectivity, Inhibition
- Hormone regulation Water potential → difference of Kinetic energy
- Solute potential → loss of free energy (Kinetic energy) due to addition of solutes
- Pressure potential → change in free energy due to external pressure (other than atmospheric pressure)
- Tonoplast and plasma membrane are two important determinants of movement of molecules in or out of the cell.
- Net direction and rate of osmosis depends on both pressure gradient and concentration gradient.  $OP = \psi_s$
- During plasmolysis water lost first from cytoplasm and then from vacuole
- Imbibition depends on diffusion, water potential gradient & affinity between adsorbant and liquid
- Bulk flow - can be achieved either through positive hydrostatic pressure gradient or negative hydrostatic pressure gradient.
- Xylem - water, minerals and organic nitrogen, hormones
- Phloem - Organic substances, inorganic nutrients (mobile elements)
- Apoplastic path - Cellwall & intercellular space (Non living path)
- Symplastic path - Systems of interconnected protoplasts (Living path)
- Root-pressure - positive hydrostatic pressure, leads to guttation, modest push in overall water transport, greatest contribution - reestablishments of continuity of water column.
- Cell wall of guard cells show radial arrangement of microfibrils.
- Cohesion, adhesion and surface tension -are three physical properties of water which provide - Tensile strength and capillarity
- Evolutions of C<sub>4</sub> photosynthetic path is for maximising CO<sub>2</sub> utilisation and to minimising water loss.
- Plants obtain their most of the carbon & oxygen from CO<sub>2</sub>
- Plants obtain most of their minerals from soil actively because
  - (1) Minerals present in soil as charged particles
  - (2) In soil mineral concentration is lower than plant cell.
- Active mineral absorption helps in creation of water potential gradient.
- Some ions can move passively by mass flow.
- Transport proteins of endodermal cells are control points, where a plant adjust the quantity and types of solutes that reach to xylem, hence it allow transport of ions in one direction only.

**SOLVED EXAMPLE**

**Ex.1** Best soil for healthy and vigorous growth of a plant is

- (A) Sandy soil                      (B) Loam  
(C) Clay                              (D) None of these

**Sol.** (B) : Loam are sufficiently aerated and have good water holding capacity. Therefore, they are very good for water absorption and growth.

**Ex.2** Attractive forces of cell walls for water molecules is termed as

- (A) Adhesion                      (B) Cohesion  
(C) Osmosis                        (D) Plasmolysis

**Sol.** (A) : Walls of tracheids and vessels of xylem are made up of lignin and cellulose and have strong affinity for water (adhesion).

**Ex.3** The relationship  $\pi v = nRT$  is not obeyed by

- (A) Concentrated solution  
(B) Dilute solution  
(C) Extermely dilute solution  
(D) All of these

**Sol.** (C)

**Ex.4** Selective permeability identifies the process of transmission through semipermeable membrane is called

**Or**

The movement of water from higher water potential to lower water potential through a semi-permeable membrane is called

**Or**

Living cells placed in isotonic solution (0.9% saline) retain their size and shape. This is based on the concept of

- (A) Diffusion                      (B) Osmosis  
(C) Plasmolysis                    (D) Imbibition

**Sol.** (B) : Osmosis is a special type of diffusion of a liquid, when solvent moves through a semipermeable membrane.

**Ex.5** In rainy season, the doors get wet due to

- (A) Imbibition                      (B) Absorption  
(C) Diffusion                        (D) Endosmosis

**Sol.** (A) : Due to adsorption of water molecules into wooden furniture it get swelled.

**Ex.6** The plant undergoes wilting when

- (A) Xylem is blocked  
(B) Cambium is blocked  
(C) Phloem is blocked  
(D) Some roots are reduced in number

**Sol.** (A) : Xylem is responsible for transport of water. If xylem is blocked, plant will undergo wilting due to the lack of proper transport of water.

**Ex.7** Root pressure develops due to

- (A) Low osmotic potential in soil  
(B) Passive absorption  
(C) Increase in transpiration  
(D) Active absorption

**Sol.** (D)

**Ex.8** In xerophytes, the osmotic concentration of cell sap is

- (A) Less than normal  
(B) Normal  
(C) More than normal  
(D) No osmotic pressure at all

**Sol.** (C) : Osmotic pressure is dependent upon the concentration of solutes. It is higher in xerophytes as compared to mesophytes.

**Ex.9** Which one of the following statements is wrong

- (A) Water potential is the chemical potential of the water  
(B) Solute potential is always negative  
(C) Pressure potential is zero in a flaccid cell  
(D) Water potential equals solute potential in a fully turgid cell  
(E) Pressure potential is negative in a plasmolyzed cell

**Sol.** (A)

**Ex.10** Upwards movement of water in plants is called

- (A) Sucking                              (B) Ascent of sap  
(C) Translocation                      (D) None of these

**Sol.** (B)

**Ex.11** Which of the following would be in insignificant amount in xylem sap

- (A) Sugar                              (B) Nitrates  
(C) Phosphates                        (D) Water

**Exercise # 1**

**SINGLE OBJECTIVE**

**NEET LEVEL**

1. The physical process involved in the release of molecular oxygen from leaves is :-  
 (A) Diffusion (B) Transpiration  
 (C) Osmosis (D) Capillarity
2. Pieces of beet root do not lose their colour in cold water, but do so in boiling water because :-  
 (A) The cell wall is killed in boiling water  
 (B) Hot water can enter the cells readily  
 (C) The plasma membrane gets killed in boiling water and becomes permeable  
 (D) The pigment is not soluble in cold water
3. What statement can be cited for 10% sodium chloride solution and 10% sugar solution present ?  
 (A) Both have equal OP  
 (B) The concentration of sodium chloride solution will be less than concentration of sugar solution  
 (C) The OP of sugar solution will be higher than OP of sodium chloride solution  
 (D) DPD of sodium chloride solution will be higher than DPD of sugar solution
4. If a plant cell is immersed in water, the water continues to enter the cell until the :-  
 (A) Concentration of the salts is the same inside the cell as outside  
 (B) Cell bursts  
 (C) Concentration of water is the same inside the cell as outside  
 (D) Diffusion pressure deficit is the same inside the cell as outside
5. If a cell is reduced in size (shrinks) of placing in a solution of sugar, the solution is :-  
 (A) Hypertonic (B) Hypotonic  
 (C) Isotonic (D) None of the above
6. The process of osmosis involves :-  
 (A) Movement of solute through a semipermeable membrane  
 (B) Movement of solvent through a semipermeable membrane  
 (C) Movement of solution through semipermeable membrane  
 (D) None of the above
7. Grapes placed in salt solution shrink due to :-  
 (A) Imbibition (B) Endosmosis  
 (C) Exosmosis (D) Osmosis
8. Process of selective transmission of a liquid through semi permeable membrane is called :-  
 (A) Diffusion (B) Osmosis  
 (C) Plasmolysis (D) Transmission
9. When a cell is fully turgid which of the following will be zero ?  
 (A) Turgor pressure (B) Wall pressure  
 (C) Suction pressure (D) Osmotic pressure
10. Water from the soil enters in to the root hairs on account of :-  
 (A) Turgor pressure  
 (B) Suction pressure or DPD  
 (C) Barometric pressure  
 (D) Osmotic pressure
11. In a fully turgid cell the values of DPD, OP and TP should be :-  
 (A) DPD = 10 atm., OP = 15 atm., TP = 5 atm.  
 (B) DPD = 5 atm., OP = 12 atm., TP = 7 atm.  
 (C) DPD = 2 atm., OP = 7 atm., TP = 5 atm.  
 (D) DPD = 0 atm., OP = 15 atm., TP = 15 atm.
12. When the cell is placed in water, it takes water this is due to ?  
 (A) Osmotic pressure  
 (B) Suction pressure  
 (C) Diffusion  
 (D) Water potential and TP
13. What is the direction of the movement of water if two cells have the same OP but differ in TP ?  
 (A) No net flow  
 (B) From lower T.P to higher TP  
 (C) From higher TP to lower TP  
 (D) Data insufficient
14. When water enters into a cell what happens to its OP, TP and DPD ?  
 (A) OP & TP increase & its DPD increase  
 (B) OP & DPD increase & TP decrease  
 (C) TP & DPD decrease & OP increase  
 (D) OP & DPD decrease & TP increase

**Exercise # 2****SINGLE OBJECTIVE****AIIMS LEVEL**

1. Which helps in maintaining form and structure of cells & soft parts of plants ?  
(A) Osmotic pressure  
(B) Turgor pressure  
(C) Atmospheric pressure  
(D) DPD
2. Which process occurs against a concentration gradient of solute ?  
(A) Diffusion                      (B) Osmosis  
(C) Transpiration                (D) Translocation
3. When beet root slices are washed and then placed in cold water, anthocyanin does not come out, because plasma membrane is ?  
(A) Differentially permeable to anthocyanin  
(B) Dead structure  
(C) Impermeable to anthocyanin  
(D) Permeable to anthocyanin
4. The osmotic pressure of distilled water will be :-  
(A) Minimum  
(B) Maximum  
(C) Higher than any solution  
(D) Variable
5. Tonoplast is :-  
(A) Permeable membrane  
(B) Semi permeable membrane  
(C) Impermeable membrane  
(D) Selectively permeable membrane
6. If in a cell suction pressure value is 30 atm. while osmotic pressure 42 atm. then calculate the turgidity developed in form of TP in the cell :-  
(A) 12 atm.                      (B) 72 atm.  
(C) -12 atm.                     (D) 1.4 atm.
7. Osmosis is the phenomenon expressed by :-  
(A) Solutes present in the solution  
(B) Solution  
(C) Semi-permeable membrane  
(D) O<sub>2</sub>
8. The osmotic pressure of the cell is measured by :-  
(A) Plasmolysis method  
(B) Osmometer  
(C) Molar concentration of the cell sap  
(D) Deplasmolysis
9. Maximum osmotic pressure is found in :-  
(A) Root hair  
(B) Cortex cell of the root  
(C) Passage cell of the root  
(D) Mesophyll cell
10. The osmotic pressure is due to :-  
(A) Solute  
(B) Semi permeable membrane  
(C) Hypertonic solution  
(D) Water
11. When the solute has been added in the solution, then following observation can be made ?  
(A) The DPD of the solution decreases  
(B) The  $\Psi_w$  of the solution increases  
(C) DPD of the solution decreases while its  $\Psi_w$  increases  
(D) DPD of the solution increases while its  $\Psi_w$  decreases
12. If the given solution is of 25% concentration; then what cannot be presented for this :-  
(A) OP                              (B) DPD  
(C) Solute potential              (D) TP
13. In a flaccid cell which condition does not occur-  
(A) TP = 0                        (B) SP = 0  
(C) WP = 0                        (D) SP = OP
14. Osmotic pressure of a cell is zero when :-  
(A) T.P. is maximum            (B) DPD is maximum  
(C) T.P. is zero                    (D) Not possible
15. In which condition the Turgor pressure of the cell becomes equal to the osmotic pressure :-  
(A) In flaccid cell                (B) In plasmolysed cell  
(C) In fully turgid cell        (D) It never happens

**Exercise # 3**

**PART - 1**

**MATRIX MATCH COLUMN**

1. Match Column - I with Column - II and select the correct option from the codes given below.

**Column - I**

- A. Hypotonic
- B. Hypertonic
- C. Isotonic
- (A) A-ii, B-iii, C-i
- (C) A-i, B-ii, C-iii

**Column - II**

- i. No net flow of water
- ii. Water moves into the cell
- iii. Water moves out of the cell
- (B) A-iii, B-ii, C-i
- (D) A-ii, B-i, C-iii

2. Match Column - I with Column - II and select the correct option from the codes given below.

**Column - I**

- A. Vein ending
- B. Necessary evil
- C. Semipermeable
- D. Cohesion
- E. Stomata closure
- (A) A-iv, B-i, C-iii, D-ii, E-(v)
- (C) A-iii, B-(v), C-i, D-ii, E-iv

**Column - II**

- i. Transpiration
- ii. Osmosis
- iii. Transpiration pull membrane
- iv. Guttation
- (v) ABA
- (B) A-iv, B-i, C-ii, D-iii, E-(v)
- (D) A-i, B-ii, C-iii, D-iv, E-(v)

3. Match Column I with Column - II and select the correct option from the codes given below.

**Column - I**

- A. Dixon and Jolly
- B. Stomata
- C. Manometer
- D. Capillary water
- E. Potometer
- (A) A-iv, B-iii, C-(v), D-ii, E-i
- (C) A-iv, B-iii, C-i, D-ii, E-(v)

**Column - II**

- i. Root pressure
- ii. Only water available to plants
- iii. Transpiration
- iv. Transpiration pull
- (v) Rate of transpiration
- (B) A-i, B-iii, C-iv, D-ii, E-(v)
- (D) A-(v), B-iv, C-iii, D-ii, E-i

4. Match the following and choose the correct option

- A. Leaves
- B. Seed
- C. Roots
- D. Aspirin
- E. Plasmolyzed cell

- i. Anti-transpirant
- ii. Transpiration
- iii. Negative osmotic potential
- iv. Imbibition
- (v) Absorption

Options :

- (A) A-ii, B-iv, C-(v), D-i, E-iii
- (B) A-iii, B-ii, C-iv, D-i, E-(v)
- (C) A-i, B-ii, C-iii, D-iv, E-(v)
- (D) A-(v), B-iv, C-iii, D-ii, E-i

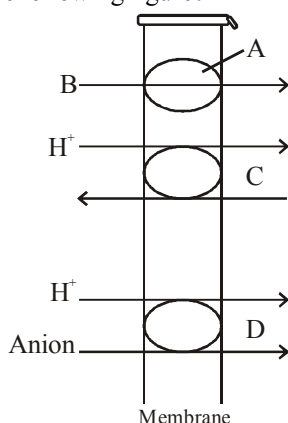


**Exercise # 4****PART - 1****PREVIOUS YEAR (NEET/AIPMT)**

1. When enters a cell due to : [CBSE AIPMT 2001]  
(A) O.P. (B) S.P.  
(C) T.P. (D) W.P.
2. In which of the following plant sunken stomata are found : - [CBSE AIPMT 2001]  
(A) Nerium (B) Hydrilla  
(C) Mango (D) Guava
3. Glycolate induces opening of stomata in : - [CBSE AIPMT 2001]  
(A) Presence of oxygen (B) Low CO<sub>2</sub> conc.  
(C) High CO<sub>2</sub> (D) CO<sub>2</sub> absent
4. Opening and closing of stomata is due to the : - [CBSE AIPMT 2002]  
(A) Hormonal change in guard cells  
(B) Change in Turgor pressure of guard cells  
(C) Gaseous exchange  
(D) Respiration
5. Stomata of CAM plants :- [CBSE AIPMT 2003]  
(A) Open during the night and close during the day  
(B) Never open  
(C) Are always open  
(D) Open during the day and close at night
6. Stomata of a plant open due to : - [CBSE AIPMT 2003]  
(A) Influx of hydrogen ions  
(B) Influx of calcium ions  
(C) Influx of potassium ions  
(D) Efflux of potassium ions
7. The translocation of organic solutes in sieve tube members is supported by- [CBSE AIPMT 2006]  
(A) P-proteins  
(B) Mass flow involving a carrier and ATP  
(C) Cytoplasmic streaming  
(D) Root pressure and transpiration pull
8. Two cells A and B are contiguous. Cell A has osmotic pressure 10 atm, turgor pressure - 7atm and diffusion pressure deficit 3 atm. Cell B has osmotic pressure 8 atm, turgor pressure 3 atm and diffusion pressure deficit 5 atm. The result will be: [CBSE AIPMT 2007]  
(A) Movement of water from Cell B - A  
(B) No movement of water  
(C) Equilibrium between the two  
(D) Movement of water of Cell A - B
9. The rupture and fractionation do not usually occur in the water column in vessel/tracheids during the ascent of sap because of : [CBSE AIPMT 2008]  
(A) lignified thick walls  
(B) cohesion and adhesion  
(C) weak gravitational pull  
(D) transpiration pull
10. Guard cells help in : [CBSE AIPMT 2009]  
(A) Protection against grazing  
(B) Transpiration  
(C) Guttation  
(D) Fighting against infection
11. In land plants, the guard cells differ from other epidermal cells in having : [CBSE AIPMT 2011]  
(A) Mitochondria  
(B) Endoplasmic reticulum  
(C) Chloroplasts  
(D) Cytoskeleton
12. 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
13. A column of water within xylem vessels of tall trees does not break under its weight because of : [CBSE AIPMT 2015]  
(A) Dissolved sugars in water  
(B) Tensile strength of water  
(C) Lignification of xylem vessels  
(D) Positive root pressure

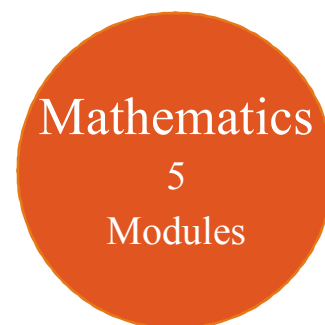
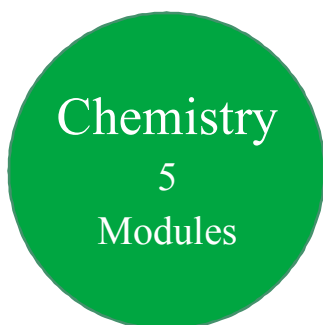
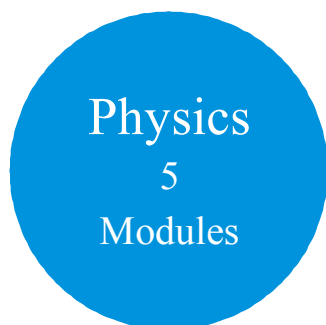
**MOCK TEST**

- When a molecule moves across a membrane independent of other molecules the process is called  
 (i) uniport                      (ii) symport                      (iii) antiport.  
 (A) (i) only                      (B) (i) and (ii) only                      (C) (i) and (iii) only                      (D) (ii) and (iii) only  
 (E) (iii) only
- The cellular transport method which involves use of transmembrane proteins without energy expenditure is called  
 (A) diffusion                      (B) facilitated diffusion                      (C) active transport                      (D) exocytosis
- The type of transport taking across the biomembranes without the help of proteins is  
 (A) facilitated diffusion                      (B) active transport                      (C) simple diffusion                      (D) diffusion *via* symport
- Which of these is/are not a property of facilitated transport?  
 A. Requires special membrane proteins                      B. Highly selective  
 C. Uphill transport                      D. Requires ATP energy  
 (A) A and B only                      (B) C and D only                      (C) A and C only                      (D) B and C only  
 (E) B and D only
- Consider the following statements with reference to facilitated transport.  
 A. Requires ATP energy                      B. Transport saturates  
 C. Highly selective                      D. Requires special membrane properties  
 E. Uphill transport  
 Of the above statements  
 (A) A, B and C are relevant but D and E are irrelevant  
 (B) B, C and E are relevant but A and D are irrelevant  
 (C) C, D and E are relevant but A and B are irrelevant  
 (D) A, D and E are relevant but B and C are irrelevant  
 (E) B, C and D are relevant but A and E are irrelevant
- What do A, B, C and D represent in the following figure?



- A : carrier protein, B : symport, C : uniport, D : antiport
- A : carrier protein, B : uniport, C : antiport, D : symport
- A : carrier protein, B : antiport, C : symport, D : uniport
- A : carrier protein, B : uniport, C : symport, D : antiport

# 11<sup>th</sup> Class Modules Chapter Details



PHYSICS	CHEMISTRY	BIOLOGY
<p><b>Module-1</b></p> <ol style="list-style-type: none"> <li>1. Physical World &amp; Measurements</li> <li>2. Basic Maths &amp; Vector</li> <li>3. Kinematics</li> </ol> <p><b>Module-2</b></p> <ol style="list-style-type: none"> <li>1. Law of Motion &amp; Friction</li> <li>2. Work, Energy &amp; Power</li> </ol> <p><b>Module-3</b></p> <ol style="list-style-type: none"> <li>1. Motion of system of particles &amp; Rigid Body</li> <li>2. Gravitation</li> </ol> <p><b>Module-4</b></p> <ol style="list-style-type: none"> <li>1. Mechanical Properties of Matter</li> <li>2. Thermal Properties of Matter</li> </ol> <p><b>Module-5</b></p> <ol style="list-style-type: none"> <li>1. Oscillations</li> <li>2. Waves</li> </ol>	<p><b>Module-1(PC)</b></p> <ol style="list-style-type: none"> <li>1. Some Basic Concepts of Chemistry</li> <li>2. Atomic Structure</li> <li>3. Chemical Equilibrium</li> <li>4. Ionic Equilibrium</li> </ol> <p><b>Module-2(PC)</b></p> <ol style="list-style-type: none"> <li>1. Thermodynamics &amp; Thermochemistry</li> <li>2. Redox Reaction</li> <li>3. States Of Matter (Gaseous &amp; Liquid)</li> </ol> <p><b>Module-3(IC)</b></p> <ol style="list-style-type: none"> <li>1. Periodic Table</li> <li>2. Chemical Bonding</li> <li>3. Hydrogen &amp; Its Compounds</li> <li>4. S-Block</li> </ol> <p><b>Module-4(OC)</b></p> <ol style="list-style-type: none"> <li>1. Nomenclature of Organic Compounds</li> <li>2. Isomerism</li> <li>3. General Organic Chemistry</li> </ol> <p><b>Module-5(OC)</b></p> <ol style="list-style-type: none"> <li>1. Reaction Mechanism</li> <li>2. Hydrocarbon</li> <li>3. Aromatic Hydrocarbon</li> <li>4. Environmental Chemistry &amp; Analysis Of Organic Compounds</li> </ol>	<p><b>Module-1</b></p> <ol style="list-style-type: none"> <li>1. Diversity in the Living World</li> <li>2. Plant Kingdom</li> <li>3. Animal Kingdom</li> </ol> <p><b>Module-2</b></p> <ol style="list-style-type: none"> <li>1. Morphology in Flowering Plants</li> <li>2. Anatomy of Flowering Plants</li> <li>3. Structural Organization in Animals</li> </ol> <p><b>Module-3</b></p> <ol style="list-style-type: none"> <li>1. Cell: The Unit of Life</li> <li>2. Biomolecules</li> <li>3. Cell Cycle &amp; Cell Division</li> <li>4. Transport in Plants</li> <li>5. Mineral Nutrition</li> </ol> <p><b>Module-4</b></p> <ol style="list-style-type: none"> <li>1. Photosynthesis in Higher Plants</li> <li>2. Respiration in Plants</li> <li>3. Plant Growth and Development</li> <li>4. Digestion &amp; Absorption</li> <li>5. Breathing &amp; Exchange of Gases</li> </ol> <p><b>Module-5</b></p> <ol style="list-style-type: none"> <li>1. Body Fluids &amp; Its Circulation</li> <li>2. Excretory Products &amp; Their Elimination</li> <li>3. Locomotion &amp; Its Movement</li> <li>4. Neural Control &amp; Coordination</li> <li>5. Chemical Coordination and Integration</li> </ol>

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# 12<sup>th</sup> Class Modules Chapter Details

Physics  
5  
Modules

Chemistry  
5  
Modules

Mathematics  
5  
Modules

PHYSICS	CHEMISTRY	BIOLOGY
<p><b>Module-1</b></p> <ol style="list-style-type: none"> <li>1. Electrostatics</li> <li>2. Capacitance</li> </ol> <p><b>Module-2</b></p> <ol style="list-style-type: none"> <li>1. Current Electricity</li> <li>2. Magnetic Effect of Current and Magnetism</li> </ol> <p><b>Module-3</b></p> <ol style="list-style-type: none"> <li>1. Electromagnetic Induction</li> <li>2. Alternating Current</li> </ol> <p><b>Module-4</b></p> <ol style="list-style-type: none"> <li>1. Geometrical Optics</li> <li>2. Wave Optics</li> </ol> <p><b>Module-5</b></p> <ol style="list-style-type: none"> <li>1. Modern Physics</li> <li>2. Nuclear Physics</li> <li>3. Solids &amp; Semiconductor Devices</li> <li>4. Electromagnetic Waves</li> </ol>	<p><b>Module-1(PC)</b></p> <ol style="list-style-type: none"> <li>1. Solid State</li> <li>2. Chemical Kinetics</li> <li>3. Solutions and Colligative Properties</li> </ol> <p><b>Module-2(PC)</b></p> <ol style="list-style-type: none"> <li>1. Electrochemistry</li> <li>2. Surface Chemistry</li> </ol> <p><b>Module-3(IC)</b></p> <ol style="list-style-type: none"> <li>1. P-Block Elements</li> <li>2. Transition Elements (d &amp; f block)</li> <li>3. Co-ordination Compound</li> <li>4. Metallurgy</li> </ol> <p><b>Module-4(OC)</b></p> <ol style="list-style-type: none"> <li>1. HaloAlkanes &amp; HaloArenes</li> <li>2. Alcohol, Phenol &amp; Ether</li> <li>3. Aldehyde, Ketone &amp; Carboxylic Acid</li> </ol> <p><b>Module-5(OC)</b></p> <ol style="list-style-type: none"> <li>1. Nitrogen &amp; Its Derivatives</li> <li>2. Biomolecules &amp; Polymers</li> <li>3. Chemistry in Everyday Life</li> </ol>	<p><b>Module-1</b></p> <ol style="list-style-type: none"> <li>1. Reproduction in Organisms</li> <li>2. Sexual Reproduction in Flowering Plants</li> <li>3. Human Reproduction</li> <li>4. Reproductive Health</li> </ol> <p><b>Module-2</b></p> <ol style="list-style-type: none"> <li>1. Principles of Inheritance and Variation</li> <li>2. Molecular Basis of Inheritance</li> <li>3. Evolution</li> </ol> <p><b>Module-3</b></p> <ol style="list-style-type: none"> <li>1. Human Health and Disease</li> <li>2. Strategies for Enhancement in Food Production</li> <li>3. Microbes in Human Welfare</li> </ol> <p><b>Module-4</b></p> <ol style="list-style-type: none"> <li>1. Biotechnology: Principles and Processes</li> <li>2. Biotechnology and Its Applications</li> <li>3. Organisms and Populations</li> </ol> <p><b>Module-5</b></p> <ol style="list-style-type: none"> <li>1. Ecosystem</li> <li>2. Biodiversity and Conservation</li> <li>3. Environmental Issues</li> </ol>

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