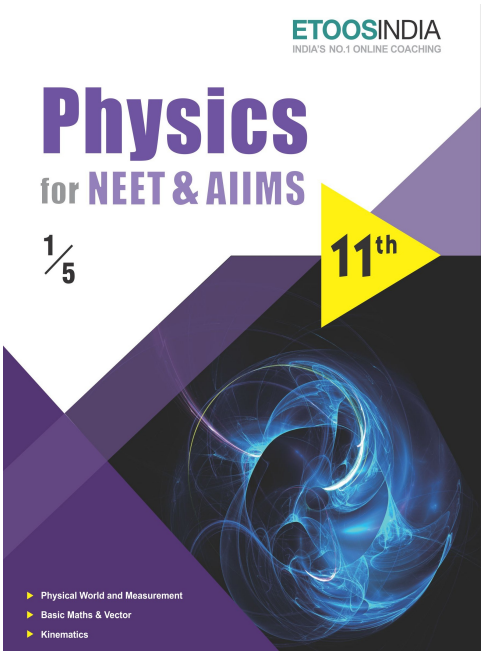
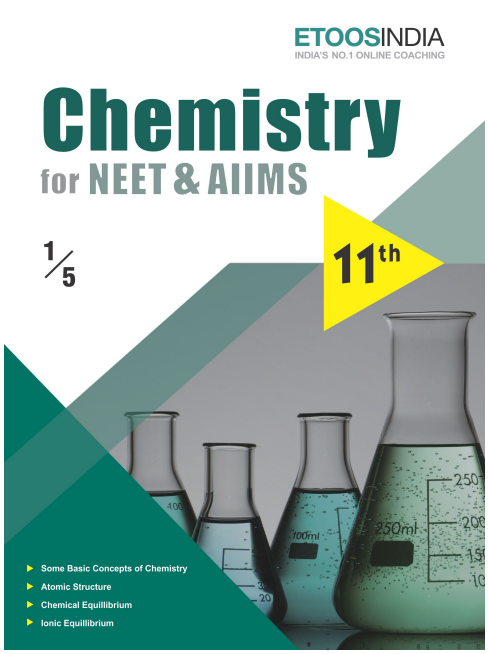
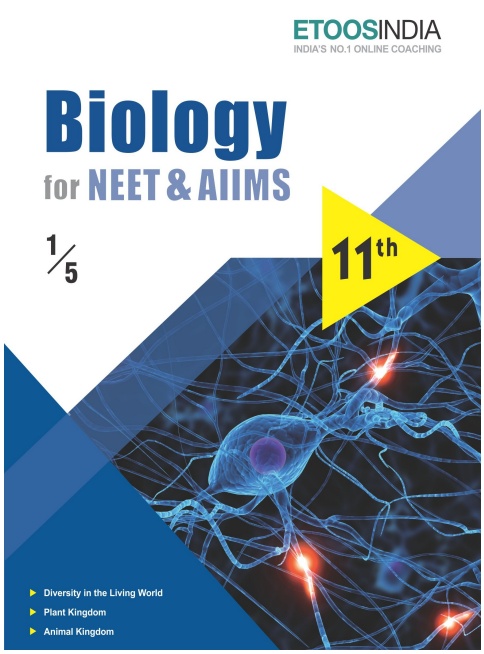
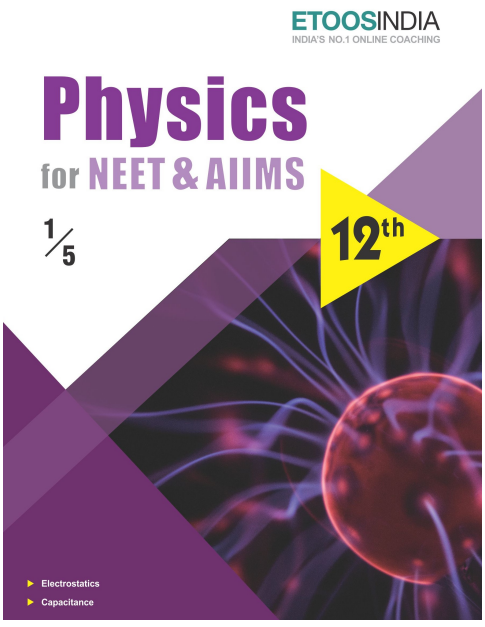
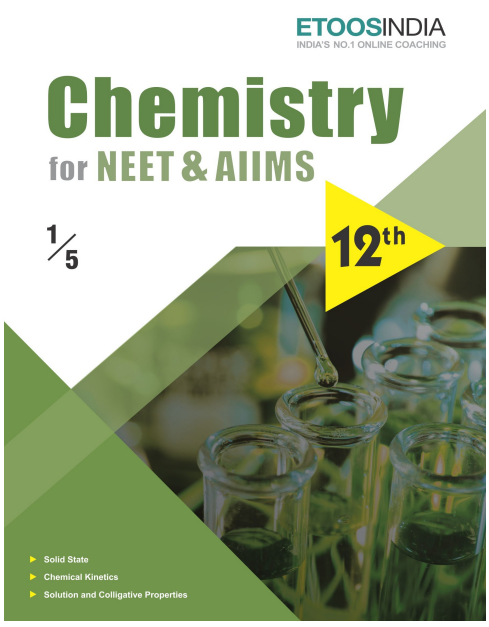
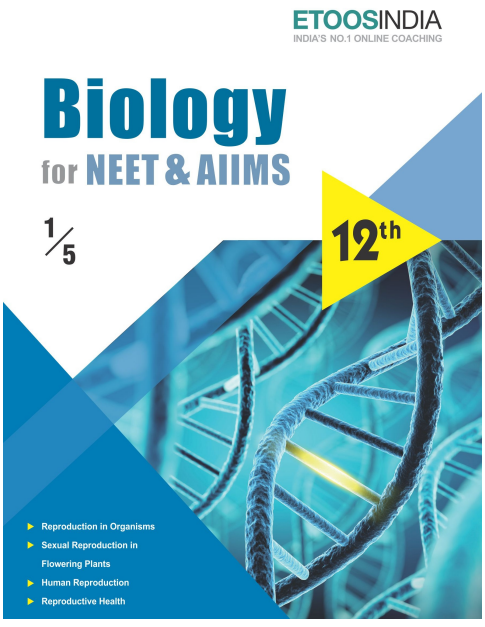












CHAPTER 11

MINERAL NUTRITION

I have repeatedly had cause to refer to certain resemblances between the phenomena of irritability in the vegetable kingdom and those of the animal body, thus touching a province of investigation which has hitherto been far too little cultivated".

"JULIUS VON SACHS (1832-1897)"

INTRODUCTION

The basic needs for all living organisms are essentially the same. The chemical substance present in food which act as a raw material for body building and maintaining its functions are termed as nutrients. Nutrients can be inorganic or can be organic in nature. They can be carbohydrates, proteins, fats and water or minerals for growth and development. The study of source, mode of absorption, distribution and metabolism of various inorganic minerals by the plants is called **Mineral nutrition**.

In this chapter you will study the role of the essential elements, their major deficiency symptoms and the mechanism of absorption of these elements.Also, the mechanism and significance of biological nitrogen fixation.

MINERALS & NUTRITION

Generally all living organism have same basic needs. They require macromolecules, such as carbohydrates, proteins and fats, and water and minerals for their growth and development.

This chapter emphasizes particularly on inorganic plant nutrition, wherein you will study the criteria for establishing the essentially and the methods to identify elements essential to growth and development of plants. In this chapter, you will study the role of the essential elements, the mechanism of absorption of these essential elements and their major deficiency symptoms The chapter also intoduces you briefly to the significance and the mechanism of biological nitrogen fixation.

METHODS TO STUDY THE MINERAL, REQUIREMENTS OF PLANTS

In **1860, Julius von Sachs**, a prominent **German botanist**, demonstrated for the first time, that plants could be grown to maturity in a defined nutrient solution in complete absence of soil.Since then, a number of improvised methods have been employed to try and determine the mineral nutrients essential for plants. This technique of growing plants in a nutrient solution is known as **Hydroponics**. The essence of all these methods involves the culture of plants in a soil-free, defined mineral solution. These methods require purified water and mineral nutrient salts.

After a series of experiments in which the roots of the plants were immersed in nutrient solutions and wherein an element was added/removed or given in varied concentration, a mineral solution suitable for the plant growth was obtained. By this method. essential elements were indentified and their deficiency symptoms discovered.

Hydroponics has been successfully employed as a technique for the commercial production of vegetables such as tomato, seedless cucumber and lettuce. It must be emphasised that the nutrient solutions must be adequately aerated to obtain the optimum growth. Diagrammatic views of the hydroponic technique is given in Figure.

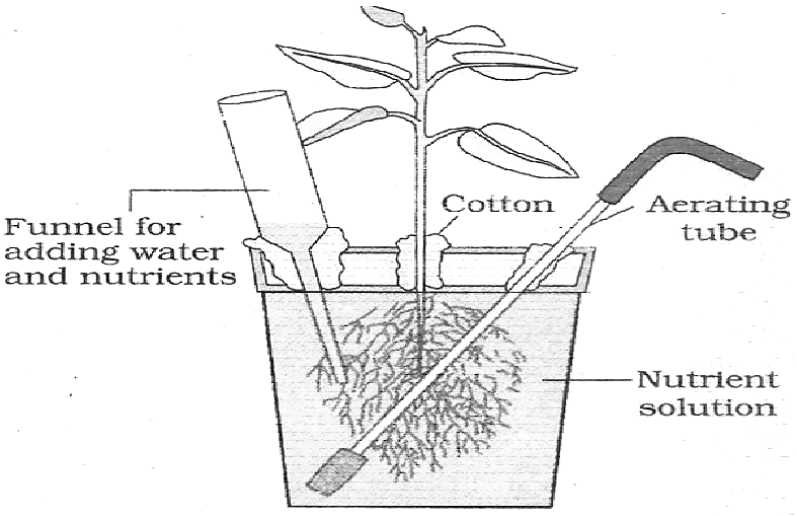


Diagram of a typical set-up for nutrient solution culture

Etoos Tips & Formulas

→ **Curtis** considered that transpiration is a necessary evil.

→ Succulent stomata are scotoactive because they open at night and closes during the day hour e.g. Bryophyllum, Opunita etc.

→ **Zelich** told that glycolic acid is responsible for opening & closing of Stomata.

→ Old aged stem and fruit respire by lenticles.

→ Fresh weight is maximum in morning & minimum at noon.

→ If a plant is taken at higher altitude it will die because of higher transpiration.

→ Guttation term was given by **Bergerstein**.

→ **Transpiration ratio :** The amount of water loss per unit of dry produced during the growing of plant.

→ CO_2 PMA = Phenyl mercuric acetate & ABA (Abscisic acid) act like antitranspirant.

→ Blue light promotes stomates opening.

→ In colocasea antiquarum guttation is a normal process. If 50% stomata are closed there will be no effect on transpiration.

→ **Transpiration flux :** The quantity of water transpired by a unit area of leaf surface in a unit time is known as transpiration flux.

→ The rate of transpiration is doubled with every rise of 10ºC.

→ In electrophoresis flow of solvent takes place between the charged particles. In electrophores in charge solute flow through the solvent.

→ The main reason of osmotic pressure of the opened stomata is the potassium chloride or potassium mallate.

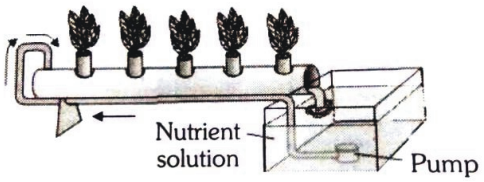
→ The photophosphorylation process in the guard cells is a energy metabolic process, not CO_2 metabolic process.

→ Accumulation of Na+ ions is found in the epidermal cells which is present near the guard cells in some of the plants. This is found in such plants which are growing in salty land.

SOLVED EXAMPLE

Ex.1 Which one of the following is not an essential mineral element for plants while the remaining three are
(A) Cadmium **(B)** Phosphorus
(C) Iron **(D)** Manganese
Sol. **(A)**

Ex.2 The given figure shows hydrophonic/soil less plant production. Plants are grown in a tube or through placed on a slight incline. The arrows indicate the direction of flow of nutrient solution.
Nutrient solution is sent to the elevated end of the tube from the reservoir by _____ and it flows back into reservoir due to _____.



(A) Pump, Gravity **(B)** Gravity, Pump
(C) Gravity, Gravity **(D)** Pump, Pump
Sol. **(A)**

Ex.3 Which of the following ions of heavy metals participate in process of photosynthesis in higher plants
(A) Pb, Fe, Ni, Co **(B)** Mg, Zn, Cu, Hg
(C) Mg, Mn, Co, Fe **(D)** Mg, Cu, Mn, Fe
Sol. **(D)**

Ex.4 The number of essential elements required for normal growth of plant is
(A) 10 **(B)** 16
(C) 20 **(D)** 25
Sol. **(B)**

Ex.5 Which of the following is associated with electron transport in photosynthesis
(A) Sodium **(B)** Potassium
(C) Iron **(D)** Cobalt
Sol. **(C)**

Ex.6 Deficiency symptoms of nitrogen and potassium are visible first in
(A) Roots **(B)** buds
(C) Senescent leaves **(D)** Yound leaves
Sol. **(C)** : N and K are mobile elements.

Ex.7 Plants requiring two metallic compounds (minerals) for chlorophyll synthesis, are
Or
One mineral activates the enzyme catalase and the other is a constituent of the ring structure of chlorophyll. These minerals are respectively
(A) Fe and Ca **(B)** Fe and Mg
(C) Cu and Ca **(D)** Ca and K
Sol. **(B)** : Mg is an important constituent of chlorophyll molecule where it occupies a central position and essential for photosynthesis and Fe plays an important role in ETS, photosynthesis and respiration because iron is the part of cytochromes. It is also essential for chlorophyll synthesis

Ex.8 Which of the following element is very essential for uptake and utilization of Ca^{2+} and membrane function
(A) Phosphorus **(B)** Molybdenum
(C) Manganese **(D)** Copper
(E) Boron
Sol. **(E)** : Boron is responsible for maintaining the solubility of calcium in cells.

Ex.9 About 98 percent of the mass of every living organism is composed of just six elements including carbon, hydrogen, nitrogen, oxygen and
(A) Phosphorus and sulphur
(B) Sulphur and magnesium
(C) Magnesium and sodium
(D) Calcium and phosphorus
Sol. **(D)**

Ex.10 Micro-nutrients are
(A) Less important in nutrition than macro-nutrients
(B) As important in nutrition as macro-nutrients
(C) May be omitted from culture media without detrimental effect on the plants
(D) Called micro because they play only minor role in nutrition
Sol. **(B)** : Micro-nutrients are present in less amount in plants but they are as important as macro-nutrients.

Ex.11 Find out the correctly matched pair
(A) Zinc
– Helps to maintain the ribosome structure
(B) Magnesium
– Needed during the formation of mitoticspindle
(C) Calcium
– Plays a role in the opening and closing ofstomata
(D) Manganese
– Needed in the splitting of water to liberate oxygen during photosynthesis
(E) Potassium – Needed in the synthesis of auxin
Sol. **(D)**

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. "Reclamation" and "Little leaf" disease, caused by deficiency of -
(A) Zn and Mo (B) Cu and Zn
(C) Cu and B (D) Mn and Cu

2. Which element is required in comparatively least quantity for the growth of plant ?
(A) Zn (B) N
(C) P (D) Ca

3. Which of the following essential element is not properly placed in the given category ?
(A) Cu (B) Zn
(C) Mg (D) Mn

4. Criteria for essentiality in mineral nutrition were shown firstly by : -
(A) Arnon (B) Liebig
(C) Steward (D) Levitt

5. Which mineral nutrients are called critical element for crops ?
(A) N, P, K (B) C, H, O
(C) N, S, Mg (D) K, Ca, Fe

6. The mineral nutrient mainly concerning with apical meristematic activity is : -
(A) K (B) Ca
(C) N (D) S

7. Little leaf disease is caused by -
(A) Zn - deficiency (B) Cu - deficiency
(C) Mo - deficiency (D) Mn - deficiency

8. Which of the following does NPK denote ?
(A) Nitrogen, Potassium, Kinetin
(B) Nitrogen, Protein, Kinetin
(C) Nitrogen, Protein, Potassium
(D) Nitrogen,Phosphours, Potassium

9. Plants absorb mineral salts from the soil solution through : -
(A) A semipermeable membrane into the cytoplasm
(B) Perforations at the apex of root hair cells
(C) The cell wall which is semipermeable
(D) None of these

10. Mineral salts which are absorbed by the roots from the soil are in the form of : -
(A) Very dilute solution
(B) Dilute solution
(C) Concentrated solution
(D) Very concentrated solution

11. By which method ions are absorbed by the plants ?
(A) Diffusion (B) DPD gradient
(C) Carrers proteins (D) Water pontential

12. Hydrophytes absorb salt and water by : -
(A) Root and root hairs (B) Leaves and root
(C) Roots and stem (D) General epidermis

13. Active and passive absorption terms were coined by : -
(A) Kramer (B) Deutrochet
(C) Priestley (D) Renner

14. Which is free ion present in a cell ?
(A) P (B) K
(C) Fe (D) B

15. Who give the Cytochrome pump theory ?
(A) Sachs (B) Lundegradh
(C) Bose & Renner (D) Bennet - Clark

16. Who proposed the protein lecithin theory ?
(A) Sachs (B) Lundegradh
(C) Bose & Renner (D) Bennet & Clark

17. Carrier protein helped in : -
(A) Active absorption of ions
(B) Passive ions absorption
(C) Water absorption
(D) Vaporization

18. Active uptake of minerals depends upon :-
(A) Active water absorption
(B) Transpiration
(C) Photorespiration
(D) Dephosphorylation

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. Which of the group of elements is not essential for a normal plant ?
(A) K, Ca, Mg (B) Fe, Zn, Mn, B
(C) Pb, I, Na (D) Mg, Fe, Mo

2. Hydroponics is a technique in which plants are grown in ?
(A) Green house
(B) Water saturated sand
(C) Balanced nutrient solution
(D) Purified distilled water

3. For cholrophyll formation a plant needs :-
(A) Fe, Ca & light (B) Fe, Mg & Light
(C) Ca, K & light (D) Mn & Cu

4. Brown heart rot of beets is due to deficiency of-
(A) B (B) P
(C) Mg (D) Mo

5. Die back disease in citrus is due to deficiency of : -
(A) Mo (B) B
(C) Cu (D) Zn

6. The disease related with deficiency of molybdenum is : -
(A) Whiptail disease of cauliflower
(B) Little leaf disease
(C) Reclamation disease of cereals
(D) Brown heart disease

7. Protoplasmic elements are : -
(A) C, H, O, P, N, S (B) C, H, O, Fe, N
(C) N, S, Fe, P, K (D) Fe, Mg, Ca, N, P

8. Which element is not considered as macronutrient ?
(A) Mg (B) Ca
(C) Mn (D) P

9. The element which can not be placed along with micronutrients : -
(A) Mn (B) Mo
(C) Cu (D) Ca

10. The amino acid having S in its composition is -
(A) Cystine (B) Cysteine
(C) Methionine (D) All

11. Which elements are considered as balancing elements ?
(A) Ca & K (B) C & H
(C) N & S (D) Mg and Fe

12. The group of mineral nutrients known as frame work elements : -
(A) N, S, P (B) C, H, O
(C) Mg, Fe, Zn (D) Zn, Mn, Cu

13. Which element essential for stability of chromosome structure ?
(A) Zn (B) Ca
(C) Mo (D) Fe

14. Hydroponics or soilless culture helps in knowing
(A) essentiality of an element
(B) deficiency of an element
(C) toxicity caused by an element
(D) all of these

15. The technique of hydroponics is being employed for the commerical production of vegetables like
(A) tomato (B) cucumber
(C) lettuce (D) all of these

16. Select the correct statement (s) regarding the solution culture techniques.
(A) Successful hydroponic culture requires a large volume of nutrient solution or frequent adjustment of the nutrient solution to prevent roots from producing radical changes in nutrient concentrations and pH of the medium.
(B) In nutrient film growth system, plant root lie on the surface of a trough, and nutrient solutions flow in thin layer along the trough over the roots.
(C) In aeroponics technique, plants are grown with their roots suspended in air while being sprayed continuosuly with a nutrient solution
(D) All of these .

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 (Activator element)	Column II (Enzyme)
A. Mg^{ii+}	i. Nitrate reductase
B. Zn^{ii+}	ii. RuBisCO, PEPCO
C. Mo	iii. Alcohol dehydrogenase

(A) A-ii, B-iii, **(C)** - i **(B)** A-iii, B-ii, **(C)**-i **(C)** A-i, B-iii, **(C)**-ii **(D)** A-ii, B-i, **(C)**-iii

2. Select the correctly matched pair.

(A) Zinc – Helps to maintain the ribosome structure
(B) Magnesium – Needed during the formation of mitotic spindle
(C) Calcium – Plays a role in the opening and closing of stomata
(D) Manganese – Needed in the splitting of water to liberate oxygen during photosynthesis

3. Match the element with its associated functions/roles and choose the correct option among given below.

A. Boron	i. splitting of $H_{ii}O$ to liberate O_{ii} during photosynthesis
B. Manganese	ii. needed for synthesis of auxins
C. Molybdenum	iii. component of nitrogenase
D. Zinc	iv. pollen germination
E. Iron	v. component of ferredoxin

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

4. Match the following with correct combination

Column I	Column II
A. Cuscuta	i. Saprophyte
B. Eichornia	ii. Pneumatophore
C. Monotropa	iii. Insectivorous plant
D. Rhizophora	iv. Parasite
E. Utricularia	v. Root pocket

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

5. Match the following and choose the correct combination from the options given

Column I	Column II
A. Potassium	i. Constituent of ferredoxin
B. Sulphur	ii. Involved in stomatal movement
C. Molybdenum	iii. Needed in the synthesis of auxin
D. Zinc	iv. Component of nitrogenase

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

6. Match the following mineral element with their deficiency symptom and choose the correct option

Column I	Column II
A. Calcium	i. Chlorotic veins
B. Potassium	ii. Delayed germination of seeds
C. Zinc	iii. Necrosis of young leaves
D. Iron	iv. Scorched leaf tips
E. Phosphorous	v. Malformed leaves

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

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

1. The plants grown in magnesium deficienty but urea sprayed soil would show [CBSE AIPMT 2000]
(A) Deep green foliage
(B) Early flowering
(C) Yellowing of leaves
(D) loss of pigments in petals

2. Zinc as a nutrient is used by the plants in the form of [CBSE AIPMT 2000]
(A) Zn (B) Zn^{2+}
(C) ZnO (D) $ZnSO_4$

3. Which aquatic fern performs nitrogen fixation : - [CBSE AIPMT 2001]
(A) Azolla (B) Nostoc
(C) Salvia (D) Salvinia

4. In plants inulin and pectin are [CBSE AIPMT 2001]
(A) Reserved material
(B) Wastes
(C) Excretory material
(D) Insect attracting material

5. Enzyme involved in nitrogen assimilation : - [CBSE AIPMT 2001]
(A) Nitrogenase (B) Nitrate reductase
(C) Transferase (D) Transaminase

6. Passive absorption of minerals depend on [CBSE AIPMT 2001]
(A) Temperature
(B) Temperature and metabolic inhibitor
(C) Metabolic inhibitor
(D) Humidity

7. Choose the correct match Bladderwort, sundew, venus fly trap [CBSE AIPMT 2002]
(A) Nepenthes, Dionea, Drosera
(B) Nepenthes, Utricularia, Vanda
(C) Utricularia, Drosera, Dionea
(D) Dionea, Trapa, Vanda

8. The major portion of the dry weight of plants comprises of : - [CBSE AIPMT 2003]
(A) Carbon, hydrogen and oxygen
(B) Nitrogen, phosphorus and potassium
(C) Calcium, magnesium and sulphur
(D) Carbon, nitrogen and hydrogen

9. Gray spots of oat are caused by deficiency of : - [CBSE AIPMT 2003]
(A) Fe (B) Cu
(C) Zn (D) Mn

10. Boron in green plants assists in : - [CBSE AIPMT 2003]
(A) Sugar transport
(B) Activation of enzymes
(C) Acting of enzyme cofactor
(D) Photosynthesis

11. The major role of minor elements inside living organisms is to act as : - [CBSE AIPMT 2003]
(A) Binder of cell structure
(B) co-factors of enzymes
(C) Building blocks of important amino acids
(D) Constituent of hormones

12. A free living nitrogen-fixing cyanobacterium which can also form symbiotic association with the water fern Azolla is :- [CBSE AIPMT 2004]
(A) Tolypothrix (B) Chlorella
(C) Nostoc (D) Anabaena

13. The deficiencies of micronutrients, not only affects growth of plants but also vital functions such as photosynthetic and mitochondrial electron flow. Among the list given below, which group of three elements shall affect most, both photosynthetic and mitochondrial electron transport - [CBSE AIPMT 2005]
(A) Co, Ni, Mo (B) Ca, K, Na
(C) Mn, Co, Ca (D) Cu, Mn, Fe

14. A plant requires magnesium for : [CBSE AIPMT 2007]
(A) Holding cells together
(B) Protein synthesis
(C) Chlorophyll synthesis
(D) Cell wall development

15. Which one of the following elements is not an essential micronutrient for plant growth? [CBSE AIPMT 2007]
(A) Mn (B) Zn
(C) Cu (D) Ca

MOCK TEST

1. Plants could be grown to maturity in a defined nutrient solution was demonstrated for the first time by
(A) Priestley (B) Von Sacchs (C) Ingenhausz (D) Van Niel

2. Which is essential for the growth of root tip?
(A) Zn (B) Fe (C) Ca (D) Mn

3. In which of the following all three are macronutrients?
(A) Molybdenum, magnesium, manganese (B) Nitrogen, nicke, phosphorus
(C) Boron, zinc, manganese (D) Iron, copper, molybdenum

4. Which of the following is not a crole played by potassium in plant growth ?
(A) Translocation of carbohydrates (B) Maintaining anion-cation balance
(C) Opening and closing of stomata (D) Synthesis of protein
(E) Maintaining turgidity of cells

5. **Assertion :** Soil particles, particularly clay and organic matter in soil, contain negative charges that attract positively-charged ions such as Ca^{++}, K^{+} and Mg^{++}.
Reason : Essential elements derived from soil are termed as mineral elements while those derived from air or water are known as non-mineral elements.
(A) If both assertion and reason are ture and reason is the correct explanation of assertion.
(B) If both assertion and reason are true but reason is not the correct explanation of assertion.
(C) If assertion is true but reason is false.
(D) If both assertion and reason are false

6. Match the Column I with that of column II and choose the correct combination from the options given

Column I Essential elements	Column II Deficiency causes
A. N, K, Mg, S, Fe, Mn,	(i) Inhibit cell division Zn and Mo
B. N, K, S and Mo	(ii) Necrosis
C. Ca, Mg, Cu and K	(iii) Delay in flowering
D. N, S and Mo	(iv) Chlorosis

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

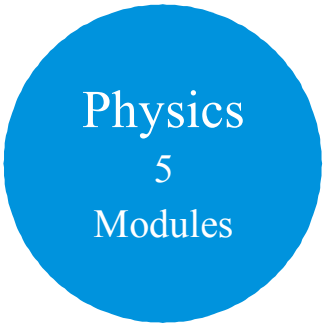
7. Which of the following groups of minerals are micronutrients?
(A) Magnesium, Manganese, Copper, Boron and Phosphorus
(B) Manganese, Copper, Magnesium, Zinc and Boron
(C) Nitrogen, Potassium, Manganese, Copper and Iron
(D) Iron, Manganese, Copper, Molybdenum and Zinc
(E) Carbon, Potassium, Phosphorus, Nitrogen and Oxygen

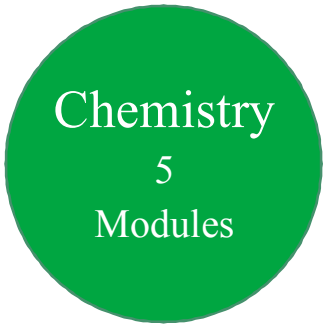
8. Match the mineral in column I with the enzyme activated by it in column II and choose the correct option.

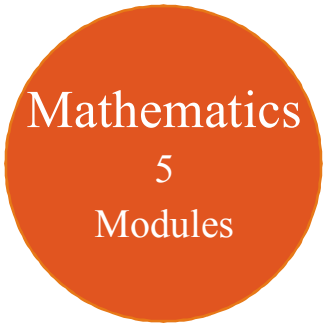
Column I	Column II
A. Magnesium	i. Alcohol dehydrogenase
B. Molybdenum	ii. Phosphoenol pyruvate carboxylase
C. Zinc	iii. Nitrogenase

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

11th Class Modules Chapter Details







PHYSICS

Module-1

1. Physical World & Measurements
2. Basic Maths & Vector
3. Kinematics

Module-2

1. Law of Motion & Friction
2. Work, Energy & Power

Module-3

1. Motion of system of particles & Rigid Body
2. Gravitation

Module-4

1. Mechanical Properties of Matter
2. Thermal Properties of Matter

Module-5

1. Oscillations
2. Waves

CHEMISTRY

Module-1(PC)

1. Some Basic Conceps of Chemistry
2. Atomic Structure
3. Chemical Equilibrium
4. Ionic Equilibrium

Module-2(PC)

1. Thermodynamics & Thermochemistry
2. Redox Reaction
3. States Of Matter (Gaseous & Liquid)

Module-3(IC)

1. Periodic Table
2. Chemical Bonding
3. Hydrogen & Its Compounds
4. S-Block

Module-4(OC)

1. Nomenclature of Organic Compounds
2. Isomerism
3. General Organic Chemistry

Module-5(OC)

1. Reaction Mechanism
2. Hydrocarbon
3. Aromatic Hydrocarbon
4. Environmental Chemistry & Analysis Of Organic Compounds

BIOLOGY

Module-1

1. Diversity in the Living World
2. Plant Kingdom
3. Animal Kingdom

Module-2

1. Morphology in Flowering Plants
2. Anatomy of Flowering Plants
3. Structural Organization in Animals

Module-3

1. Cell: The Unit of Life
2. Biomolecules
3. Cell Cycle & Cell Division
4. Transport in Plants
5. Mineral Nutrition

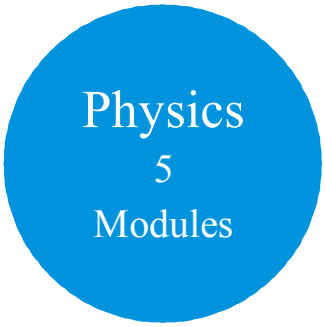
Module-4

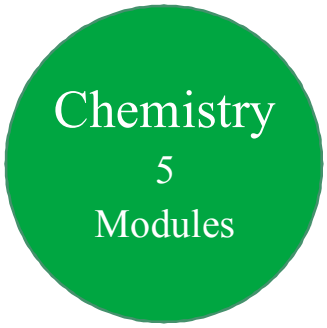
1. Photosynthesis in Higher Plants
2. Respiration in Plants
3. Plant Growth and Development
4. Digestion & Absorption
5. Breathing & Exchange of Gases

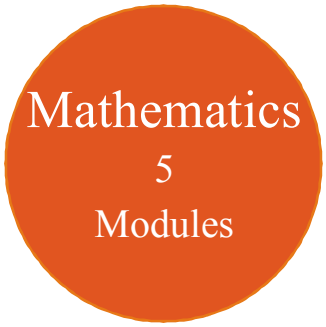
Module-5

1. Body Fluids & Its Circulation
2. Excretory Products & Their Elimination
3. Locomotion & Its Movement
4. Neural Control & Coordination
5. Chemical Coordination and Integration

12th Class Modules Chapter Details







PHYSICS

Module-1

1. Electrostatics
2. Capacitance

Module-2

1. Current Electricity
2. Magnetic Effect of Current and Magnetism

Module-3

1. Electromagnetic Induction
2. Alternating Current

Module-4

1. Geometrical Optics
2. Wave Optics

Module-5

1. Modern Physics
2. Nuclear Physics
3. Solids & Semiconductor Devices
4. Electromagnetic Waves

CHEMISTRY

Module-1(PC)

1. Solid State
2. Chemical Kinetics
3. Solutions and Colligative Properties

Module-2(PC)

1. Electrochemistry
2. Surface Chemistry

Module-3(IC)

1. P-Block Elements
2. Transition Elements (d & f block)
3. Co-ordination Compound
4. Metallurgy

Module-4(OC)

1. HaloAlkanes & HaloArenes
2. Alcohol, Phenol & Ether
3. Aldehyde, Ketone & Carboxylic Acid

Module-5(OC)

1. Nitrogen & Its Derivatives
2. Biomolecules & Polymers
3. Chemistry in Everyday Life

BIOLOGY

Module-1

1. Reproduction in Organisms
2. Sexual Reproduction in Flowering Plants
3. Human Reproduction
4. Reproductive Health

Module-2

1. Principles of Inheritance and Variation
2. Molecular Basis of Inheritance
3. Evolution

Module-3

1. Human Health and Disease
2. Strategies for Enhancement in Food Production
3. Microbes in Human Welfare

Module-4

1. Biotechnology: Principles and Processes
2. Biotechnology and Its Applications
3. Organisms and Populations

Module-5

1. Ecosystem
2. Biodiversity and Conservation
3. Environmental Issues