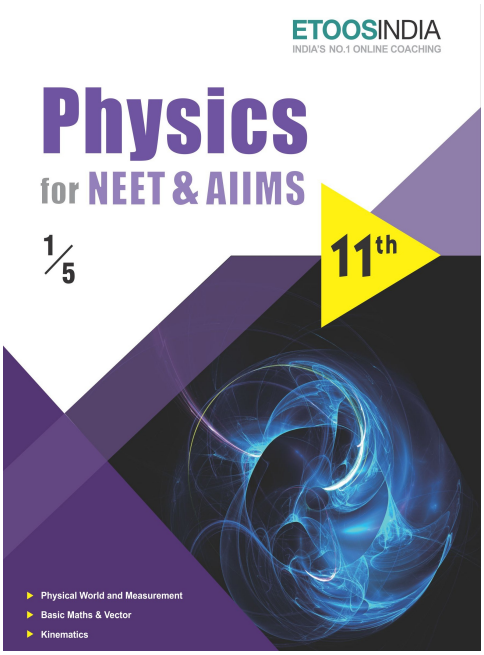
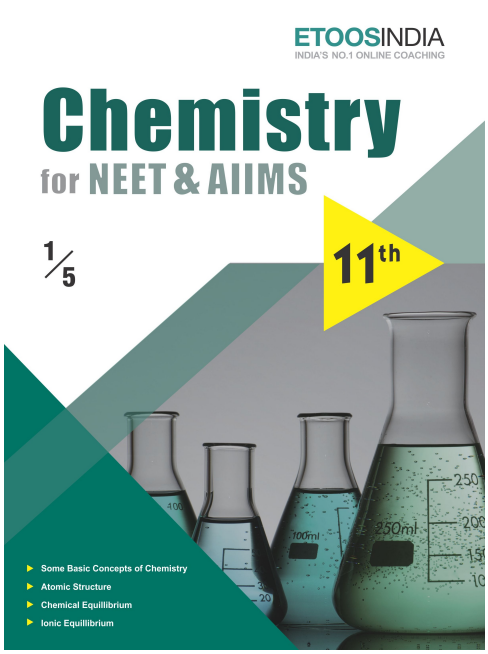
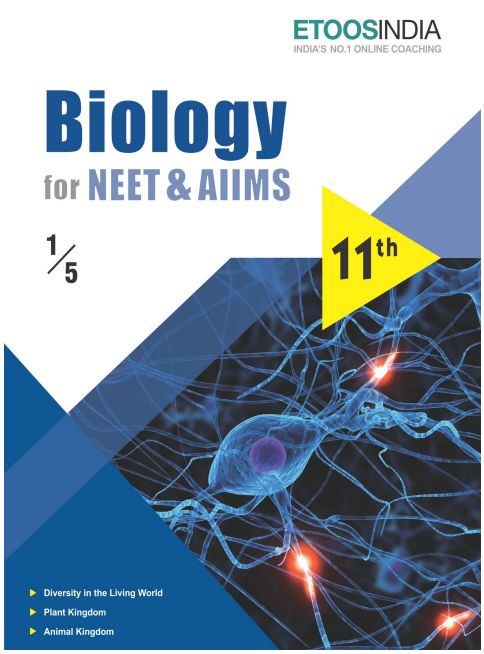
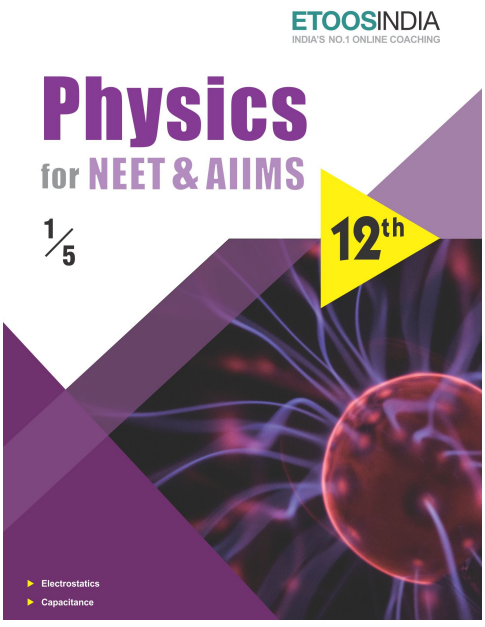
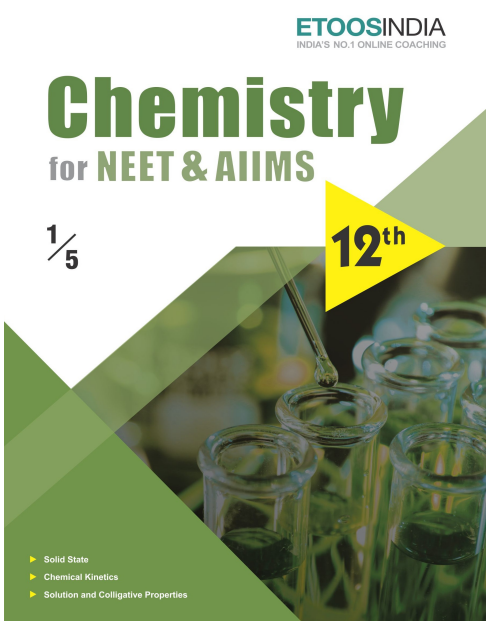
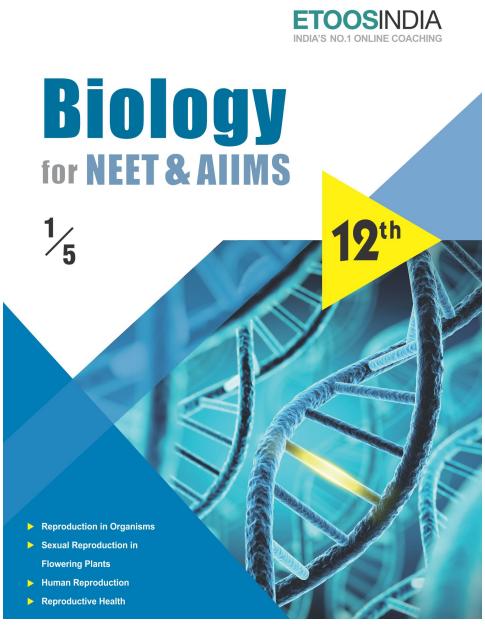












CHAPTER 05

ANATOMY OF FLOWERING PLANTS

[We need not think] that there is any Contradiction, when Philosophy teaches that to be done by Nature; which religion, and the Sacred Scriptures, teach us to be done by God: no more, than to say, That the balance of a Watch is moved by the next Wheel, is to deny that Wheel, and the rest, to be moved by the Spring; and that both the Spring, and all the other Parts, are caused to move together by the Maker of them. So God may be truly the Cause of This Effect, although a Thousand other Causes should be supposed to intervene: For all Nature is as one Great Engine,
made by, and held in His Hand.

"NEHEMIAH GREW (1641-1712)"

INTRODUCTION

The study of internal structures of organisms is called Anatomy. You can also see the structural similarities and variations in the external morphology of the larger living organism, both plants and animals. This topic will help you to understand the internal structures and functional organisation of higher plants. It also includes the study of type of cells present in the body; whether eukaryotic and prokaryotic, approximate number of cells in the body, their organisation into tissues and in turn, the tissues are organised into organs,etc.

Through this topic, you will able to answer the questions like how the plants survive in aquatic conditions, carry out their life processes.

PLANT ANATOMY

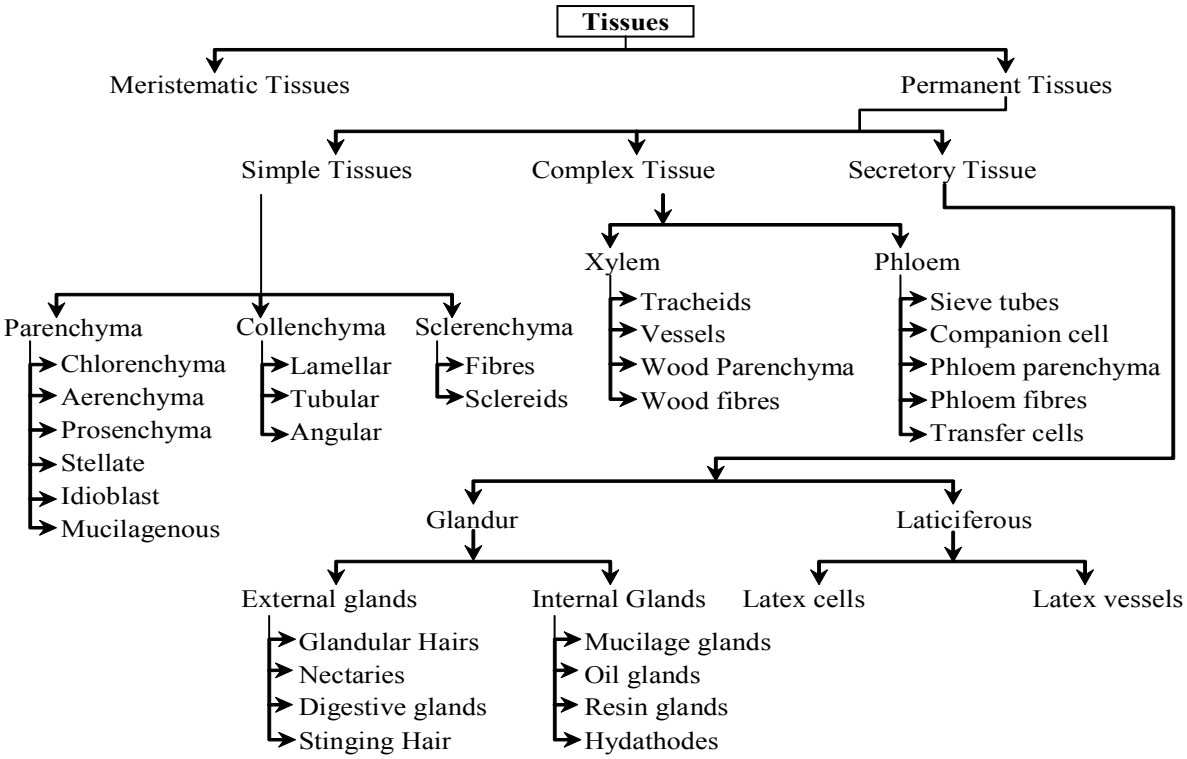
PRIMARY STRUCTURE OF PLANTS

PLANT ANATOMY

- It is the branch of Botany which deals with study of internal structures and organization of plants by the section cutting is called **Plant anatomy.**
- Anatomy is a Greek Word. Ana → asunder & temnein → to cut. Plant anatomy is also called as **Internal Morphology**.
- **N.Grew** is known as father of plant anatomy.
- **K.A. Chaudhary** is known as father of Indian plant Anatomy.

PLANT TISSUE

- An organized group of cells which is having similar or dissimilar in shape, having a common origin and usually performing a common function is called **tissue.**
- The term tissue was coined by **Nehemiah Grew.**



MERISTEMATIC TISSUE :

- Term given by Nageli.
- **Meristem :** A meristem is a localized region in which actual cell division occurs.Growth in plants is largely restricted to specialised regions of active cell division called meristerm.

CHARACTERSTIC OF MERISTEMATIC TISSUE :

- It is an **undifferentiated tissue.**
- They have **prominent** and large nucleus.
- They do not have **intercellular** spaces. Cells are closely fitted (Packed) together. So it is a **compact tissue.**
- Meristematic cells have only primary cell wall which is thin and flexible (elastic) and made up of cellulose. Secondary cell wall is absent.
- They have **dense cytoplasm.**
- Cell cycle of meristem is in **continuous** state of division. It means they have the capacity to divide. So meristematic tissue is composed of **immature cells.**
- Cells of meristem are small and isodiametric.
- Normally vacuoles are absent in meristematic cells but if present they are small.
- Meristematic cells are **metabolically** highly active so lack of reserve food occur in these cells.
- **Plastids** are **absent** in meristems. If they are present, then only in the **proplastid stage** ER is poorly developed.

CLASSIFICATION OF MERISTEMATIC TISSUE :

MERISTEMATIC TISSUE BASED ON ORIGIN AND DEVELOPMENT

On the basis of origin and development meristems can be divided into following three types :

(i) Promeristem/Embryonic Meristem/Primordial Meristem :

- This meristem develops in begining during embryonic stage.
- They divide and give rise to primary meristem.

(ii) Primary meristem :

- Meristematic cell developed from promeristem are known as **primary meristem.**
- These cells are always in division phase and form primary permanent tissue.
- They are present below the promeristem at shoot and root apices, at the apex of leaves and in intercalary parts.

(iii) Secondary meristem :

- These are the meristems developed from primary permanent tissues. They are not present in the embryonic stage of the plant. These are present in mature region of root and stem of many plants particularly those that produce woody axis.

Etoos Tips & Formulas

→ Axillary bud is derived from shoot apical meristem .

→ Both apical meristem and intercalary meristem are primary meristem, because they appear early in life of a plant and contribute to the formation of the primary plant body.

→ Lateral meristems are cylindrical.

→ Intrafascicular cambium is an example of primary lateral meristem .

→ Interfascicular cambium and cork cambium (phellogen) are examples of secondary lateral meristem .

→ In the dicot stem, vascular cambium is partly primary and partly secondary in origin .

→ In the dicot root, vascular cambium is completely secondary in origin . "Parenchymatous cells are gener ally isodiametric .

→ Collenchymatous cells are much thickened at the corners, due to deposition of pectin, cellulose and hemicellulose. Collechyma is present below epidermis either as a homogenous layer or in patches in herbaceous dicotyledonae stem.

→ Cell walls of sclerenchymatous cells are thick and lignified .

→ Sclereids are commonly found in the fruit wall of nuts, pulp of fruits like guava, pear & sapota, seed coats of legumes and leaves of tea.

→ Tracheids are unicellular, whereas vessels are multicellular .

→ Vessel is a long cylindrical tube-like structure made up of many cells called vessel elements .

→ Xylem fibres have highly thickened walls and obliterated central lumens .

→ The radial conduction of water takes place by the ray parenchymatous cells .

→ In stems, the primary xylem is endarch, whereas in roots, the primary xylem is exarch .

→ Gymnosperms have albuminous cells and sieve cells. They lack sieve tube and companion cells .

→ The companion cells are specialised parenchymatous cells, which are closely associated with sieve tube elements The companion cells help in maintaining the pressure gradient in the sieve tubes .

→ Phloem parenchyma is absent in most of the monocolyledonae .

→ Phloem fibres (Bast fibres) are generally absent in primary phloem .

→ Enucleate condition is found in mature sieve tube element and in mature vessel element.

→ Protophloem has narrow sieve tubes, whereas metaphloem has bigger sieve tubes .
Jute, flax and hemp fibres are used commercially .

→ Tissue systems are of three types on the basis of their structure, location and function .

→ Epidermal cells are parenchymatous .

→ Cuticle is absent in roots .

→ The stomatal aperture, guard cells and surrounding subsidiary cells are together called stomatal apparatus . The root hairs are unicellular elongations of epidermal cells .

→ The trichomes in the shoot system are usually multicellular .

→ The ground tissue system consists of parenchyma, collenchyma and sclerenchyma .

→ Radial vascular bundles are found in roots.

→ Endodermal cells of roots are barrel-shaped having Casparian strips on radial and tangential walls. These are of a waxy-material-suberin.

→ In dicot root, pith is small or inconspicous, whereas in monocots roots pith is large and well develope

→ In roots conjunctive tissue is present between the xylem and the phloem. It is made up of parenchyma

→ Dicot roots are usually diarch to Tetrach (Rerely hexarch), whereas monocot roots are usually polyarc

SOLVED EXAMPLE

Ex.1 A group of cell alike in form, function and origin is called

(A) Organ **(B)** Organella

(C) Tissue **(D)** None of these

Sol. **(C)**

Ex.2 Companion cells are closely associated with

Or

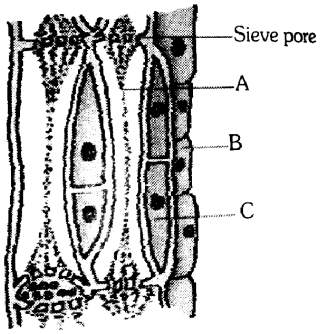
Transport of food material in higher plants takes place through

(A) Sieve elements **(B)** Vessel elements

(C) Trichomes **(D)** Guard cells

Sol. **(A)** : Companion cells are connected with sieve elements by complex plasmadesmata

Ex.3 See the following figures and identify the types of simple tissue marked by alphabets



(A) A - Sieve tube, B - Companion cell, C - Phloem fibre

(B) A - Sieve tube, B - Phloem parenchyma, C - Phloem fibre

(C) A - Vessel, B - Xylem parenchyma, C - Companion cell

(D) A - Sieve tube, B - Phloem parenchyma, C - Companion cell

Sol. **(D)**

Ex.4 Interfascicular cambium develops from the cells of

(A) Pericycle **(B)** Medullary rays

(C) Xylem parenchyma **(D)** Endodermis

Sol. **(B)**

Ex.5 The only plant cells without nuclei among the following are

Or

The tissue which is living but does not possess nucleus in mature state is

(A) Cambium cells **(B)** Cells of pericycle

(C) Xylem parenchyma **(D)** Sieve tube

Sol. **(D)** : In sieve tubes, nucleus is present only in young stage and without nuclei at maturity

Ex.6 Sieve tubes are better suited for translocation, because

(A) Possess broader lumen and perforated cross walls

(B) Are broader than long

(C) Possess bordered pits

(D) Possess no end walls

Sol. **(A)**

Ex.7 The root apex is subterminal beacuse it

(A) Is covered by tunica cells

(B) Is covered by root hairs

(C) Has many corpus cells

(D) Is covered by root cap

Sol. **(D)** A group of initial cells, present at the subterminal region of the growing root tip, which is protected by a root cap is called root apical meristem or root apex.

Ex.8 P – protein is found in

(A) Collenchyma **(B)** Parenchyma

(C) Xylem **(D)** Sieve tube

Sol. **(D)** : A sieve tube is analogous to RBC, both being living but enucleated at maturity. A network of fibres of P_1 and P_2 protein is present in the central part of lumen of sieve tube which controls movement of materials and with callose, the sealing of pores after injury.

Ex.9 Function of companion cells is

(A) Loading of sucrose into sieve elements by passive transport

(B) Loading of sucrose into sieve elements

(C) Providing energy to sieve elements for active transport

(D) Providing water to phloem

Sol. **(B)**

Ex.10 Casparian strips are present in the _____ of the root

(A) Epiblema **(B)** Cortex

(C) Pericycle **(D)** Endodermis

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. Bamboo, grass and mint stem elongate by the activity of -
(A) Primary meristem (B) Secondary meristem
(C) Intercalary meristems (D) Apical meristems

2. Maximum growth in root occurs –
(A) At its tip (B) Towards light
(C) Behind the apex (D) Towards apex

3. Periclinal division in a cell takes place by -
(A) Vertical cleavage
(B) Transverse cleavage
(C) Perpendicular cleavage
(D) Tangential cleavage

4. Monocot leaves grow by -
(A) Apical meristem (B) Lateral meristem
(C) Intercalary meristem (D) Dermatogen

5. Which of the following is a primary meristem -
(A) Intra fascicular cambium
(B) Cork cambium
(C) Vascular cambium in roots
(D) None of the above

6. In plants, during embryonic condition –
(A) All cells of the embryo divide
(B) Meristematic activity is confined to single apical cell
(C) Meristematic activity is confined to a group of apical cells
(D) Apical & lateral cells only divide

7. Which of the following plants grow by a single "apical cell" -
(A) Monocots (B) Dicots
(C) Gymnosperms (D) Bryophyta

8. Which of the following is secondary meristem
(A) Protoderm (B) Procambium
(C) Cork cambium (D) All of the above

9. The function of root cap is -
(A) Protection of root tip and control of geotropic movement
(B) Storage of food products
(C) Absorption of nutrients
(D) None of the above

10. Tunica is a rib meristem because it divides in -
(A) Anticlinal plane only
(B) Periclinal plane only
(C) Both 1 & 2
(D) Several different planes

11. The cells of a permanent tissue do not divide because these are -
(A) Dead (B) Enucleate
(C) Arrested at G-1 stage (D) Arrested at prophase

12. Plate meristem shows -
(A) Anticlinal divisions in two planes to right angle to each other
(B) Anticlinal divisions in one plane
(C) Both periclinal & anticlinal divisions in one plane
(D) Three dimensional divisions

13. Plastochron is -
(A) Period between initiation of two successive leaf primordia
(B) Distance between two successive leaf primordia
(C) Region of origin of root branch
(D) Region of origin of stem branch

14. A parenchyma cell which stores ergastic materials or waste substance is -
(A) Phragmoblast (B) Conidioblast
(C) Idioblast (D) Blastomere

15. The tissue not having specifically thickened walls are -
(A) Parenchyma (B) Collenchyma
(C) Fibres (D) Sclereids

16. According to histogen concept of apical meristem, three histogens are present. Which of the following is differentiated from plerome
(A) Cortex (B) Xylem & Phloem
(C) Ground tissue system (D) Stele

17. Who differentiated tissue system in epidermal tissue system, ground tissue system and vascular tissue system -
(A) Hanstein (B) Buvet
(C) Sachs (D) Nageli

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. Laticiferous vessels are found in -
(A) Xylem tissue
(B) Phloem tissue
(C) Cortex
(D) None of the above

2. When phloem is completely surrounded by xylem, the vascular bundle is called -
(A) Concentric, leptocentric/amphivasal
(B) Concentric, hadrocentric/amphicribral
(C) Conjoint, Collateral
(D) Conjoint, bicollateral

3. Amphivasal or leptocentric vascular bundles are found is -
(A) *Cycas* and *Dryopteris*
(B) *Dracaena*
(C) *Helianthus* and *Cucurbita*
(D) Maize and Wheat

4. Callose can occur in -
(A) Phloem parenchyma
(B) Companion cells
(C) Sieve tubes
(D) Tracheids

5. A narrow thin-walled cell with large nucleus and lying on the side of sieve tube is absent in
(A) Angiosperms (B) Pteridophytes
(C) Gymnosperms (D) Both (B) and (C)

6. An open collateral bundle is one in which -
(A) Xylem and phloem are separated by cambium
(B) Xylem and phloem lie side by side
(C) Cambium occurs on the outside of bundle
(D) Cambium does not occur in the bundle

7. Which is enucleate at maturity
(A) Sieve cell (B) Companion cell
(C) Cortical cell (D) Palisade cell

8. Longest fibres are found in -
(A) Jute (B) Cotton
(C) Sunn Hemp (D) Coir

9. Phloem tissue of angiosperms differs from that of gymnosperms in having -
(A) Companion cells
(B) Sieve cells
(C) Sieve plates
(D) None of the above

10. A bundle with xylem and phloem separated by a strip of cambium is -
(A) Collateral and closed
(B) Collateral and open
(C) Concentric and closed
(D) Bicollateral and open

11. Transport of water and dissolved minerals occurs through -
(A) Phloem (B) Xylem
(C) Sieve tubes (D) Sclerenchyma

12. Which one of the following comprises only simple tissues -
(A) Parenchyma, Collenchyma and Sclerenchyma
(B) Parenchyma, Xylem and Collenchyma
(C) Parenchyma, Xylem and Sclerenchyma
(D) Parenchyma, Xylem and Phloem

13. Vessel elements differ from other elements of xylem in having -
(A) Simple and bordered pits on end walls
(B) Simple perforation on their end walls
(C) Simple pits on their radial walls
(D) Bordered pits on their lateral walls

14. Function of vessels is -
(A) Conduction of water and minerals
(B) Conduction of food
(C) Mechanical strength
(D) All of the above

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1. Match the following

Column-I	Column-II
A. Hypodermis in dicot stem	**i.** Absent
B. Pericycle in dicot stem	**ii.** Parenchymatous
C. Ground tissue in monocot stem	**iii.** Collenchymatous
D. Phloem parenchyma in monocot stem	**iv.** Sclerenchymatous

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

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

2. Select a set having correct match

Dicot stem	Monocot stem
A. Sclerenchymatous hypodermis	Collenchymatous hypodermis
B. Parenchymatous pericycle	Sclerenchymatous pericycle
C. Epidermis with trichomes	Water containing cavities in vascular bundles
D. Oval bundles	Wedge shaped bundles

3. Match the followings in column I with column II and choose the correct combination

Column -I	Column -II
A. Xylem vessels	**i.** Store food materials
B. Xylem trachieds	**ii.** Obliterated lumen
C. Xylem fibre	**iii.** Perforated plates
D. Xylem parenchyma	**iv.** Chisel like ends

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

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

(D) A – iii, B – iv, C – ii, D – i

4. Match the items in Column – I with Column – II and choose the correct option

Column-I	Column-II
A. Radial Vascular Bundle	**i.** Cucurbita pepo
B. Collateral Vascular Bundle	**ii.** Dracaena
C. Bicollateral Vascular Bundle	**iii.** Roots of angiosperms
D. Amphicribal Bundle	**iv.** Sunflower stem
E. Amphivasal Vascular Bundle	**v.** Fern

5. Match the following and choose the correct option from below

Column - I	Column –II
A. Meristem	**i.** Photosynthesis, storage
B. Parenchyma	**ii.** Mechanical support
C. Collenchyma	**iii.** Actively dividing cells
D. Sclerenchyma	**iv.** Stomata
E. Epidermal tissue	**v.** Sclereids

Options :

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

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

Exercise # 4

PART - 1 PREVIOUS YEAR (NEET/AIPMT)

1. What happens during vascularisation in plants ? [CBSE AIPMT-2000]
(A) Differentiation of procambium is immediately followed by the development of secondary xylem and phloem
(B) Differentiation of procambium followed by the development of xylem and phloem
(C) Differentiation of procambium, xylem and phloem is simultaneous
(D) Differentiation of procambium followed by the development of primary phloem and then by primary xylem

2. Loading of phloem is related to - [CBSE AIPMT-2001]
(A) increases of sugar in phloem
(B)Tracheids are multicellular with narrow lumen
(C) Vessels are unicellular with wide lumen
(D) Tracheids are unicellular with wide lumen

3. Which of the following statements is true ? [CBSE AIPMT-2002]
(A) Vessels are multicellular with narrow lumen
(B) Tracheids are multicellular with narrow lumen
(C) Vessels are unicellular with wide lumen
(D) Tracheids are unicellular with wide lumen

4. Axillary bud and terminal bud are derived from the activity of [CBSE AIPMT-2002]
(A) lateral meristem (B) intercalary meristem
(C) apical meristem (D) parenchyma

5. Four radial vacular bundles are found in [CBSE AIPMT-2002]
(A) dicot root (B) monocot root
(C) dicot stem (D) monocot stem

6. Vessels are found in [CBSE AIPMT-2002]
(A) all angiosperms and some gymnosperms
(B) most of angiosperms and few gymnosperms
(C) all angiosperms and few gymnosperms and some pteridophytes
(D) all pteridophytes

7. Main function of lenticel is [CBSE AIPMT-2002]
(A) transpiration (B) guttation
(C) gaseous exchange (D) bleeding

8. The cells of the quiescent centre are characterised by [CBSE AIPMT-2003]
(A) dividing regularly to add to tunica
(B) having dense cytoplasm and prominent nuclei
(C) having light cytoplasm and small nuclei
(D) dividing regularly to add to the corpus

9. The apical meristem of the root is present [CBSE AIPMT-2003]
(A) in all the roots
(B) only in radicals
(C) only in tap roots
(D) spore capsule of a moss

10. Chlorenchyma is known to develop in the [CBSE AIPMT-2003]
(A) Pollen tube of *Pinus*
(B) cytoplasm of *Chlorella*
(C) mycelium of a green mould such as *Aspergillus*
(D) spore capsule of a moss

11. In a longitudinal section of root, starting from the tip upward, the four zones occur in the following order. [CBSE AIPMT-2004]
(A) root cap, cell division, cell enlargement, cell maturation
(B) root cap, cell division, cell maturation, cell enlargement
(C) cell division, cell enlargement, cell maturation, root cap
(D) cell division, cell maturation, cell enlargement, root cap

12. In a woody dicotyledonous tree which of the following parts will mainly consist of primary tissues? [CBSE AIPMT-2005]
(A) All parts
(B) Stem and root
(C) Flowers, fruits and leaves
(D) Shoot tips and root tips

13. A common structural feature of vessel elements and sieve tube elements are [CBSE AIPMT-2006]
(A) pores on lateral walls
(B) presence of p-protein
(C) enucleate condition
(D) thick secondary walls

MOCK TEST

1. Which of the following meristems are lateral meristems?
   (A) Apical meristem, interfascicular cambium and cork cambium
   (B) Fascicular vascular cambium, interfascicular cambium and cork cambium
   (C) Apical meristem, intercalary meristem and cork cambium
   (D) Intercalary meristem, interfascicular cambium and cork cambium
   (E) Fascicular cambium, apical meristem and cork cambium

2. The increase in length of petiole results from the division of
   (A) apical meristem (B) lateral meristem (C) intercalary meristem (D) phellogen

3. The girth or diameter of the stem increases due to the activity of the following.
   (A) Apical meristems (B) Intercalary meristems (C) Lateral meristems (D) Parenchyma cells

4. Which one of the following is not a lateral meristem?
   (A) Intrafascicular cambium (B) Interfascicular cambium
   (C) Phellogen (D) Intercalary meristem

5. Which one of the following pairs is an example for lateral meristem?
   (A) Procambium and phelloderm (B) Interfascicular cambium and phellem
   (C) Phellogen and phelloderm (D) Phellogen and fascicular cambium

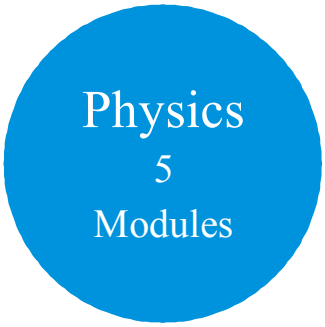
6. Which among these statements about collenchyma is true?
   (A) Collenchyma cells are usually dead without protoplasts.
   (B) The cells are long and narrow with thick lignified walls
   (C) Collenchyma occurs in layers below the epidermis in dicotyledonous plants.
   (D) These cells are found in the pulp of fruits like guava, pear and sapota.
   (E) Collenchyma may be either fibres or sclereids.

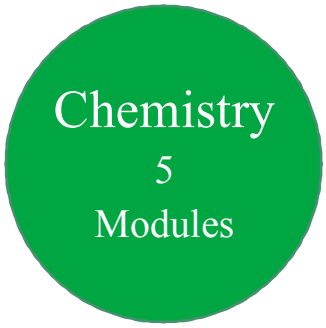
7. Oval, spherical or polygonal cells, thickening at the corners due to deposition of cellulose, hemicellulose and pectin, often containing chloroplasts and having or not having inter-cellular spaces are called
   (A) parenchyma (B) chlorenchyma (C) sclerenchyma (D) collenchyma

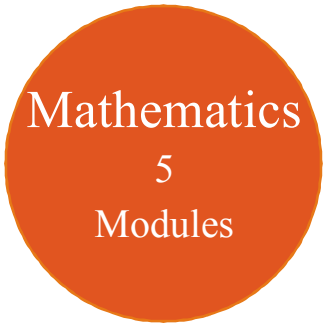
8. Aerenchyma is found in
   (A) epiphytes (B) hydrophytes (C) halophytes (D) xerophytes

9. Pick out the wrong statement.
   (A) Gymnosperms lack vessels in their xylem.
   (B) The cell wall of parenchyma is made up of pectin.
   (C) The first formed primary xylem elements are called protoxylem.
   (D) Gymnosperms have albuminous cells and have sieve cells in their phloem.
   (E) Intercellular spaces are absent in collenchyma.

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

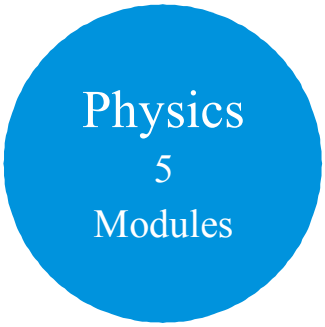
Module-4

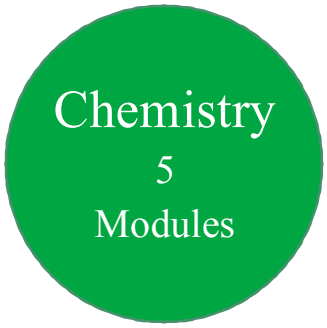
1. Photosynthesis in Higher Plants
2. Respiration in Plants
3. Plant Growth and Development
4. Digestion & Absorption
5. Breathing & Exchange of Gases

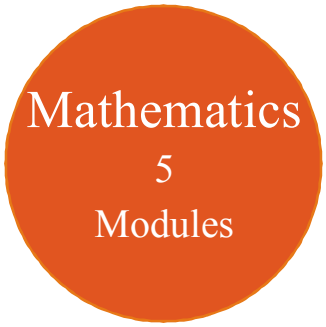
Module-5

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