

SAMPLE CONTENT



Absolute

For all Medical Entrance Examinations held across India.

Biology Vol - I

NEET-UG

4039 MCQs with Hints

Classification:

Kingdom : Animalia
Phylum : Chordata
Class : Mammalia
Genus : *Panthera*
Species : *pardus*



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For all Medical Entrance Examinations held across India.

Absolute NEET – UG Biology Vol. I

Salient Features

- ☞ Exhaustive coverage of MCQs subtopic wise.
- ☞ '4039' MCQs including questions from various competitive exams.
- ☞ Includes solved MCQs from NEET-UG, MHT-CET and various entrance examinations from year 2015 to 2018.
- ☞ Includes NEET-UG 2019 and NEET 2019 (Odisha) Question Paper and Answer Key along with Hints.
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- ☞ Concise theory for every topic.
- ☞ Neat and labelled authentic diagrams.
- ☞ Relevant Hints provided.
- ☞ Quick Review and Additional Information to build concepts.
- ☞ Topic test at the end of each chapter.

Scan the adjacent Q.R. Code or visit www.targetpublications.org/tp13650 to access solutions/hints to Topic Test.



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PREFACE

Target's "**Absolute Biology Vol – I**" is compiled according to the notified syllabus for NEET-UG. The content of this book is framed after reviewing the format of NCERT textbook.

The sections of **Theory, Quick Review, MCQs** and **Topic Test** form the backbone of every chapter and ensure adequate revision.

The MCQs in each chapter are a mix of questions based on high order thinking, theory and multiple concepts. The level of difficulty of these questions is at par with that of various competitive examinations like CBSE, AIIMS, CPMT, AFMC, JIPMER, TS EAMCET (Med. and Engg.), BCECE, AP EAMCET (Med. and Engg.) and likes. Also to keep students updated, questions from most recent examinations such as AIPMT/NEET, MHT CET, KCET, GUJ CET, WB JEEM of years 2015, 2016, 2017 and 2018 are covered exclusively.

NEET-UG 2019 and NEET 2019 (Odisha) Question Paper and Answer Key has been provided. Students can access the hints of this Question Paper given in the form of QR Code.

Topic Test has been provided at the end of each chapter to assess the level of preparation of the student on a competitive level.

We are confident that this book will cater to needs of students across a varied background and effectively assist them to achieve their goal. We welcome readers' comments and suggestions which will enable us to refine and enrich this book further.

Please write to us at: mail@targetpublications.org

All the best to all Aspirants!

Yours faithfully,

Authors

Edition: Second

Disclaimer

This reference book is based on the NEET-UG syllabus prescribed by Central Board of Secondary Education (CBSE). We the publishers are making this reference book which constitutes as fair use of textual contents which are transformed by adding and elaborating, with a view to simplify the same to enable the students to understand, memorize and reproduce the same in examinations.

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INDEX

No.	Topic Name	Page No.
1	The Living World	1
2	Biological Classification	12
3	Plant Kingdom	35
4	Animal Kingdom	64
5	Morphology of Flowering Plants	100
6	Anatomy of Flowering plants	135
7	Structural Organisation in Animals	166
8	Cell: The Unit of Life	189
9	Biomolecules	213
10	Cell Cycle and Cell Division	240
11	Transport in Plants	260
12	Mineral Nutrition	293
13	Photosynthesis in Higher Plants	314
14	Respiration in Plants	346
15	Plant Growth and Development	375
16	Digestion and Absorption	400
17	Breathing and Exchange of Gases	426
18	Body Fluids and Circulation	446
19	Excretory Products and their Elimination	473
20	Locomotion and Movement	498
21	Neural Control and Coordination	523
22	Chemical Coordination and Integration	551
	Mnemonics	581
	Scientists Name and Discoveries	583
	NEET 2019 - (ODISHA): Question Paper & Answer Key	588
	NEET 2019 - (UG): Question Paper & Answer Key	593

06 Anatomy of Flowering Plants

- 6.0 Introduction
- 6.1 The Tissues
- 6.2 The Tissue System

- 6.3 Anatomy of Dicotyledonous and Monocotyledonous Plants
- 6.4 Secondary Growth

6.0 Introduction

- **Anatomy:** The study of internal structure of plants is called **anatomy**. Anatomical differences are shown by varied organs in a plant.

6.1 The Tissues

- **Tissue:** A tissue is a group of cells having a common origin and usually performing a common function. In plants, tissues are classified into two main groups:

i. Meristematic tissues

ii. Permanent tissues

i. Meristematic tissues:

- a. A group of young cells which have the capacity of active cell division is known 'meristem'.
- b. Meristematic cells are self-perpetuating.
- c. **Characteristics of meristematic cells:**

- Living cells.
- Dense protoplasm and prominent nucleus
- Cells may be spherical, oval, polygonal or rectangular in shape
- Compactly arranged without intercellular spaces
- Cell wall is thin, elastic and made up of cellulose
- Divide in a particular plane of division
- Few or no vacuoles
- Show presence of small endoplasmic reticulum and few mitochondria

d. Classification of Meristematic tissue:

Based on position of meristematic tissue

Apical meristem

- Occurs at the tips of roots and shoots
- Divides continuously and brings about growth in length of shoot and root.
- Produces primary tissues (responsible for primary growth).
- Induces primary meristem.

Intercalary meristem

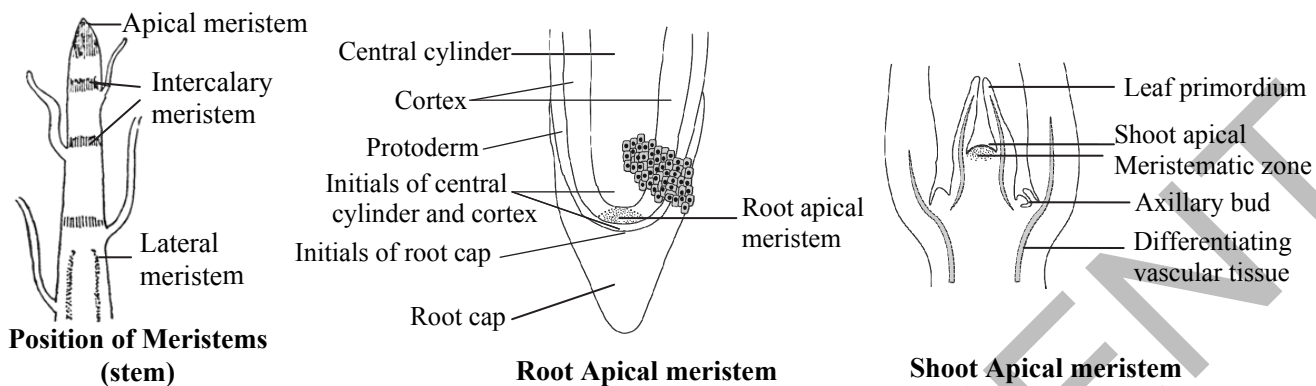
- These are the parts of apical meristems which separate from them due to the formation of permanent tissue in between.
- They are present at the base of internode e.g. grasses and wheat or at the base of node e.g. mint.
- It helps in growth of leaves and internodes.
- Some cells left behind from shoot apical meristem form axillary buds which are capable of forming a branch or flower.

Lateral meristem

- Occurs in the mature regions of roots and shoots of plants with woody axis.
- These meristems are arranged parallel to the sides of the organs or around the central axis of the organ.
- Their activity results in increasing the diameter of plant organs and development of secondary tissues.
- Fascicular vascular cambium, interfascicular cambium and cork cambium are the common examples of such meristems.
- These meristems are also known as secondary meristems.



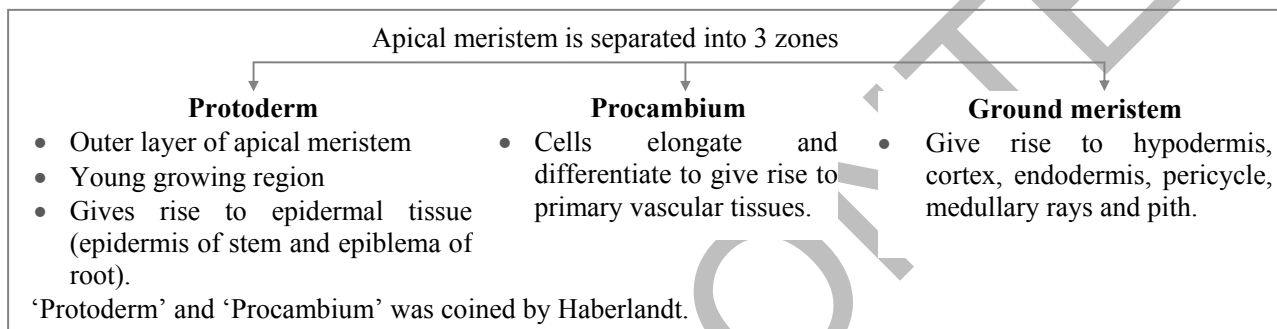
- e. Both apical and intercalary meristems are primary meristems because they appear early in life of a plant and contribute to the formation of the primary plant body.



Position of Meristems (stem)

Root Apical meristem

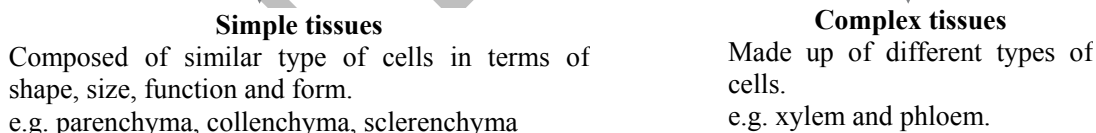
Shoot Apical meristem



ii. Permanent tissues:

- a. Meristematic cells lose the power of cell division and become permanent. These cells are known as permanent cells or mature cells, which constitute the permanent tissue.
- b. Permanent tissues have definite shape, size and function.
- c. Cells may be dead or living with either a thick or thin wall, which may be composed of cellulose, hemicellulose, pectin and lignin.

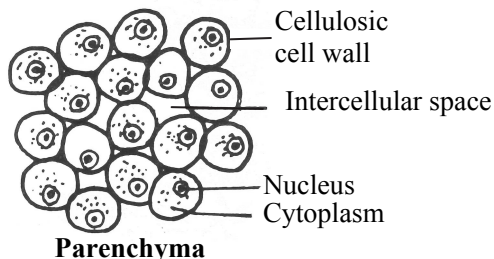
Types of Permanent tissues



➤ **Simple tissues:**

i. Parenchyma:

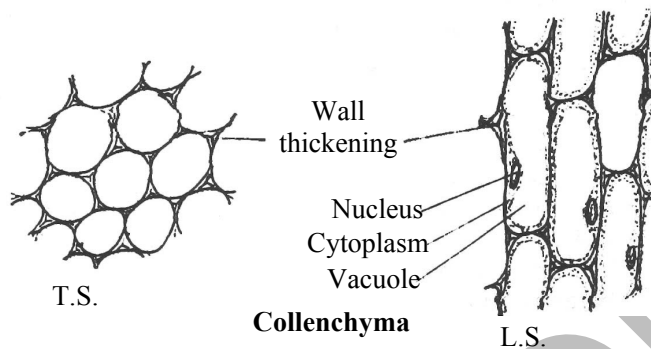
- a. The most commonly found tissue, hence is also known as the ‘**fundamental tissue**’.
- b. Made up of living cells with distinct nuclei and vacuolated cytoplasm.
- c. Cells are generally isodiametric and may be spherical, oval, round, polygonal or elongated in shape.
- d. Cell walls are thin and made up of cellulose.
- e. Closely packed cells with small intercellular spaces.
- f. Perform functions like **photosynthesis, storage, secretion**.



Parenchyma

**ii. Collenchyma:**

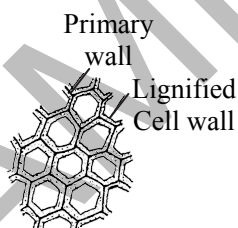
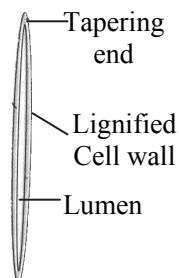
- a. Simple, living, mechanical tissue.
- b. Occurs in layers below the epidermis in dicots (hypodermis).
- c. Consists of cells which are much thickened at the corners due to deposition of cellulose, hemicellulose and pectin.
- d. May be oval, spherical or polygonal and some contain chloroplasts.
- e. Intercellular spaces are absent.
- f. Provides mechanical support and elasticity to the growing part of the plant such as young stem and petiole of a leaf.
- g. The collenchyma cells which contain chloroplast perform the function of photosynthesis.

**iii. Sclerenchyma:**

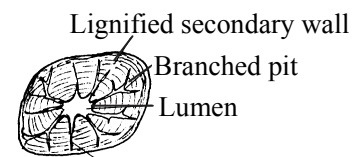
- a. Thick walled, dead cells, devoid of protoplasm.
- b. Cells vary in shape, size and origin.
- c. Intercellular spaces are small or absent.
- d. Cell walls are highly lignified, evenly thickened and hard due to uniform deposition of lignin, sometimes, may be unlignified.

Types of Sclerenchyma Cells**Fibres**

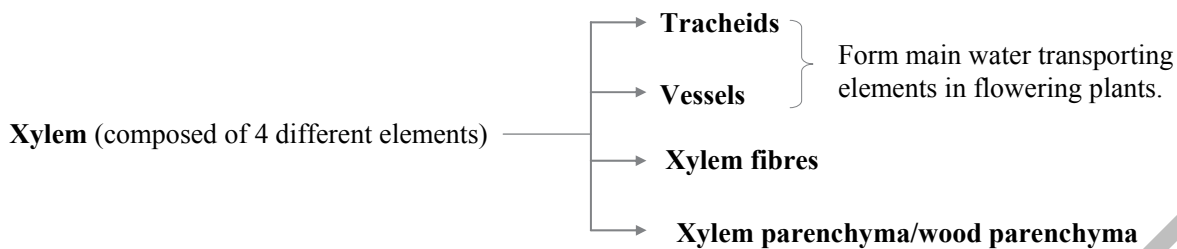
- Elongated, narrow and thick walled, pointed at both ends and are lignified.
- Provide mechanical strength to the plant part.
- Help in conduction of water when present in secondary xylem.

**T.S. of Fibres****L.S. of Fibres****Sclereids**

- Their walls become very thick, hard and highly lignified, lumens remain narrow.
- Broad cells which may be oval, spherical, dumb-bell shaped or stellate.
- Commonly found in the fruit walls of nuts; pulp of fruits like guava, pear and sapota; seed coats of legumes and leaves of tea.
- Provide mechanical strength to the plant.

**Simple pit sclereid****Complex tissues:**

- i. Made up of different types of cells working together as a unit.
 - ii. **Xylem** and **phloem** make up the **complex tissue**.
- a. **Xylem:**
Conducting tissue for water and minerals from roots to the stem and leaves.
Also provides mechanical strength to the plant parts.



i. Tracheids:

These are elongated, tube-like, dead cells (without protoplasm) with tapering ends with lumen and lignified walls except at certain points called **pits**. Tracheids form main water conducting elements of xylem in pteridophytes and gymnosperms. Few tracheids are found in xylem of angiosperms. They possess thickening on their walls. Pitted is the most advanced type of thickening.

Function:

The main function of tracheids is to conduct water and dissolved mineral salts from root to the stem, leaves and floral parts.

Tracheids



Xylem tracheids

ii. Vessels:

Long, cylindrical, tube-like structure, made up of number of cells known as Vessel members.

Cells possess lignified walls and a large central cavity.

Devoid of protoplasm.

Vessel members are interconnected through perforations in the cell wall.

Characteristic feature of angiosperms (thus wood is called '**porous wood**')

Absent in gymnosperms, pteridophytes (thus wood is non-porous).

Function:

- a. Translocate water and dissolved mineral salts.
- b. Provides mechanical strength to plant parts.

Vessel



Xylem vessel

iii. Xylem fibres:

They are sclerenchymatous cells associated with xylem tissue.

Long, narrow, thick, highly lignified cells usually pointed at both ends.

Dead cells bearing a narrow lumen.

They may be septate or aseptate.

Function:

Provides mechanical strength to xylem and plant body.

iv. Xylem parenchyma:

Consists of living parenchymatous cells associated with xylem.

Cell walls are thin made up of cellulose.

Function:

- a. Store food materials (in the form of starch or fat) and other substances like tannins.
- b. The radial conduction of water takes place by the ray parenchymatous cells.

➤ **Primary xylem can be classified as:**

i. Depending on the stage when it is formed:

- a. Protoxylem: The first formed primary xylem elements
- b. Metaxylem: The later formed primary xylem elements

ii. Depending upon the position of protoxylem and metaxylem, it is classified as:

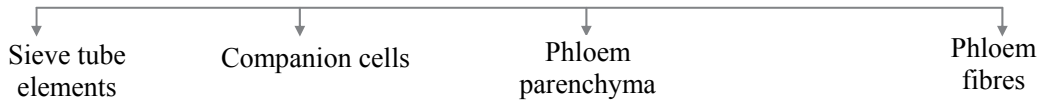
- a. Endarch: The protoxylem lies towards the centre (pith) and metaxylem lies towards the periphery of the organ e.g. found in stem.
- b. Exarch: The protoxylem lies towards periphery and metaxylem lies towards the centre. e.g. found in roots.

b. Phloem:

- i. It is the chief food conducting tissue of vascular plants responsible for translocation of food from leaves to other plant parts.



ii. **Phloem** composed of 4 different elements:



Gymnosperms show presence of albuminous cells and sieve cells. They lack sieve tubes and companion cells.

a. Sieve tube elements:

Main component of phloem.

These are elongated, longitudinally arranged, tube-like structures and are associated with the companion cells.

Sieve tubes have their end walls perforated, in a sieve-like manner to form **Sieve plates**.

Matured sieve element is deprived of nucleus but possesses peripheral cytoplasm and a vacuole.

The nucleus of companion cell controls the functions of sieve tubes.

Sieve plates help the contents of the cell to communicate with each other.

Function:

The main function is transportation of prepared food materials from leaves to the storage organs in downward direction and then to growing regions in the upward direction (bi-directional).

b. Companion cells:

These are specialised parenchymatous cells, closely associated with the sieve tubes elements.

Nuclei of companion cells control the metabolic activities of sieve tubes.

Companion cells are connected to the sieve tube elements by 'pits fields' present between their common longitudinal wall.

Function:

Helps to maintain pressure gradient in sieve tubes.

c. Phloem parenchyma:

These are thin walled, living parenchymatous cells with elongated tapering ends.

The cells have dense cytoplasm and nucleus.

Cell wall is made up of cellulose.

Cell wall has pits through which plasmodesmatal connections exist between the cells.

Phloem parenchyma is absent in monocots.

Function:

Phloem parenchyma stores food material and other substances such as resins, latex and mucilage.

d. Phloem fibre:

It is also called bast fibres.

These are made up of sclerenchymatous cells.

Phloem fibres are absent in the primary phloem but present in secondary phloem.

The fibres of secondary phloem are elongated, unbranched and have needle-like apices.

Cell wall of phloem fibre is thick.

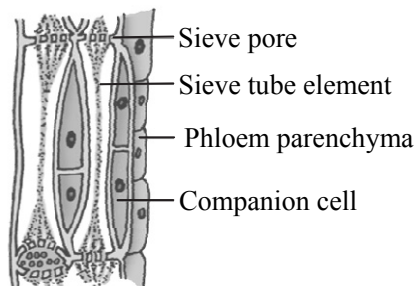
Matured fibres lose their protoplast and become dead.

Phloem fibres of jute, flax and hemp are used commercially.

Primary phloem (named so, as it is first formed) consists of narrow sieve tubes and is known as **Protophloem**, while the one formed later with wider sieve tube is known as **Metaphloem**.

Function:

Phloem fibres provide mechanical support and give strength and rigidity to the organs.

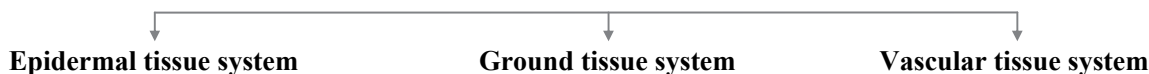


Phloem tissues



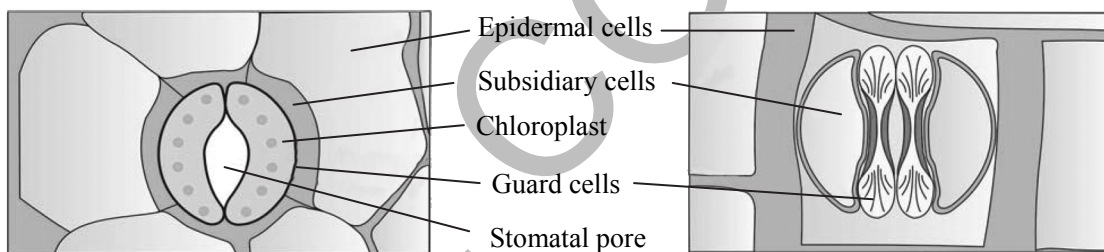
6.2 The Tissue System

The tissue system can be classified based on their structure and location in plant body as:



i. Epidermal tissue system:

- a. Outer-most layer of plant body.
- b. Made up of epidermal cells, stomata and the epidermal appendages (Trichomes and hairs).
- c. Epidermis is usually single layered and made up of elongated compactly arranged cells.
- d. Epidermal cells are parenchymatous with small amount of cytoplasm and a large vacuole.
- e. A thick waxy layer covers the epidermis of leaves, known as the ‘**cuticle**’ which prevents loss of water. Cuticle is absent in roots.
- f. Epidermis of plant cells contain specialised structure, known as ‘**stomata**’. It regulates the process of transpiration and exchange of gases.
Each stoma is made of two bean shaped cells known as **guard cells**.
These cells enclose a pore known as **stomatal pore**.
The guard cells have a thickened inner wall (towards stomatal pore) and a thin outer wall.
The guard cells regulate the opening and closing of stomata. They also possess chloroplast.
Subsidiary cells are epidermal cells around guard cells which become modified in shape and size.
- g. **Stomatal apparatus** is the collective term used for stomatal aperture (pore), guard cell, and subsidiary cells.



Stoma with bean-shaped guard cells

Stoma with dumb-bell shaped guard cells

- h. Number of hairs are present on cells of epidermis.
Those present in root region are known as ‘**Root hairs**’. They are unicellular elongations that help in absorption of water and minerals.
Those present on stem are known as ‘**Trichomes**’.
Trichomes are usually multicellular.
They may be branched or unbranched, soft or stiff.
They help to prevent water loss by transpiration, some are secretory in nature.

ii. The Ground Tissue System:

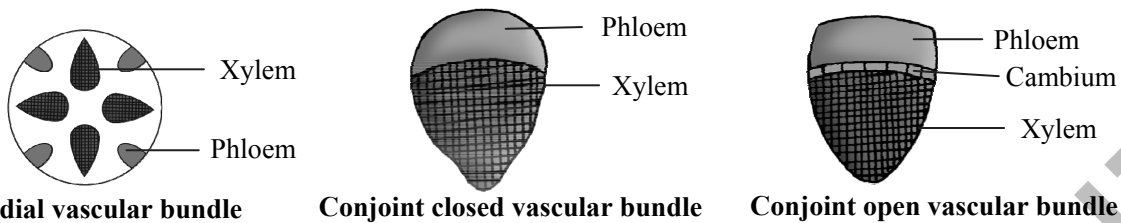
- a. Originate from ground meristem.
- b. Except vascular bundles and epidermis, all other tissue constitute the ground tissue.
- c. It consist of Parenchyma, Collenchyma and Sclerenchyma cells.
- d. The ground tissue in cortex, pericycle, pith and medullary rays of the primary stems and roots, usually consists of parenchymatous cells.
- e. Ground tissue found in leaves posses thin-walled chloroplast and together they are known as **mesophyll**.

iii. The vascular tissue system:

- a. It consists of complex tissues.
- b. **Xylem** and **phloem** together forms vascular bundles.
- c. **Dicot stems** show **open vascular bundles**, i.e. they have the **presence of cambium** between phloem and xylem. The presence of cambium enables the vascular bundles to form secondary xylem and phloem.



- d. **Monocot stems** have vascular bundles that **lack cambium** between phloem and xylem, thus they are unable to form secondary tissues, and are known to have **closed vascular bundles**.



Vascular bundles may be of following types:

- i. **Radial:** The xylem and phloem strands alternate with each other separated by parenchymatous cells. Such kinds of vascular bundles are called radial and found mainly in roots.
- ii. **Conjoint:** A vascular bundle having both xylem and phloem together, in the same radius. They occur in stems and leaves.
Usually phloem is located on the outer side, while xylem on the inner side.

6.3 Anatomy of Dicotyledonous and Monocotyledonous Plants

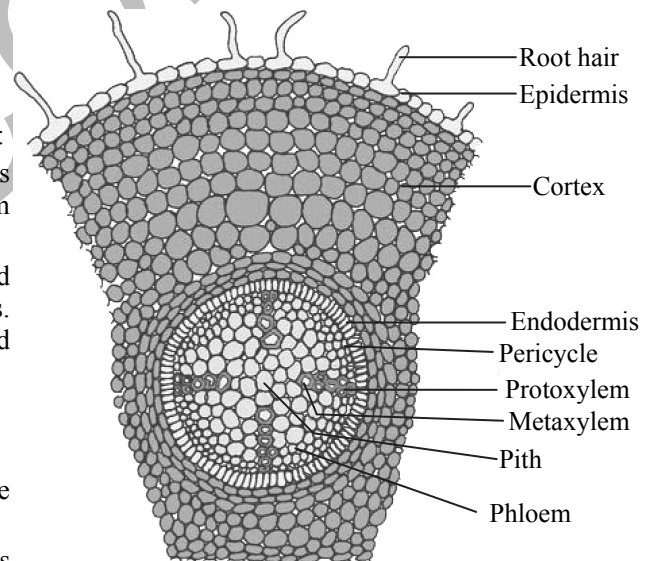
1. Dicotyledonous root
2. Monocotyledonous root
3. Dicotyledonous stem
4. Monocotyledonous stem
5. Dorsiventral (Dicotyledonous) leaf
6. Isobilateral (Monocotyledonous) leaf

Dicotyledonous Root:

T.S. of Dicot Root

Typical dicot root shows following parts from outside to inside:

- i. **Epidermis:** It is the outermost single layer of cells (without cuticle) which protrude at some points to form unicellular root hairs.
- ii. **Cortex:** It is made up of many layers of thin walled parenchyma cells with conspicuous intercellular spaces. (The cells contain starch grains that store food and water.) The last layer of cortex is called endodermis.
- iii. **Endodermis:**
 - a. It is the innermost layer of cortex.
 - b. These are barrel – shaped cells that form a single layer.
 - c. The radial and tangential walls of endodermal cells are coated with water impermeable waxy material ‘suberin’ which form the ‘casparian strips’.
 - d. Pericycle lies next to endodermis.
- iv. **Pericycle:**
 - a. It is few layers thick.
 - b. It is made up of thick – walled parenchymatous cells.
 - c. It is the site of initiation of lateral roots and vascular cambium during secondary growth.
- v. **Pith:**
 - a. It is small, narrow, central portion and made up of parenchymatous cells.
 - b. It lacks intercellular spaces.
 - c. The tissue inner to the endodermis, i.e. pericycle, vascular bundles and pith make up the ‘stele’.
- vi. **Conjunctive tissue:**
 - a. It is the parenchymatous tissue present in between xylem and phloem.
 - b. These are usually 2 – 4 Xylem and Phloem patches.



T.S. of dicot root

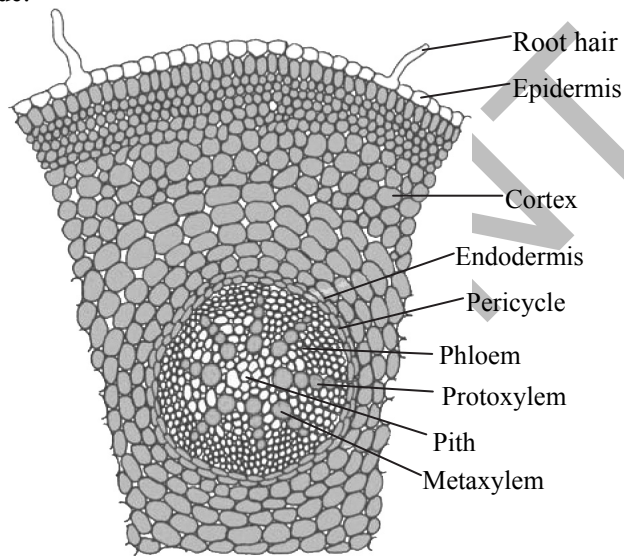


Monocotyledonous root:

T.S. of Monocot root

Monocot root resembles with dicot root in its basic structure. Secondary growth is absent in monocot root. Typical monocot root shows following parts from outside to inside:

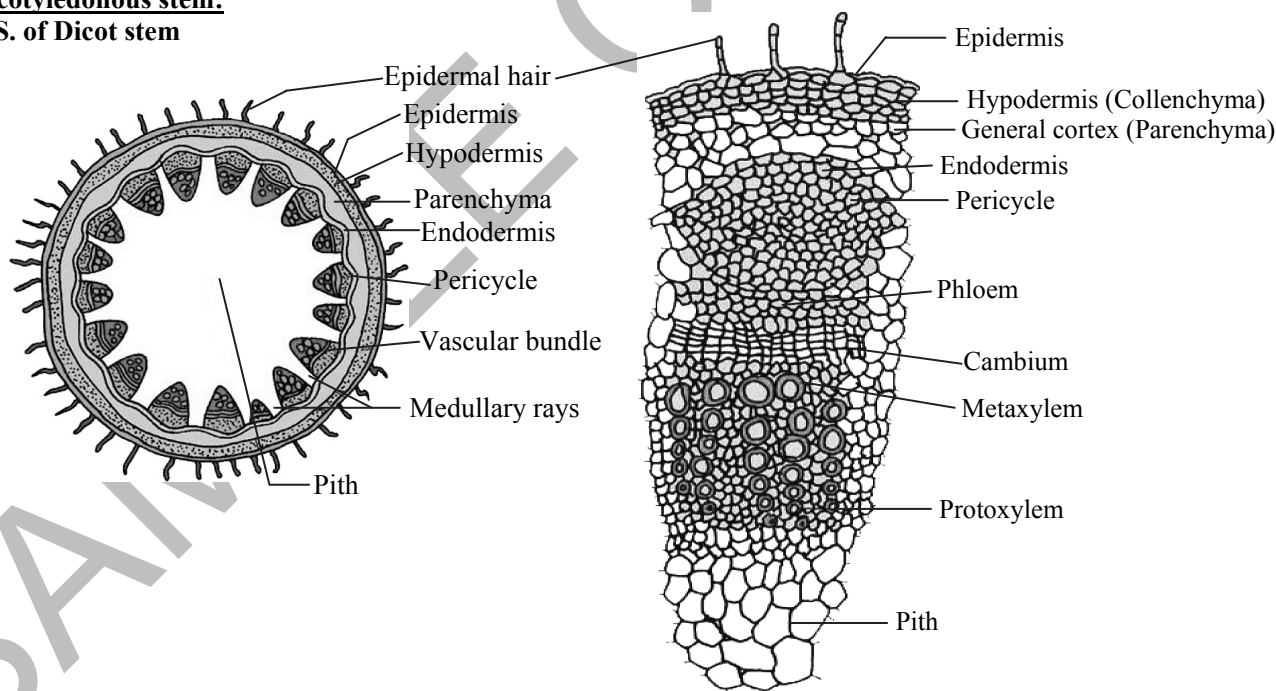
- i. Epidermis:**
It is outermost layer showing root hairs.
- ii. Cortex:**
 - a. It is composed of layers of parenchymatous cells.
 - b. It performs the function of conduction of water and storage of food.
- iii. Endodermis:**
It is innermost layer of cortex, cells are barrel-shaped with casparian strips on their radial walls.
- iv. Pericycle:**
It does not form cambium but produces lateral roots.
- v. Vascular bundles:**
 - a. Vascular bundles are arranged in the form of ring around a central pith.
 - b. There are more xylem bundles in monocot root as compared to dicot root.
 - c. There are usually more than six xylem bundles (polyarch condition) alternating with phloem bundles.
 - d. Xylem is exarch.
- vi. Pith:**
It is well developed and large.



T.S. of a monocot root

Dicotyledonous stem:

T.S. of Dicot stem



T.S. of dicot stem

A young dicot stem shows three distinct regions from outside to inside:

- i. Epidermis**
 - ii. Cortex**
 - iii. Stele**
- i. Epidermis:**
 - a. It is the outermost, protective layer of cells.
 - b. It shows of presence of cuticle.
 - c. It produces multicellular trichomes (hairs) and bears few stomata.

**ii. Cortex:**

- a. It is made of multiple layers which lie between epidermis and pericycle.
- b. It is divided into three regions namely, **hypodermis**, **cortical layer** and **endodermis**.
- c. Hypodermis lies just below epidermis and is made up of 4-5 layers of collenchymatous cells. They are living, with deposition of cellulose at corners. It gives mechanical strength to young plants.
- d. Cortical layer lies below hypodermis.
It is made up of many layers of rounded parenchymatous cells with conspicuous intercellular spaces.
- e. Endodermis is an innermost layer of cortex containing starch grains. This layer is also known as '**starch sheath**'.

iii. Pericycle: It is the region present on inner side of endodermis and above phloem in the form of semi-lunar patches of sclerenchyma.

iv. Medullary rays:

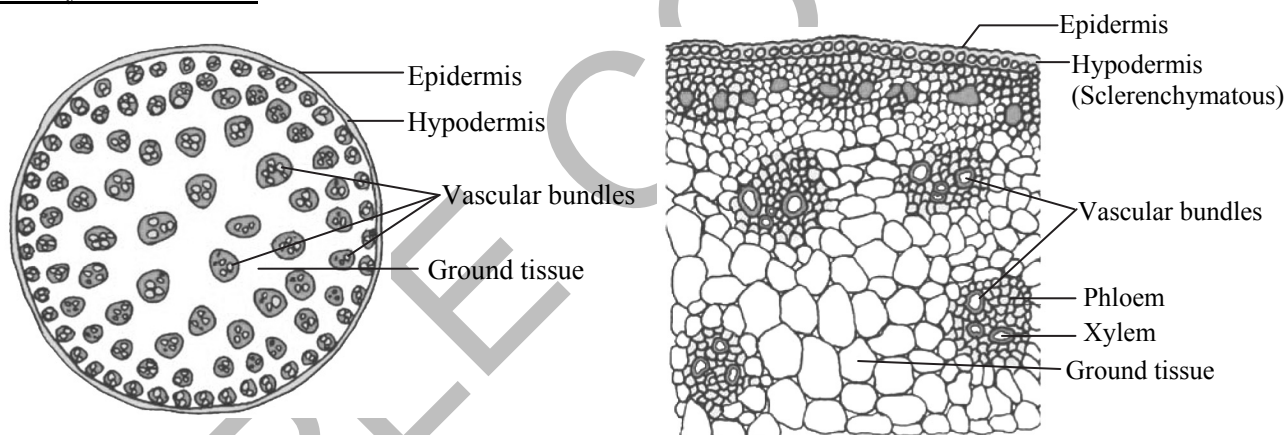
- a. In between the vascular bundles, the gap is filled with thin walled, parenchymatous cells arranged in four to five radial rows.
- b. It is called as medullary rays or the pith rays.

v. Vascular bundles:

Vascular bundles are large in number, conjoint, open with endarch protoxylem arranged in the form of a ring. Xylem is towards the centre, while phloem is towards periphery. Cambium is present.

vi. Pith:

It consists of large number of thin walled, rounded parenchymatous cells with distinct intercellular spaces.

Monocotyledonous stem:

T. S. of a monocot stem (Maize)

Monocotyledonous stem shows following parts from outside to inside:

i. Epidermis:

- a. It is the outermost layer, made up of living, thin walled cells, with a thick cuticle on the outer surface.
- b. Epidermal hairs are totally absent but few stomata may be present.

ii. Hypodermis:

- a. It lies just below epidermis.
- b. It is made up of two – three layers of thick walled sclerenchymatous cells.

iii. Ground tissue:

- a. It is present below hypodermis.
- b. It is made up of living, thin walled parenchymatous cells, loosely arranged with intercellular spaces.
- c. It is not differentiated into cortex, endodermis, pericycle etc. as in dicotyledonous stem.

iv. Vascular bundles:

- a. They are large in number, scattered in ground tissue.
- b. Conjoint and closed (cambium absent).
- c. Bundle sheath made up of sclerenchymatous cells surround the vascular bundles.
- d. Vascular bundles towards periphery are smaller in size, while vascular bundles towards centre are larger in size.
- e. Water containing cavities are present within the vascular bundles.
- f. Phloem parenchyma is absent.



Dorsiventral (Dicotyledonous) Leaf:

A typical dorsiventral leaf shows following parts in a transverse section (T.S):

i. Epidermis:

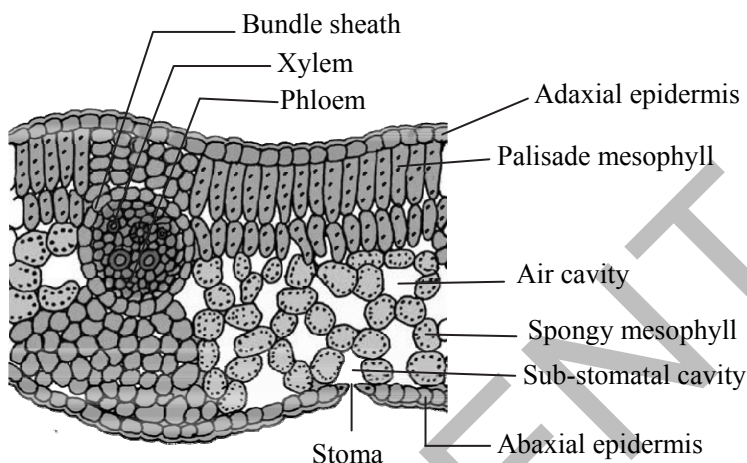
- a. It is found on both upper (adaxial) and lower (abaxial) surface of the leaf.
- b. A conspicuous cuticle is present.
- c. Lower surface bears more stomata than upper surface. Sometimes stomata may be absent on the upper surface.

ii. Mesophyll:

- a. It is the tissue present between the upper and the lower epidermis.
- b. It possesses chloroplasts and performs photosynthesis.
- c. It is made up of parenchymatous cells which are of two types:
 1. **Palisade parenchyma:**
It is present below the upper epidermis. It consists of closely packed elongated cells, which are arranged vertically and parallel to one other.
 2. **Spongy parenchyma:**
It is present below palisade. It consists of oval or round loosely arranged cells. It extends upto the lower epidermis.

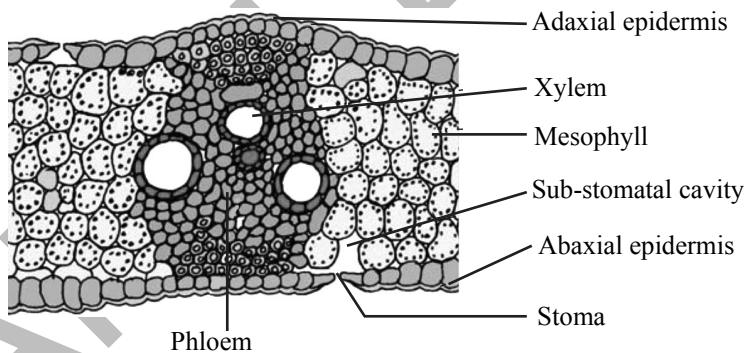
iii. Vascular system:

- a. It consists of number of vascular bundles that are visible in veins and midrib. The vascular bundles are of varying sizes, which depends on the size of veins. In reticulate venation veins vary in thickness.
- b. A layer of thick-walled parenchymatous cells which surrounds the vascular bundle is known as **'Bundle sheath'**.
- c. In vascular bundle of dorsiventral leaf, xylem is located towards upper epidermis, while phloem towards lower epidermis.
e.g. Dicotyledonous leaf.



T.S. of a Dicot leaf

Isobilateral (Monocotyledonous) Leaf:



T.S. of monocot leaf

A typical isobilateral leaf shows following parts in a transverse section (T.S):

i. Epidermis:

- a. It is present on both the surfaces of leaf.
- b. It consists of compactly arranged rectangular transparent parenchymatous cells.
- c. Both the surfaces show presence of **stomata**.
- d. Upper epidermis show presence of **bulliform cells** (motor cells), which are large, empty and colourless. These cells help in rolling and unrolling of a leaf. When the bulliform cells absorb water and become turgid, the leaf surface is exposed, when the cells become flaccid due to water loss, the leaf surface curls to minimize water loss.
- e. Guard cells are dumb-bell shaped.
- f. A distinct cutaneous layer is present.

**ii. Mesophyll:**

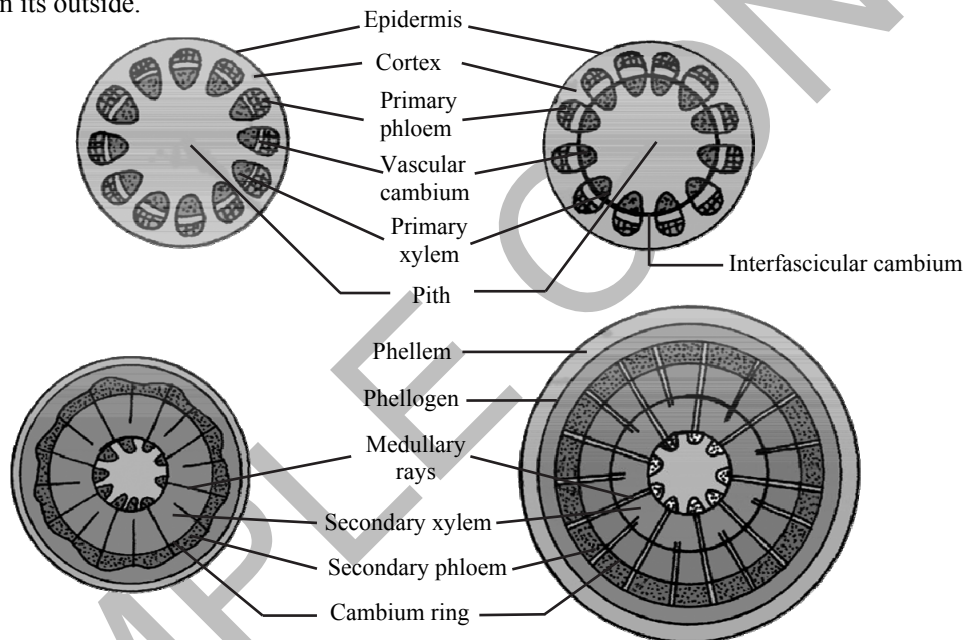
Parenchyma is not differentiated into spongy and palisade.

iii. Vascular system:

Due to the parallel venation in monocot leaf, the vascular bundles are of similar sizes (except in main veins).

6.4 Secondary Growth

- i. Most of the plants grow as long as they are alive, i.e. have indeterminate growth.
- ii. There are two types of plant growth – Primary growth and Secondary growth.
- iii. Primary growth is due to apical meristem which brings about increase in length of the plant.
- iv. Woody plants such as trees, shrubs and vines, i.e. dicots have secondary growth. This is the outward growth of the plant, making it thicker and wider.
- v. The increase in width or girth of a plant is called secondary growth and it arises from the lateral meristem in stems and roots.
- vi. Monocots do not show secondary growth, as they lack cambium.
- vii. When the cells divide during primary growth, the tissues are known as ‘primary tissues’ (primary xylem and phloem).
- viii. Secondary growth is brought about by the lateral meristems. These divide to form the secondary tissue (Secondary phloem and secondary xylem).
- ix. Lateral meristems that produce secondary growth are ‘**vascular cambium**’ and ‘**cork cambium**’.
- x. As the plant grows each year, the vascular cambium creates a new layer of xylem on its inside and phloem on its outside.



Secondary growth in a dicot stem

➤ Vascular Cambium:

- i. It is the meristematic layer which is responsible for cutting off vascular tissues, i.e. xylem and phloem in a vascular plant.
- ii. It is present in patches as a single layer between the xylem and phloem in young plants.
- iii. It forms a complete ring in older plants.

➤ Formation of cambial ring:

- i. **Intrafascicular Cambium:** The cells of cambium present between primary xylem and primary phloem of a vascular bundle.
- ii. **Interfascicular Cambium:** The cells of medullary rays adjoining intrafascicular cambium strips become meristematic and form a continuous ring which is known as interfascicular cambium.

➤ Activity of Cambial ring:

- i. The cells of cambium divide repeatedly to form new cells on both sides (a new layer of xylem on its inside and phloem on its outside), thereby forming a secondary vascular bundle.
- ii. The cells towards the pith mature into **Secondary xylem**.
- iii. The cells towards periphery mature into **Secondary phloem**.



- iv. Cambium is generally more active on the inner side.
- v. The secondary xylem is produced comparatively more abundantly than secondary phloem.
- vi. The primary xylem remains intact in the centre.
- vii. In dicots, as the stem increases in thickness, the primary and secondary phloem are crushed and replaced by 'secondary xylem', which is continuously formed.
As a result, the wavy vascular bundles become circular in nature.
- viii. Cambium that forms the narrow band of parenchyma which passes through the secondary xylem and the secondary phloem in radial directions is known as the **secondary medullary rays**.
- ix. Secondary xylem further forms the '**wood**', while the secondary phloem forms the '**bark**'.
- x. As the cambium becomes more active, producing secondary xylem inside and secondary phloem outside, the continuous formed cylinder of secondary vascular bundles destroys the primary vascular bundles.

➤ **Spring wood and Autumn wood:**

- i. Many physiological and environmental factors affect the activity of cambium.
- ii. In temperate regions, the climatic conditions are not uniform through the year.
 - a. During spring, cambium actively produces large number of xylem elements and vessels known as the **spring wood or early wood**.
 - b. During winter, when the cambium activity is less, it leads to formation of fewer xylem elements which have narrow vessels and known as **autumn wood or late wood**.
- iii. The spring wood is lighter in colour and has a lower density, whereas the autumn wood is darker and has a higher density.
- iv. The two kinds of woods that appear as alternate concentric rings constitute an **annual ring**.
Annual rings which can be seen in cut stem give an estimate of the age of the tree.

➤ **Heartwood and Sapwood:**

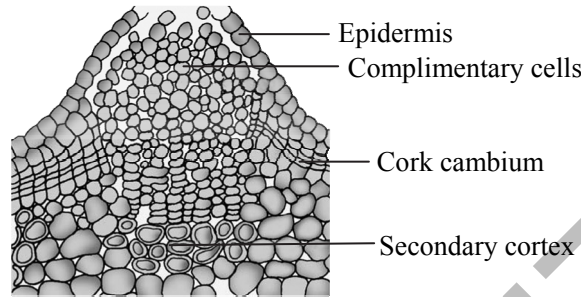
- i. In old trees, there is deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oils in the central or innermost layers of the stem.
- ii. It makes the secondary xylem dark brown in colour, hard, durable and resistant to microbial and insect attack.
- iii. These regions of dead elements with highly lignified cell walls are known as **Heart wood**.
- iv. It does not conduct water but provides mechanical support and protection to the plant.
- v. The peripheral region of the secondary xylem which is lighter in colour and is involved in conduction of water and minerals from root to leaf is known as **Sapwood**.

➤ **Cork Cambium:**

- i. As the stem width increases due to vascular cambial activity, the outer cortical and epidermal layers are broken and need to be replaced by new protective cell layers.
- ii. Thus, new protective cell layers are formed from meristematic tissue known as **cork cambium or phellogen** in the cortex region.
- iii. The phellogen is usually 1-2 layers thick and made up of narrow, thin-walled, nearly rectangular cells. It cuts off cells on both the sides (i.e. outer as well as inner side).
- iv. The outer side cells of phellogen form the **cork** or **phellem**.
- v. **Suberin** is the waxy substance deposited on the cell wall of cork cells making them impervious to water.
- vi. The inner cells of phellogen comprising of living parenchymatous cells differentiate to form **secondary cortex** or the **phelloderm**.
- vii. Phellogen, phellem and phelloderm together are called as **periderm**.



- viii. As the cork cambium cuts off cells, pressure builds up on the remaining peripheral layers of phellogen. Ultimately these layers die and fall off.
- ix. **Bark** is a non-technical term used for all tissues that lie exterior to vascular cambium. The periderm along with secondary phloem constitutes the Bark.
- x. **Soft or Early Bark** is the bark formed early in the season.
- xi. **Late or Hard Bark** is the bark formed late in the season.
- xii. The various layers that form the bark are epidermis, complimentary cells, cork cambium and secondary cortex.



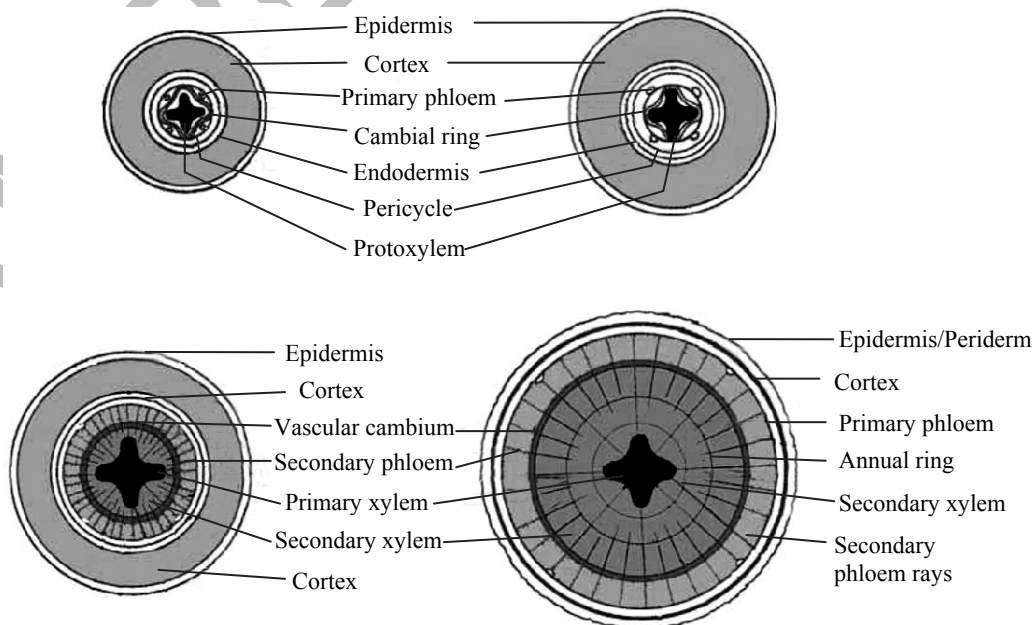
Cork Cambium

- xiii. **Lenticels:**
 - a. Lenticels are lens-shaped openings on epidermis, through which gaseous exchange takes place.
 - b. At certain regions, the cork cambium cuts off loosely arranged parenchymatous cells, which then rupture the epidermis and forms openings called lenticels.

Functions: Permits exchange of gases between outer atmosphere and internal tissue of stem.

➤ **Secondary Growth in Roots:**

- i. The vascular cambium in dicot roots is secondary in origin.
- ii. The growth is initiated by cells which regain their ability to divide (become meristematic).
- iii. These are the cells formed from the tissues located just below the phloem bundles, a portion of pericycle located above the protoxylem forming a wavy ring which later becomes circular.
- iv. The inner layer of the pericycle cells becomes the vascular cambium and the outer layer is retained (as pericycle).
- v. The vascular cambium forms continuous ring around the primary xylem.
- vi. The strips of meristematic cells join to form a cambial ring.
- vii. Secondary growth is seen in roots and stems of gymnosperms but is absent in monocot.



Different stages of the secondary growth in a typical dicot root



Plant tissues

Meristematic tissue

Have the power of cell division.

i. Classification based on origin:

- a. Promeristem
- b. Primary
- c. Secondary

ii. Classification based on position:

- a. Apical
- b. Intercalary
- c. Lateral

iii. Classification based on function:

- a. Protoderm
- b. Procambium
- c. Ground meristem

Permanent tissue
Has lost the power of cell division

Simple

Made up of similar type of cells

- i. Parenchyma
- ii. Collenchyma
- iii. Sclerenchyma
 - a. Fibres
 - b. Sclereids

Complex

Made up of different types of cells

- i. Xylem (transport water and minerals)
 - a. Tracheids
 - b. Vessels
 - c. Xylem sclerenchyma
 - d. Xylem parenchyma
- ii. Phloem (transport food)
 - a. Sieve elements
 - b. Companion cells
 - c. Phloem parenchyma
 - d. Phloem fibres

Types of Vascular Bundles

Radial

Xylem and phloem are present alternate with each other.

Conjoint

Xylem and phloem both are present at the same radius of vascular bundles

Collateral

Xylem towards innerside, Phloem towards periphery.

Bicollateral

Phloem is present on both the sides of xylem. Cambium present. e.g. *Cucurbita*

Concentric

One vascular tissue is surrounded by other vascular tissue.

Open

Cambium is present e.g. Dicot stem

Closed

Cambium is absent e.g. Monocot stem

	Dicot Root	Monocot Root
Epidermis	Single cell layer; cuticle absent	Single cell layer; cuticle absent
Cortex	Consist of several layers of thin walled parenchymatous cells with intercellular spaces.	Consist of several layers of thin walled parenchymatous cells with intercellular spaces.
Endodermis	Present with prominent casparian strips.	Casparian strips seen only in young roots
Secondary Growth	Pericycle produces lateral roots and vascular cambium.	Secondary growth absent (produces lateral roots only).
Pith	Absent (if present very small)	present (large and well developed)
Xylem bundles	Vary from 2 to 4	More than 6
Cambium	Present	Absent



	Dicot Stem	Monocot Stem
Epidermis	Single layered with cuticle.	Absent
Hypodermis	Made up of Collenchymatous cells	Made up of Sclerenchymatous cells
Vascular bundles	Arranged in ring, conjoint, open with endarch protoxylem	Vascular bundles are scattered, conjoint and closed.
Phloem parenchyma	Present	Absent
Secondary Growth	Present	Absent
Medullary rays	Layers of parenchymatous cells placed between the vascular bundles	Absent
Pith	Present (large number of rounded parenchymatous cells with intercellular spaces)	Absent

	Dorsiventral leaf	Isobilateral leaf
Type of plant	Dicotyledons	Monocotyledons
Presence of stomata	More on lower surface, generally few or absent on upper surface	Equally distributed on both the surfaces.
Presence of spongy and palisade tissue	Mesophyll cells well differentiated into spongy and palisade.	Mesophyll cells are not differentiated.
Bulliform cells	Absent	Present (e.g. Specially in grasses)

Multiple Choice Questions

6.1 The Tissues

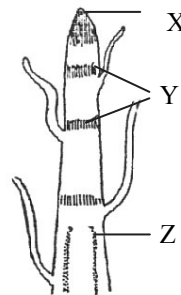
- The branch of biology which deals with the study of internal structure of plants is called
(A) Anatomy (B) Histology
(C) Cytology (D) Morphology
- Select the correct option for the following statement:
Plants have cells as the basic unit, cells are organised into (X) which in turn are organised into (Y).

	X	Y
(A)	Organs	Tissues
(B)	Tissues	Organs
(C)	Buds	Tissues
(D)	Organs system	Organs

- Apical meristem, intercalary meristem and lateral meristem are differentiated on the basis of
(A) development (B) position
(C) function (D) origin
- Assertion:** Apical and lateral meristem are called primary meristems.
Reason: Primary meristems appear late in plant life and help in maturation of plant body.
(A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.

5.

- (C) Assertion is true but reason is false.
(D) Both assertion and reason are false.



The given figure represents the positions of meristems in stem. Select the correct option to label X, Y and Z in the given figure.

- (A) X = Intercalary meristem
Y = Lateral meristem
Z = Apical meristem
- (B) X = Apical meristem
Y = Intercalary meristem
Z = Lateral meristem
- (C) X = Lateral meristem
Y = Apical meristem
Z = Intercalary meristem
- (D) X = Intercalary meristem
Y = Apical meristem
Z = Lateral meristem
- The growth of the roots and stems in length with the help of apical meristem is called
(A) Primary growth
(B) Lateral growth
(C) Secondary growth
(D) Intercalary growth



7. The transition of young plant to a fully grown tree is marked with increase in girth of the plant. This phenomenon is known as
 (A) primary growth
 (B) intercalary growth
 (C) secondary growth
 (D) none of these
8. Following are some statements about primary tissues. Select the INCORRECT option.
 (A) Primary tissues are produced by the apical meristem.
 (B) They are responsible for primary growth in plants.
 (C) They arise from primary meristem and occupy the tip.
 (D) The activity of primary tissue results in increase in girth of plant.
9. Both apical and intercalary meristems are _____ meristems.
 (A) primary (B) secondary
 (C) tertiary (D) mixed type
10. **Assertion:** Grasses (*Cynodon dactylon*) used for lawn need to be trimmed frequently.
Reason: Grasses show presence of intercalary meristem which helps them to elongate rapidly.
 (A) Both assertion and reason are true and reason is the correct explanation of assertion.
 (B) Both assertion and reason are true but reason is not the correct explanation of assertion.
 (C) Assertion is true but reason is false.
 (D) Both assertion and reason are false.
11. Lateral meristem is also called as _____ meristem.
 (A) intercalary (B) apical
 (C) secondary (D) permanent
12. Which of the following statements about lateral meristem is incorrect?
 (A) Occurs in the mature regions of roots and shoots.
 (B) They are cylindrical meristems, which increases the diameter of the plant organs.
 (C) Responsible for producing primary tissues.
 (D) Fascicular vascular cambium, interfascicular cambium and cork-cambium are examples of lateral meristem.
13. Example/s of secondary meristem is/are
 (A) Cork-cambium
 (B) Intercalary cambium
 (C) Epidermis
 (D) Both (A) and (B)
14. The apical meristem of the root is present
 (A) only in tap roots
 (B) only in adventitious roots
 (C) only in radicles
 (D) in all the roots
15. Vascular cambium and cork cambium are examples of _____
 [CBSE PMT 1990, AIIMS 1999; J & K CET 2002]
 (A) Lateral meristem
 (B) Apical meristem
 (C) Elements of xylem and phloem
 (D) Intercalary meristem
16. Which meristem helps in increasing girth?
 [AFMC 1994; RPMT 2002]
 (A) Lateral meristem
 (B) Intercalary meristem
 (C) Primary meristem
 (D) Apical meristem
17. Stem of grasses and related plants elongate by the activity of
 (A) lateral meristem
 (B) apical meristem
 (C) both apical and intercalary meristem
 (D) intercalary meristem
18. In some plants like sugarcane, length of internode is variable due to activity of
 (A) intercalary meristem
 (B) shoot apical meristem
 (C) position of axillary buds
 (D) size of lamina of lower node
19. The cells or tissues of plants which have lost the power of division are called
 (A) permanent tissue
 (B) temporary tissue
 (C) meristematic tissue
 (D) primary tissue
20. Parenchyma is _____
 [CPMT 1986]
 (A) a fundamental tissue physiologically and morphologically
 (B) a fundamental tissue phylogenetically
 (C) progenitor of all specialised tissue
 (D) all of the above
21. Which of the following are simple tissues?
 [CPMT 2000]
 (A) Parenchyma, xylem and phloem
 (B) Parenchyma, collenchyma and sclerenchyma
 (C) Parenchyma, xylem and collenchyma
 (D) Parenchyma, xylem and sclerenchyma
22. **Assertion:** Sclerenchyma is a simple and dead tissue.
Reason: Sclerenchyma tissue is made of only one type of cells which lack protoplast.
 (A) Both assertion and reason are true and reason is the correct explanation of assertion.
 (B) Both assertion and reason are true but reason is not the correct explanation of assertion.
 (C) Assertion is true but reason is false.
 (D) Both assertion and reason are false.




23. Which of the following information about parenchyma is INCORRECT?
- (A) Cells of parenchyma are generally isodiametric.
(B) Cell walls are thin and made up of cellulose.
(C) Found in parts of plants such as pulp of fruit, fruit walls of nuts, etc.
(D) Cells may have small intercellular spaces.
24. Which of the following information about collenchyma is incorrect?
- (A) Simple, living mechanical tissue.
(B) Cells thickened at the corners due to deposition of cellulose, hemicellulose and pectin.
(C) Intercellular spaces are absent.
(D) Perform function of secretion and storage of food.
25. Collenchyma differs from sclerenchyma in [CPMT 1980]
- (A) retaining protoplasm at maturity
(B) having thick walls
(C) having wide lumen
(D) being meristematic
26. Cell walls of collenchymatous cells are thickened at the corners due to deposition of
- (A) cellulose (B) hemicellulose
(C) pectin (D) all of the above
27. _____ provides mechanical support to growing parts of plants such as young stem and petiole of leaf.
- (A) sclerenchyma (B) parenchyma
(C) collenchyma (D) sclereids
28. In which of the following simple tissues, the cell wall is thick, lignified and has pits?
- (A) Sclerenchyma
(B) Collenchyma
(C) Parenchyma
(D) Both (B) and (C)
29. Read the following statements regarding sclerenchyma cells and select the INCORRECT option.
- (A) Intercellular spaces are small or absent.
(B) Posses hard, thick, secondary lignified wall.
(C) Cells are alive in the beginning and have protoplast but, later become dead.
(D) Some of the cells of sclerenchyma contain chloroplast.
30. Which of the following show presence of sclereids?
- (A) Fruit walls of nuts
(B) Grit of guava and pear
(C) Seed coats of legumes
(D) All of these

31. Match the Column I with Column II and select the correct option.

	Column I (simple tissues)		Column II (cell wall deposition)
a.	Parenchyma	i.	Cellulose, hemicellulose, pectin
b.	Sclerenchyma	ii.	Cellulose only
c.	Collenchyma	iii.	Lignin

- (A) a-i, b-ii, c-iii (B) a-iii, b-i, c-ii
(C) a-iii, b-ii, c-i (D) a-ii, b-iii, c-i
32. Which of the function is common to both collenchyma and parenchyma?
- (A) Absorption of water
(B) Photosynthesis
(C) Mechanical support
(D) Secretion
33. Which of the following tissue is responsible for conducting water and minerals from roots to the stem and leaves?
- (A) Phloem (B) Xylem
(C) Sclerenchyma (D) Sclereids
34. Out of the following, which is the dead tissue?
- (A) Meristematic tissue
(B) Xylem
(C) Phloem
(D) Parenchyma
35. Lignified cell wall is the characteristic feature of [MP PMT 1994]
- (A) Phloem cells
(B) Epidermal cells
(C) Cambial cells
(D) Xylem cells
36. A component of xylem is [MP PMT 1999]
- (A) sieve tube (B) medullary ray
(C) sclereids (D) tracheids
37. In Angiosperms, _____ and _____ are main water transporting elements.
- (A) tracheids, vessels
(B) vessels, xylem fibres
(C) xylem fibres, xylem parenchyma
(D) tracheids, xylem parenchyma
38. Complete the given analogy by selecting the correct option.
Tracheids and vessels : Dead tissue :: _____ : Living tissue
- (A) Xylem fibres
(B) Xylem parenchyma
(C) Sclerenchyma
(D) Both (A) and (B)



39. Which of the following components of xylem is devoid of protoplasm?
 (A) Tracheids
 (B) Vessels
 (C) Sieve tube elements
 (D) Both (A) and (B)
40. Certain unligified areas of tracheids are called as
 (A) pits (B) cork
 (C) cortex (D) none of these
41. Identify the given figure.
 (A) Xylem vessel
 (B) Xylem tracheid
 (C) Sieve tube element
 (D) Companion cell
- 
42. Porous wood is the characteristic feature of angiosperm. Which of the following accounts for wood porosity?
 (A) Xylem tracheids
 (B) Xylem vessels
 (C) Sieve tube elements
 (D) Companion cells
43. Xylem vessels are absent in gymnosperms and pteridophytes, thus the wood is
 (A) porous
 (B) pitted
 (C) non-porous
 (D) both (A) and (B)
44. Tracheids differ from other tracheary elements in [AIPMT 2014]
 (A) having casparian strips
 (B) being imperforate
 (C) lacking nucleus
 (D) being lignified
45. In plants, _____ brings about the lateral conduction of water.
 (A) phloem
 (B) ray parenchymatous cells
 (C) parenchyma
 (D) sclerenchyma
46. Which of the following is NOT true?
 (A) In plants, conductive function is performed by xylem and phloem.
 (B) Tracheids possess protoplasm, whereas vessel cells are devoid of protoplasm.
 (C) Xylem fibres may either be septate or aseptate.
 (D) The primary xylem elements which are formed first are called protoxylem.
47. In the xylem of stems, protoxylem lies
 (A) towards periphery
 (B) towards pith
 (C) in the centre of pith
 (D) outside of metaxylem

48. In roots,
 (A) endarch condition of xylem is seen.
 (B) protoxylem lies towards periphery.
 (C) metaxylem lies towards periphery.
 (D) both (A) and (B)
49. In root, xylem is [CBSE PMT 1990]
 (A) mesarch
 (B) exarch
 (C) placed at different places in different plants
 (D) endarch
50. Which of the following elements has its end walls perforated? [AIEEE 2004]
 (A) Tracheid (B) Vessel
 (C) Fiber (D) Sclereids
51. In 'X' protoxylem lies towards the centre and metaxylem lies towards the periphery. Such arrangement of primary xylem is called 'Y'. Identify 'X' and 'Y' and select the correct option.

	'X'	'Y'
(A)	Stems	Endarch
(B)	Roots	Endarch
(C)	Stem	Exarch
(D)	Roots	Exarch

52. **Assertion:** Sieve tubes and companion cells are absent in angiosperms.
Reason: In flowering plants, sieve tubes help in conduction of water and minerals.
 (A) Both assertion and reason are true and reason is the correct explanation of assertion.
 (B) Both assertion and reason are true but reason is not the correct explanation of assertion.
 (C) Assertion is true but reason is false.
 (D) Both assertion and reason are false.
53. A mature sieve tube differs from vessel in [DPMT 1982]
 (A) being nearly dead
 (B) lacking cytoplasm
 (C) lacking a functional nucleus
 (D) absence of lignified walls
54. Companion cells are usually seen associated with [CPMT 1972, 84, 85; MP PMT 1988, 2000]
 (A) fibres (B) vessels
 (C) tracheids (D) sieve tubes
55. Sieve tubes are better suited for translocation, because [CBSE PMT 1989]
 (A) they possess broader lumen and perforated cross walls
 (B) they are broader than long
 (C) possess bordered pits
 (D) possess no end walls



56. Which of the following can be used to distinguish sieve tubes from companion cells?
(A) Being shorter
(B) Being dead
(C) Lacking nuclei
(D) Having sieve plates
57. The chief function of sieve tubes is
[DPMT 1990]
(A) to translocate the organic materials manufactured in the leaves
(B) to conduct minerals
(C) to transport water from roots to leaves
(D) to help the plant in forming wood
58. Which of the following controls the functions of sieve tubes?
(A) Tracheids (B) Vessels
(C) Companion cells (D) Xylem fibres
59. Sieve tube elements, companion cells, phloem parenchyma and bast fibres are all present in
(A) angiosperms (B) gymnosperms
(C) monocotyledons (D) both (B) and (C)
60. **Assertion:** Phloem fibres of jute, flax and hemp are used commercially.
Reason: Phloem fibres have elongated cells, with thick cell wall and thus they provide strength and rigidity to plant organs.
(A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is correct while reason is incorrect.
(D) Both assertion and reason are incorrect.
61. Read the following statements and select the correct option.
i. Phloem fibres are used commercially.
ii. Phloem parenchyma is absent in most monocots.
iii. Sieve tube elements lose protoplasm at maturity and control the functions of companion cells.
(A) i, ii and iii are true
(B) i and ii are true
(C) i and iii are true
(D) ii and iii are true
62. All the given statements about phloem are true, except
(A) the first formed primary phloem having narrow sieve tubes are called as protophloem.
(B) metaphloem and metaxylem perform the same function of conducting water and minerals.
(C) phloem fibres are also called as bast fibres which are made up of parenchymatous cells.
(D) the phloem parenchyma stores food, resins, latex and mucilage.
63. Which of the following are the characteristic features of phloem?
i. Gymnosperms have albuminous cells and sieve cells
ii. Presence of tracheids
iii. They store food materials in the form of starch or fat.
iv. They have sieve tube elements that are long, tube-like structures
v. Their end walls are perforated in a sieve like manner
The correct combination is
[TS EAMCET 2018]
(A) ii, iii, iv and i (B) ii, iii and i
(C) i, iv and v (D) v, ii, iv and ii
64. Read the following statements and select the correct ones.
i. Tracheids are absent in flowering plants.
ii. Vessels are commonly found in xylem of gymnosperms.
iii. Gymnosperm lack sieve tubes and companion cells.
iv. Vessels are characteristic feature of angiosperms.
(A) i and ii (B) iii and iv
(C) i and iv (D) ii and iii

6.2 The Tissue System

65. _____ tissue system forms the outermost covering of the whole plant body.
(A) Epidermal (B) Ground
(C) Vascular (D) Complex
66. Epidermal outgrowths are known as
[DPMT 1976; JIPMER 1983, 88]
(A) Stomata (B) Leaves
(C) Trichomes (D) flower buds
67. **Assertion:** Root hairs are unicellular elongations of epidermal cells that absorb water and minerals.
Reason: Epidermal cells are often modified to perform specialized functions in plants.
(A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is true but reason is false.
(D) Both assertion and reason are false.



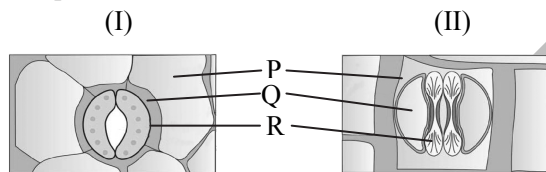
68. Which of the following is NOT a part of epidermal tissue system?
 (A) Companion cells (B) Trichomes
 (C) Root hairs (D) Guard cells
69. The epidermal hairs on stem are called _____, while on roots are called _____.
 (A) stomata, root hairs
 (B) trichomes, root hairs
 (C) bast fibres, trichomes
 (D) tracheids, root hairs
70. Epidermal cells are _____ in nature.
 (A) sclerenchymatous
 (B) parenchymatous
 (C) collenchymatous
 (D) none of these
71. Epiblema of roots is equivalent to _____
 (A) pericycle (B) endodermis
 (C) epidermis (D) stele
72. Read the statement given below about 'epidermal cells' and select the correct option for 'X' and 'Y'. Outer side of epidermis is covered with a waxy thick layer called 'X'. 'X' is absent in 'Y'.

	'X'	'Y'
(A)	Cuticle	Roots
(B)	Trichome	Roots
(C)	Trichome	Stem
(D)	Root hairs	Stem

73. The outer walls of guard cells (away from stomatal pore) are _____ and the inner walls (towards the stomatal pore) are highly _____.
 (A) thin, thickened
 (B) thin, opaque
 (C) thick, transparent
 (D) thick, thin
74. X, Y and Z are together called the stomatal apparatus. Select the correct option to identify X, Y and Z.

	X	Y	Z
(A)	Stomatal aperture	Guard cells	Subsidiary Cells
(B)	Epidermal cells	Guard cells	Subsidiary Cells
(C)	Epidermal cells	Stomatal aperture	Guard Cells
(D)	Epidermal cells	Stomatal aperture	Subsidiary Cells

75. Given figures I and II represent the stomatal apparatus of dicot and monocot leaves respectively. Select the option that correctly represents P, Q and R.



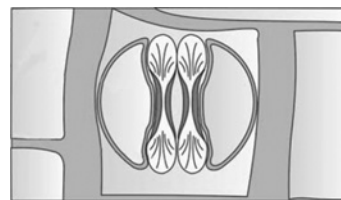
	P	Q	R
(A)	Epidermal cells	Subsidiary cells	Guard cells
(B)	Epidermal cells	Guard cells	Chloroplast
(C)	Guard cells	Epidermal cells	Chloroplast
(D)	Guard cells	Chloroplast	Subsidiary Cells

76. Match the terms in Column I with their description in Column II and select the correct option.

	Column I		Column II
a.	Subsidiary cells	i.	specialised epidermal cells on root.
b.	Guard cells	ii.	regulate opening and closing of stomata
c.	Trichomes	iii.	specialised epidermal cells on stem
d.	Root hairs	iv.	specialised epidermal cells on leaves

- (A) a – iv, b – iii, c – ii, d – i
 (B) a – i, b – ii, c – iv, d – iii
 (C) a – ii, b – i, c – v, d – iii
 (D) a – iv, b – ii, c – iii, d – i

77. Given in the figure below is a type of guard cells. Identify the plants (from list i-vi) which possess the given type of guard cells in their leaves.



- i. Banana ii. Water lily
 iii. Lilies iv. Grass
 v. Tomato vi. Brinjal
 (A) ii, v and vi (B) i, iii and iv
 (C) ii and iii (D) iv only



78. Which of the following statement about trichomes is false?
(A) Trichomes may be branched or unbranched.
(B) On the root, the epidermal hairs are called as trichomes.
(C) Trichomes may even be secretory.
(D) Trichomes help in preventing water loss due to transpiration.

79. _____ tissue system consists of simple tissues such as parenchyma, collenchyma and sclerenchyma.

- (A) Ground (B) Epidermal
(C) Vascular (D) None of these

80. In leaves, the ground tissue consists of thin-walled, chloroplast containing cells and is called
(A) Subsidiary cells (B) Mesophyll
(C) pith (D) cortex

81. All tissues except, the _____ and vascular bundles make up the ground tissue.

- (A) epidermis (B) cortex
(C) mesophyll (D) pith

82. Complete the given analogy by selecting the correct option.

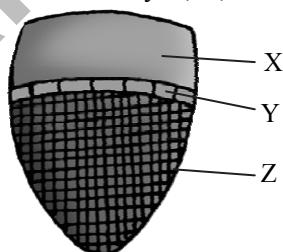
In vascular bundle, Xylem and phloem are in alternate manner on different radii : Radial :: Xylem and phloem are situated at the same radius : _____

- (A) closed (B) open
(C) conjoint (D) adjacent

83. Vascular bundles in monocotyledons are considered closed because [AIPMT 2015]

- (A) Cambium is absent.
(B) There are no vessels with perforations.
(C) Xylem is surrounded all around by phloem.
(D) A bundle sheath surrounds each vascular bundle.

84. Given below is the diagrammatic representation of conjoint open type of vascular bundle. Identify X, Y, Z.



- (A) X = Xylem, Y = Pericycle, Z = Pith
(B) X = Phloem, Y = Cambium, Z = Xylem
(C) X = Xylem, Y = Cambium, Z = Phloem
(D) X = Cortex, Y = Endodermis, Z = Phloem

85. In which type of vascular bundles are Xylem and Phloem present at the same radius?

[KCET 2018]

- (A) Radial (B) Closed
(C) Conjoint (D) Exarch

86. Identify the correct correlation.

- (A) In dicotyledons → cambium present → closed vascular bundles
(B) In monocotyledons → cambium absent → open vascular bundles
(C) In dicotyledons → cambium present → open vascular bundles
(D) In monocotyledons → cambium present → closed vascular bundles

87. For a vascular bundle to be open, what is the prime requisite?

- (A) Presence of xylem
(B) Presence of phloem
(C) Presence of cambium
(D) Both (A) and (B)

88. In which vascular bundle, cambium is present between phloem and xylem?

- (A) Open (B) Closed
(C) Exarch (D) Endarch

6.3 Anatomy of Dicotyledonous and Monocotyledonous Plants

89. Layer of cells between endodermis and vascular bundles is called [AMU 1983, 89]

- (A) epidermis (B) pericycle
(C) hypodermis (D) pith

90. Casparian strips occur in [NEET (UG) 2018]

- (A) Cortex (B) Pericycle
(C) Epidermis (D) Endodermis

91. In plants, lateral roots arise from

[KCET 2016]

- (A) endodermis (B) epidermis
(C) pericycle (D) hypodermis

92. The arrangement of cells / tissue from outside to inside, in a transverse section (T.S) of a dicot root is

- (A) Epidermis → Cortex → Endodermis → Pericycle → Pith
(B) Epidermis → Endodermis → Cortex → Pericycle → Vascular bundle → Pith
(C) Epidermis → Cortex → Hypodermis → Pericycle
(D) Epidermis → Cortex → Pericycle → Endodermis

93. Cortex is the region found between

[NEET P-II 2016]

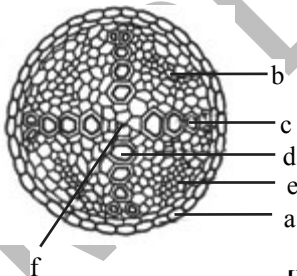
- (A) endodermis and vascular bundle
(B) epidermis and stele
(C) pericycle and endodermis
(D) endodermis and pith



94. Initiation of lateral roots and vascular cambium during secondary growth takes place in cells of
 (A) pericycle (B) cortex
 (C) vascular bundle (D) pith
95. Root of pea plant differs from root of maize in having
 (A) well developed pith
 (B) radial vascular bundle
 (C) open vascular bundle
 (D) presence of endodermis
96. Match the Column I with Column II and select the correct option.

Column I		Column II	
a.	Stele	i.	Innermost layer of cortex
b.	Endodermis	ii.	Suberin
c.	Casparian strips	iii.	All the tissues on the inner side of endodermis
d.	Bark	iv.	All the tissues on the outer side of vascular cambium
		v.	Outermost layer of cortex

- (A) a – iii, b – i, c – ii, d – iv
 (B) a – i, b – v, c – iii, d – ii
 (C) a – i, b – ii, c – iii, d – iv
 (D) a – iv, b – v, c – ii, d – iii
97. Which of the following is composed of single layer of barrel-shaped cells in a dicot root?
 (A) Pith (B) Cortex
 (C) Endodermis (D) Pericycle
98. In the diagram of T.S. of stele of dicot root, the different parts have been indicated by the alphabets. Choose the correct combination.



- [KCET 2005]
- (A) a – Pericycle, b – Conjunctive tissue, c – Metaxylem, d – Protoxylem, e – Phloem, f – Pith
 (B) a – Endodermis, b – Conjunctive tissue, c – Protoxylem, d – Metaxylem, e – Phloem, f – Pith
 (C) a – Endodermis, b – Conjunctive tissue, c – Metaxylem, d – Protoxylem, e – Phloem, f – Pith
 (D) a – Endodermis, b – Pith, c – Protoxylem, d – Metaxylem, e – Phloem, f – Conjunctive tissue

99. A major characteristic of the monocot root is the presence of [AIPMT 2015]
 (A) scattered vascular bundles
 (B) vasculature without cambium
 (C) cambium sandwiched between phloem and xylem along the radius
 (D) open vascular bundles
100. Cortex in the monocot root is formed of
 (A) parenchymatous cells
 (B) collenchymatous cells
 (C) sclerenchymatous cells
 (D) companion cells
101. Summarize the differences between a dicot and monocot root from the following table and pick up the wrong differences.

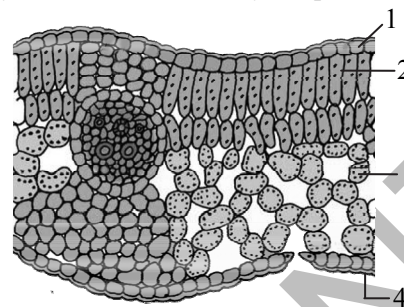
	Characters	Dicot root	Monocot root
i.	Activity of pericycle	Lateral root production	Secondary growth and cambium
ii.	Vascular bundle	Diarch to Tetrarch	Polyarch
iii.	Cambium	Lateral developed	Absent
iv.	Pith	Well developed	Poorly developed

- [EAMCET 2016]
- (A) ii, iv (B) i, iii
 (C) i, iv (D) i, ii
102. Hypodermis is _____ in dicot stem and _____ in monocot stem.
 (A) collenchymatous, sclerenchymatous
 (B) sclerenchymatous, collenchymatous
 (C) collenchymatous, parenchymatous
 (D) parenchymatous, collenchymatous
103. Which of the following best describes the vascular bundles in a dicot stem?
 (A) numerous scattered
 (B) arranged in a ring
 (C) without cambium
 (D) surrounded by bundle sheath
104. Which of the following is not a characteristic of monocot stem?
 (A) Conjoint and closed vascular bundles
 (B) A large number of scattered vascular bundles
 (C) Presence of phloem parenchyma
 (D) Presence of water containing cavities in the vascular bundles
105. A conjoint and open vascular bundle will be observed in the transverse section of [NCERT Exemplar]
 (A) monocot root (B) monocot stem
 (C) dicot root (D) dicot stem



106. Cortex and pith are not distinguished in
(A) dicot stem (B) monocot stem
(C) dicot root (D) monocot root
107. Well developed pith is found in [BHU 1980]
(A) monocot stem and dicot root
(B) monocot and dicot stems
(C) dicot stem and dicot root
(D) dicot stem and monocot root
108. What do the semi-lunar patches of sclerenchyma cells form in a dicot stem?
(A) Hypodermis (B) Endodermis
(C) Pericycle (D) Pith
109. Which of the following is a characteristic feature of only monocot stem and not dicot stem?
(A) Presence of conspicuous ground tissue.
(B) Vascular bundles arranged in ring.
(C) Medullary rays made up of radially placed parenchymatous cells.
(D) All of the above
110. In a dicot stem, cells of _____ are rich in starch grains.
(A) Endodermis (B) Hypodermis
(C) Epidermis (D) Pericycle
111. Pith in dicot stem is made up of _____ cells.
(A) rounded, parenchymatous
(B) rounded, collenchymatous
(C) polygonal, parenchymatous
(D) polygonal, sclerenchymatous
112. In a dicotyledonous leaf, palisade parenchyma is located at _____ surface and _____ surface shows more number of stomata.
(A) adaxial, abaxial (B) abaxial, adaxial
(C) abaxial, abaxial (D) adaxial, adaxial
113. Read the following given statements carefully, regarding the anatomy of dorsiventral leaf.
- Stomata are present on both the surfaces of the epidermis.
 - Some abaxial epidermal cells show presence of bulliform cells.
 - Vascular bundles are surrounded by a layer of bundle sheath cells.
 - Mesophyll is not differentiated into spongy and palisade cells.
- Which of the above statement/s is/are correct?
(A) i and iv (B) ii and iv
(C) only iii (D) none
114. Stomata are distributed more on the abaxial surface than on the adaxial surface in
(A) dorsiventral leaf
(B) isobilateral leaf
(C) monocotyledonous leaf
(D) both (B) and (C)

115. In the given transverse section of a dicotyledonous leaf, identify the parts labelled.



	1	2	3	4
(A)	Abaxial epidermis	Mesophyll cells	Vascular bundles	Stomata
(B)	Abaxial epidermis	Palisade	Adaxial tissue	Cuticle
(C)	Adaxial epidermis	Spongy	Palisade	Abaxial epidermis
(D)	Adaxial epidermis	Palisade	Spongy	Abaxial epidermis

116. Which of the statement regarding Monocot leaf is NOT true?
(A) Monocot leaf shows parallel venation.
(B) It shows presence of bulliform cells, modified from epidermal cells.
(C) Mesophyll is well differentiated into spongy and palisade.
(D) It shows stomata on both the surfaces.
117. Read carefully the statements given below
- Trichomes present
 - Pith present
 - Collenchymatous hypodermis
 - Vascular bundles arranged in a ring.
 - Conjoint, open vascular bundle.
- Based on the information given above, identify the plant part.
(A) Dicot stem (B) Dicot root
(C) Monocot root (D) Monocot stem

6.4 Secondary Growth

118. Growth rings (annual rings) are formed by activity of [AFMC 1984, 85, 86, 90]
(A) Cambium
(B) Xylem
(C) Phloem
(D) Both xylem and phloem
119. The increase in width of a plant or its girth is called
(A) primary growth
(B) secondary growth
(C) determinate growth
(D) none of these



120. Which would do maximum harm to a tree?
[CPMT 1984]
- (A) The loss of half of its branches
(B) The loss of all of its leaves
(C) The loss of half of its flowers
(D) The loss of its bark
121. In dicot stems, cambium present between the primary xylem and primary phloem is
- (A) Fascicular cambium
(B) Intrafascicular cambium
(C) Interfascicular cambium
(D) Both (B) and (C)
122. **Assertion:** Monocots and some herbaceous plants show only primary growth.
Reason: Monocots show closed type of vascular bundles, thus do not show normal secondary growth.
- (A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is true but reason is false.
(D) Both assertion and reason are false.
123. During secondary growth, the cambium cuts off more actively towards the
- (A) innerside (B) outside
(C) center (D) Both (A) and (B)
124. Initiation of lateral roots and vascular cambium during the secondary growth takes place in
[TS EAMCET 2017]
- (A) cortex (B) endodermis
(C) epidermis (D) pericycle
125. **Assertion:** The amount of secondary xylem produced is more than secondary phloem.
Reason: The cambium is generally more active towards pith and cuts off cells.
- (A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is true but reason is false.
(D) Both assertion and reason are false.
126. Interfascicular cambium develops from the cells of
[NEET 2013]
- (A) Medullary rays
(B) Xylem parenchyma
(C) Endodermis
(D) Pericycle
127. Vascular cambium is a meristematic layer that gives rise to
- (A) Primary xylem and primary phloem
(B) Primary xylem and secondary phloem

- (C) Secondary xylem and primary phloem
(D) Secondary xylem and secondary phloem
128. The vascular cambium normally gives rise to
[NEET (UG) 2017]
- (A) Phelloderm
(B) Primary phloem
(C) Secondary xylem
(D) Periderm
129. Secondary xylem and phloem in dicot stem are produced by
[NEET (UG) 2018]
- (A) phellogen
(B) vascular cambium
(C) apical meristems
(D) axillary meristems
130. _____ remains more or less intact during secondary growth.
- (A) Primary xylem
(B) Primary phloem
(C) Secondary xylem
(D) Secondary phloem
131. As compared to spring wood, autumn wood has
- (A) more xylary elements that have vessels with narrow cavities.
(B) more xylary elements that have vessels with wide cavities.
(C) few xylary elements that have vessels with wide cavities.
(D) few xylary elements that have narrow vessels with narrow cavities.
132. In old trees, central dark coloured, non-conducting part of secondary xylem is referred to as
- (A) Heartwood (B) Early wood
(C) Sapwood (D) Late wood
133. In old trees, the peripheral region of the secondary xylem which is lighter in colour and conducts water and minerals, is called
- (A) heartwood (B) early wood
(C) hardwood (D) sapwood
134. Match the Column I with Column II and select the correct option.

	Column I		Column II
a.	The wood formed during winter season.	i.	Heart wood
b.	The region of wood which is durable and resistant to attack of micro-organisms and insects.	ii.	Early wood
c.	The wood formed during spring season	iii.	Sapwood
d.	The part of wood which is involved in conduction of water and minerals.	iv.	Autumn wood

- (A) a-i, b-iii, c-ii, d-iv
(B) a-iv, b-i, c-iii, d-ii
(C) a-ii, b-i, c-iv, d-iii
(D) a-iv, b-i, c-ii, d-iii



135. **Assertion:** The central or innermost layer of the stem in old trees is dark brown, hard and durable.
Reason: The central or innermost layer of stem in old trees contains deposition of organic compounds like tannins, resins, oils and gums.
(A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is true but reason is false.
(D) Both assertion and reason are false.
136. Identify the correctly matched pair.
i. Hard bark: Formed early during the season
ii. Heart wood: Dark brown due to tannins
iii. Soft bark: Formed late during the season
(A) All i, ii, iii (B) only i and iii
(C) only ii (D) only i and ii
137. Age of a tree can be estimated by
[NEET 2013]
(A) its height and girth
(B) biomass
(C) number of annual rings
(D) diameter of its heartwood
138. Identify the wrong statement in context of Heartwood.
[NEET (UG) 2017]
(A) Organic compounds are deposited in it.
(B) It is highly durable.
(C) It conducts water and minerals efficiently.
(D) It comprises dead elements with highly lignified walls.
139. Which of the following options correctly shows the sequence of cells of periderm? (Starting from periphery to the interior)
(A) Phellem → Phelloderm → Phellogen
(B) Phellogen → Phellem → Phelloderm
(C) Phelloderm → Phellogen → Phellem
(D) Phellem → Phellogen → Phelloderm
140. Which of the following is made up of dead cells?
[NEET (UG) 2017]
(A) Xylem parenchyma
(B) Collenchyma
(C) Phellem
(D) Phloem
141. Phellogen and phellem respectively denote
[NCERT Exemplar]
(A) cork and cork cambium
(B) cork cambium and cork
(C) secondary cortex and cork
(D) cork and secondary cortex
142. **Assertion:** Phelloderm is non-living and impervious to water.
Reason: Cell wall of phelloderm shows deposition of suberin.
(A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is true but reason is false.
(D) Both assertion and reason are false.
143. Cork cambium cuts off cells on the inner side to form _____ and on the outside to form _____.
(A) secondary cortex, cork
(B) cork, secondary cortex
(C) phellogen, cork
(D) phellem, phelloderm
144. Bark is made up of
(A) secondary xylem only
(B) secondary phloem only
(C) secondary phloem and periderm
(D) periderm only
145. What is the fate of primary xylem in a dicot root showing extensive secondary growth?
[NCERT Exemplar]
(A) It is retained in the centre of the axis.
(B) It gets crushed.
(C) May or may not get crushed.
(D) It gets surrounded by primary phloem.
146. As the plant grows each year, the vascular cambium creates a new layer of secondary _____ on its inside and secondary _____ on its outside.
(A) xylem, phloem
(B) phloem, xylem
(C) phellogen, phloem
(D) phloem, phellogen
147. What makes cork impervious to water?
(A) Suberin (B) Calcium crystals
(C) Cuticle (D) Starch grains
148. Phellogen, phellem and phelloderm are collectively known as
(A) protoderm (B) promeristem
(C) periderm (D) pericycle



149. Which of the following statements about phellogen is true?
- It is also known as cork cambium.
 - It is the lateral meristematic tissue that produces cork from old secondary xylem.
 - Phellogen cuts off cells on the outer side into phelloderm and on the inner side into phellem.
 - At certain regions, the phellogen cuts off closely arranged cells on the outer side and these cells rupture epidermis forming lenticels.
- (A) ii and iii (B) i and iv
(C) i, ii and iii (D) i, ii and iv
150. **Assertion:** Lenticels are first formed by rupturing the epidermis.
Reason: Lenticels originate when phellogen cuts off loosely arranged parenchymatous cells on the outer side instead of cork cells.
- (A) Both assertion and reason are true and reason is the correct explanation of assertion.
(B) Both assertion and reason are true but reason is not the correct explanation of assertion.
(C) Assertion is true but reason is false.
(D) Both assertion and reason are false.
151. Find out the wrong statement from the following.
- (A) Lenticels do not allow the exchange of gases between the outer atmosphere and internal tissue of the stem.
(B) The heartwood does not conduct water but it gives mechanical support to the stem.
(C) Annual rings seen in a cut stem give an estimate of the age of the tree.
(D) Annual rings are prominently seen in trees of temperate regions.

Miscellaneous

152. Which of the following is a secondary meristem? **[CET Pune 1998]**
- (A) Phelloderm
(B) Primary cambium
(C) Cork cambium
(D) Promeristem
153. Which of the following is a meristematic tissue?
- (A) Epidermis (B) Cortex
(C) Hypodermis (D) Cambium
154. Function of storage is performed by **[BHU 1999]**
- (A) Parenchyma (B) Sclerenchyma
(C) Phloem (D) All the above

155. _____ is a simple, living mechanical tissue.
- (A) Sclerenchyma (B) Collenchyma
(C) Xylem tracheids (D) Phloem fibres
156. Trachea, tracheids, wood fibres and parenchyma tissues are found in **[BHU 1991; PMT 1992]**
- (A) Xylem (B) Phloem
(C) Cambium (D) Cortex
157. How many shoot apical meristems are likely to be present in a twig of a plant possessing, 4 branches and 26 leaves? **[NCERT Exemplar]**
- (A) 26 (B) 1 (C) 5 (D) 30
158. Read the following statements and select the correct ones. **[NEET 2013]**
- Phloem parenchyma is absent in most monocots
 - Gymnosperms lack tracheids and vessels.
 - Gymnosperms lack companion cells
- (A) i and ii (B) ii and iii
(C) i and iii (D) i, ii and iii
159. Which of the following is a permanent tissue?
- (A) cork cambium
(B) fascicular vascular cambium
(C) inter-fascicular cambium
(D) xylem
160. The terms 'Wood' and 'Bark' respectively refer to
- (A) xylem and phloem
(B) vascular cambium and cork cambium
(C) phloem and xylem
(D) cork and phloem
161. Which of the following lacks sieve tubes and companion cells?
- (A) Pines (B) Mango
(C) Banyan (D) Wheat
162. Select the mismatched pair.
- Guard cells – regulate opening and closing of stomata.
 - Root hairs – absorption of water from soil.
 - Trichomes – protect against grazing animals
- (A) i only (B) i and ii
(C) iii only (D) ii only
163. Three types of tissue systems have been observed in plants on the basis of their structure and location. Select the correct option regarding the information about tissue systems.
- (A) Epidermal tissue system consists of epidermis, trichomes and hairs.
(B) All tissues except epidermis and vascular bundles constitute ground tissue.
(C) Vascular tissue system consists of xylem and phloem.
(D) All of the above



164. Which one of the following has bast fibres?

[MH CET 2014]

- (A) Parenchyma (B) Sclerenchyma
(C) Phloem (D) Xylem

165. You are given a fairly old piece of dicot stem and a dicot root. Which of the following anatomical structures will you use to distinguish between the two? [AIPMT 2014]

- (A) Secondary xylem
(B) Secondary phloem
(C) Protoxylem
(D) Cortical cells

166. Secondary growth usually does not occur in

- (A) Stem and root of dicots
(B) Stem and root of gymnosperms
(C) Stem and root of monocots
(D) Both (A) and (B)

167. Plants having little or no secondary growth are

[NEET (UG) 2018]

- (A) Conifers
(B) Deciduous angiosperms
(C) Grasses
(D) Cycads

168. Which one of the following is NOT true about monocotyledonae?

- (A) Embryo has single cotyledon
(B) Leaves show parallel venation
(C) Flowers are generally trimerous
(D) Vascular bundles are conjoint, collateral and open

169. A piece of wood having no vessels (trachea) must be belonging to [NCERT Exemplar]

- (A) Teak (B) Mango
(C) Pine (D) Palm

170. Which of the following anatomical character helps you to identify a 'Gymnosperm'?

- (A) Presence of sieve cells, absence of companion cells and wood is non-porous.
(B) Presence of sieve cells and companion cells and wood is porous.
(C) Presence of companion cells, absence of sieve tubes and wood is porous.
(D) Presence of companion cells, absence of sieve tubes and wood is non-porous.

171. Match the following and choose the correct option from below. [NCERT Exemplar]

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

- (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

172. Cells of this tissue are living and show angular wall thickening. They also provide mechanical support. The tissue is [NCERT Exemplar]

- (A) xylem (B) sclerenchyma
(C) collenchymas (D) epidermis

173. In which of the following pairs of parts of a flowering plant is epidermis absent?

[NCERT Exemplar]

- (A) Root tip and shoot tip
(B) Shoot bud and floral bud
(C) Ovule and seed
(D) Petiole and pedicel

174. When we peel the skin of a potato tuber, we remove [NCERT Exemplar]

- (A) periderm
(B) epidermis
(C) cuticle
(D) sapwood

175. Identify the ODD term from the following based on presence or absence of nuclei at maturity.

- (A) Cambium cells
(B) Cells of pericycle
(C) Xylem parenchyma
(D) Sieve tubes

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

a.	Cuticle	i.	guard cells
b.	Bulliform cells	ii.	single layer
c.	Stomata	iii.	waxy layer
d.	Epidermis	iv.	empty colourless cell

[NCERT Exemplar]

- (A) a-iii, b-iv, c-i, d-ii
(B) a-i, b-ii, c-iii, d-iv
(C) a-iii, b-ii, c-iv, d-i
(D) a-iii, b-ii, c-i, d-iv

177. Specialised epidermal cells surrounding the guard cells are called [NEET P-I 2016]

- (A) Bulliform cells
(B) Lenticels
(C) Complementary cells
(D) Subsidiary cells

178. Conjunctive tissue is present between (i) and (ii) in (iii). [KCET 2018]

- (A) (i) Pericycle (ii) Endodermis (iii) Dicot root
(B) (i) Xylem (ii) Phloem (iii) Dicot root
(C) (i) Palisade parenchyma (ii) Spongy parenchyma (iii) Dicot leaf
(D) (i) Xylem (ii) Phloem (iii) Dicot stem



179. **Assertion:** Heartwood does not comprise dead element any lignified walls,
Reason: The peripheral region of the secondary Xylem is lighter in colour and is involved in the conduction of water and minerals from root to leaf.
[TS EAMCET 2017]
- (A) Both assertion and reason are true, reason is the connect explanation of assertion.
 (B) Bothe assertion and reason are true, but reason is not the correct explanation of assertion.

- (C) Assertion is true, but reason is false.
 (D) Assertion is false, but reason is true.
180. The secondary wall material suberin is deposited on the walls of **[KCET 2017]**
- (A) Pericycle of stem and endodermis of root
 (B) Phellem of stem and endodermis of root
 (C) Epidermis of stem and endodermis of root
 (D) Phellogen and phelloderm



Answers to MCQs

1. (A) 2. (B) 3. (B) 4. (D) 5. (B) 6. (A) 7. (C) 8. (D) 9. (A) 10. (A)
 11. (C) 12. (C) 13. (D) 14. (D) 15. (A) 16. (A) 17. (C) 18. (A) 19. (A) 20. (D)
 21. (B) 22. (A) 23. (C) 24. (D) 25. (A) 26. (D) 27. (C) 28. (A) 29. (D) 30. (D)
 31. (D) 32. (B) 33. (B) 34. (B) 35. (D) 36. (D) 37. (A) 38. (B) 39. (D) 40. (A)
 41. (A) 42. (B) 43. (C) 44. (B) 45. (B) 46. (B) 47. (B) 48. (B) 49. (B) 50. (B)
 51. (A) 52. (D) 53. (D) 54. (D) 55. (A) 56. (D) 57. (A) 58. (C) 59. (A) 60. (A)
 61. (B) 62. (B) 63. (C) 64. (B) 65. (A) 66. (C) 67. (A) 68. (A) 69. (B) 70. (B)
 71. (C) 72. (A) 73. (A) 74. (A) 75. (A) 76. (D) 77. (B) 78. (B) 79. (A) 80. (B)
 81. (A) 82. (C) 83. (A) 84. (B) 85. (C) 86. (C) 87. (C) 88. (A) 89. (B) 90. (D)
 91. (C) 92. (A) 93. (B) 94. (A) 95. (C) 96. (A) 97. (C) 98. (B) 99. (B) 100. (A)
 101. (C) 102. (A) 103. (B) 104. (C) 105. (D) 106. (B) 107. (D) 108. (C) 109. (A) 110. (A)
 111. (A) 112. (A) 113. (C) 114. (A) 115. (D) 116. (C) 117. (A) 118. (A) 119. (B) 120. (D)
 121. (B) 122. (A) 123. (D) 124. (D) 125. (A) 126. (A) 127. (D) 128. (C) 129. (B) 130. (A)
 131. (D) 132. (A) 133. (D) 134. (D) 135. (A) 136. (C) 137. (C) 138. (C) 139. (D) 140. (C)
 141. (B) 142. (D) 143. (A) 144. (C) 145. (A) 146. (A) 147. (A) 148. (C) 149. (B) 150. (A)
 151. (A) 152. (C) 153. (D) 154. (A) 155. (B) 156. (A) 157. (C) 158. (C) 159. (D) 160. (A)
 161. (A) 162. (C) 163. (D) 164. (C) 165. (C) 166. (C) 167. (C) 168. (D) 169. (C) 170. (A)
 171. (B) 172. (C) 173. (A) 174. (A) 175. (D) 176. (A) 177. (D) 178. (B) 179. (*) 180. (B)

Note: 179. (*) None of the options are correct.



Hints to MCQs

4. Both apical and intercalary meristem are primary meristems. Primary meristems appear early in life of a plant and contribute to form the primary plant body.
8. The primary tissues are responsible for longitudinal growth of the plant, while secondary tissues increase the girth of plant.
10. Presence of intercalary meristem between mature tissue elongates the plant organs.
12. Lateral meristems are responsible for producing secondary tissues.
19. Permanent tissues are made up of mature cells which have lost the capacity to divide and have attained a permanent shape, size and function, due to division and differentiation in meristematic tissue.
25. The cells of collenchyma contain protoplasm and are living without intercellular spaces. Whereas sclerenchyma cells consist of thick-walled dead cells. In the beginning, the cells of sclerenchyma are living and have protoplasm, but due to deposition of impermeable secondary walls (lignin) they become dead, thick and hard.
38. Both xylem fibres and sclerenchyma are dead cells, while xylem parenchyma contains protoplasm and is living.
39. Tracheids and vessels are dead as they do not contain protoplasm. Sieve tube elements are the components of phloem.
49. In root, protoxylem is towards periphery and metaxylem is towards pith.



50. The opening in vessel element walls are called perforation, which may be simple perforation or multiple perforations.
52. Sieve tubes and companion cells are present in angiosperms and absent in gymnosperms and pteridophytes. Sieve tubes transport the prepared food materials from leaves to the storage organs and to growing regions.
53. The walls of vessels are lignified and hard. Sieve tubes have thin cellulose walls.
54. Sieve tubes and companion cells are the parts of phloem.
58. Sieve tube lacks nucleus, thus nucleus of companion cell controls the activity of sieve tube.
59. Gymnosperms lack sieve tubes and companion cells. Phloem parenchyma is absent in most of the monocotyledons.
68. Companion cells are characteristic element of phloem tissue associated with the sieve tubes in the angiosperms. They are absent in pteridophytes and gymnosperms.
77. Dumb-bell-shaped stomata is characteristic feature of monocots. While dicots show bean shaped (kidney shaped) stomata.
89. Pericycle is a single layered or multilayered cylinder of thin or thick walled cells present between the endodermis and vascular tissues.
95. In pea plant (dicot), cambium is present between xylem and phloem, thus vascular bundle is open.
101. Pericycle shows initiation of lateral roots and vascular cambium only in dicots, as monocots lack secondary growth, they show absence of cambium. Pith is large and well developed in monocots, while small and inconspicuous in dicots.
107. Pith or medulla occupies the central part in dicot stem and monocot root, made up of parenchymatous cells.
116. Mesophyll cells are not differentiated into spongy and palisade, in monocots.
120. When bark is lost, phloem will be destroyed; due to which conduction of food from leaves to root will be stopped and in absence of food, root will stop water absorption and cause death of whole plant.
129. The phellogen (cork cambium) is usually 1-2 layers thick and made up of narrow, thin-walled, nearly rectangular cells. It cuts off cells on both the sides (i.e. outer as well as inner side).
Apical meristems bring about primary growth, like formation of new organs and elongation of very young stem, root, etc.
Axillary meristems in leaf axils play a central role in continuous organogenesis and produce the diversity of plant architecture.
138. Heartwood is physiologically inactive due to the deposition of organic compounds. It does not conduct water but gives mechanical support to the stem.
142. Phellem or cork is impervious to water due to deposition of suberin in the cell wall.
145. The cambial ring becomes active and begins to cut off new cells, both towards the inner and outer sides. The cells cut off towards pith, mature into secondary phloem get gradually crushed due to the continued formation and accumulation of secondary xylem. The primary xylem however remains more or less intact, in or around the centre.
154. Phloem carries food to different parts of plant, while sclerenchyma provides mechanical support to plant organs.
157. The shoot apical meristems are present at the tips of the stem, and its branches. They produce growth in length. As the twig possesses 4 branches, number of shoot apical meristems are likely to be 5 including one of the twig itself.
158. Gymnosperms lack vessels in their xylem.
161. Pine tree belongs to Gymnosperms. Absence of sieve tubes and companion cells is a characteristic feature of Gymnosperms.
162. Trichomes: Prevent water loss due to transpiration.
165. In dicot stem, protoxylem lies towards the centre (pith), while in a dicot root, the protoxylem lies towards the periphery.
167. Secondary growth takes place in stems and roots of dicotyledons and gymnosperms, but does not occur in monocotyledons.
169. Vessels are absent in gymnosperms and pteridophytes with the exceptions of a few e.g., *Selaginella*, *Gnetum*. Presence of vessels is a characteristic feature of angiosperms. Out of the given options, teak, mango and palm are angiosperms, thus they will contain vessels.
170. The gymnosperm lacks xylem vessels, thus the wood is 'non-porous'.



174. Periderm is a tissue of secondary origin that replaces damaged epidermis. It can be found in underground plant organs.
175. Sieve tubes lack nucleus at maturity, nucleus is present only in young stage.

179. **Note:** The peripheral region of the secondary xylem, is lighter in colour and is known as the sapwood. It is involved in the conduction of water and minerals from root to leaf.



Topic Test

- Axillary bud and terminal bud are derived from activity of _____.
 (A) lateral meristem
 (B) intercalary meristem
 (C) apical meristem
 (D) both (A) and (C)
- Palisade parenchyma is absent in leaves of?
 (A) Mustard (B) Soybean
 (C) Gram (D) Sorghum
- Which of the following has an organised and differentiated cellular structure having cytoplasm but no nucleus?
 (A) Vessels
 (B) Xylem parenchyma
 (C) Sieve tube element
 (D) Tracheids
- Pericycle of the dicot root
 (A) provides mechanical support
 (B) produces lateral roots
 (C) forms the vascular bundles
 (D) gives rise to adventitious buds
- How will you differentiate a dicot root from a diot stem?
 (A) Absence of secondary phloem
 (B) Presence of pith
 (C) Position of protoxylem
 (D) Absence of pericycle
- Identify the false statement regarding stomatal apparatus.
 (A) Guard cells invariably possess chloroplasts and mitochondria.
 (B) Guard cells in grasses are kidney shaped.
 (C) Stomata are involved in gaseous exchange.
 (D) Inner wall of guard cell is thick.
- The cell of _____ gives rise to interfascicular cambium.
 (A) Endodermis (B) Epidermis
 (C) Pericycle (D) Medullary rays
- A monocot root has _____ as compared to a dicot root.
 (A) more abundant xylem bundles
 (B) relatively thicker cambium
 (C) abundant secondary xylem
 (D) highly active apical meristem

- Identify the correct statement.
 (A) Vessels are unicellular with wide lumen.
 (B) Xylem parenchyma cells are living.
 (C) Vessels contain dense cytoplasm.
 (D) Tracheids are unicellular with wide lumen.
- Assertion:** Annual rings can be seen in stems of trees growing in temperate regions.
Reason: The activity of cambium is under control many physiological and environmental factors.
 (A) Both assertion and reason are true and reason is the correct explanation of assertion.
 (B) Both assertion and reason are true but reason is not the correct explanation of assertion.
 (C) Assertion is correct while reason is incorrect
 (D) Both assertion and reason are incorrect.
- Complete the given analogy.
 Cork : phellem :: Secondary cortex : _____
 (A) periderm (B) phelloderm
 (C) phellogen (D) pericycle
- Mass of cells covering and protecting the root apical meristem is known as
 (A) lateral meristem (B) root hairs
 (C) root cap (D) protoderm
- Match the columns with respect to terms given in Column I to their characteristics in Column II.

	Column I		Column II
a.	Sapwood	i.	Opening on bark of the tree
b.	Heart wood	ii.	Generally absent in dicots
c.	Endodermis	iii.	Inner layer of cortex
d.	Lenticels	iv.	Central hard region of tree trunk
e.	Sieve tubes	v.	Peripheral region of secondary xylem in a tree trunk
		vi.	Tube within the phloem
		vii.	Non – functional wood

- (A) a-v, b-vii, c-iii, d-i, e-vi
 (B) a-vii, b-ii, c-iii, d-iv, e-i
 (C) a-v, b-i, c-ii, d-iii, e-iv
 (D) a-vi, b-iv, c-ii, d-iii, e-v



14. The description given below refers to
- Cells are thickened at corners due to deposition of cellulose, hemicellulose and pectin.
 - Intercellular spaces absent.
 - Perform photosynthesis, due to presence of chloroplast.
- (A) Collenchyma (B) Sclerenchyma
(C) Parenchyma (D) Phloem
15. Vascular cambium consist of
- Interfascicular cambium
 - Intrafascicular cambium
 - Cork cambium
- (A) i and ii only (B) ii and iii only
(C) i, ii and iii (D) i and iii only
16. Which of the following will not happen during secondary growth by cambium ring?
- (A) Primary and secondary phloem get crushed due to continued formation and accumulation of secondary xylem.
(B) Secondary xylem is produced more than secondary phloem
(C) Primary xylem remains more or less intact around the centre
(D) The cells of cambial ring cut off towards pith mature into secondary phloem and cells towards periphery mature into secondary xylem.
17. Select the correct pair from the following.
- (A) Protophloem – bigger sieve tubes
(B) Late wood – formed in spring season
(C) Apical meristem – Primary meristem
(D) Metaxylem – narrow sieve tubes
18. Which of the following is a function of bulliform cells in monocot leaf?
- (A) to take part in secondary growth
(B) to store resins
(C) to minimise water loss by being flaccid and making leaf to curl inwards.
(D) to expose leaf for getting sunlight.

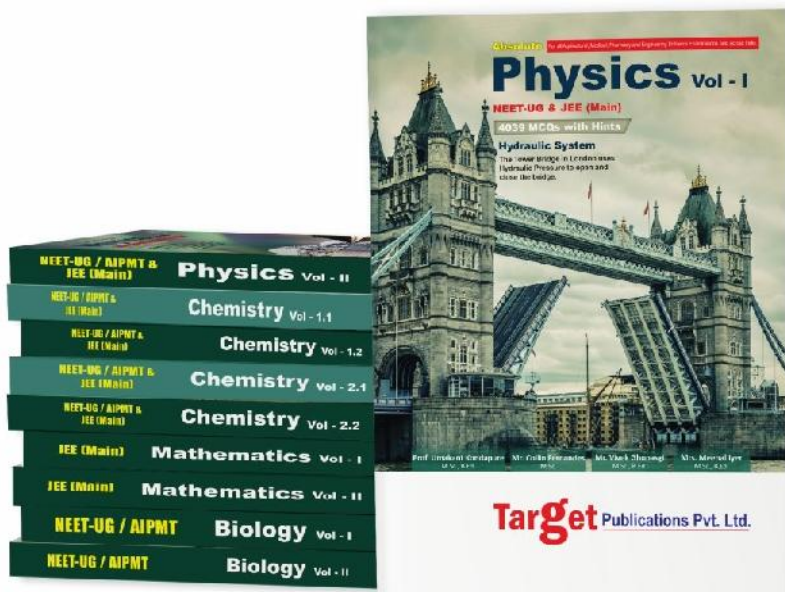
**Answers to Topic Test**

1. (C) 2. (D) 3. (C) 4. (B)
5. (C) 6. (B) 7. (D) 8. (A)
9. (B) 10. (A) 11. (B) 12. (C)
13. (A) 14. (A) 15. (A) 16. (D)
17. (C) 18. (C)



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