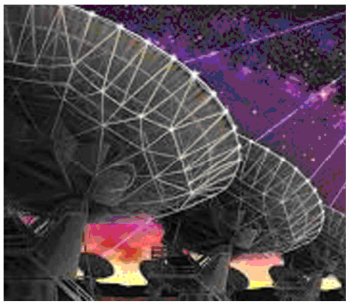
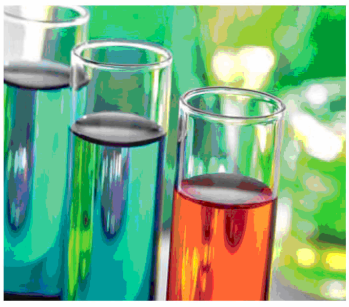
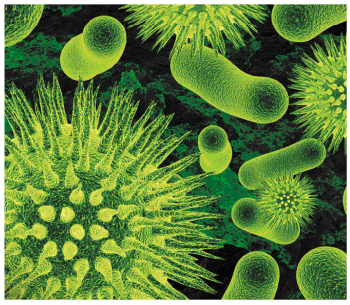
STUDY MATERIAL

NEET

XI & XII STD







BIOLOGY

CP PUBLICATION

BIOLOGY

Study Material for NEET preparation

Prepared by Career Point Kota Experts

CAREER POINT

CONTENTS OF THE PACKAGE AT A GLANCE

BIOLOGY

Class 11

Plant Diversity

- The living world
- Biological classification
- Plant Kingdom

Animal Diversity

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- Animal Kingdom (Chordata)

Structural Organisation in Plants & Animals

- Morphology of Flowering Plants
- Anatomy Of flowering plants
- Animal Tissue
- Cockroach
- Frog

Cell : Structure & Function

- Cell : the unit of life
- Cell Cycle and cell division
- Biomolecules

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- Plant Growth & Developments

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- Breathing and exchange of gases
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- Locomotion and movements
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- Chemical Coordination & Regulation

Class 12

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- Sexual Reproduction in Flowering Plants
- Human Reproduction
- Reproductive Health

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- Biotechnology and Its Applications

Evolution & Biology in Human Welfare

- Evolution
- Health and disease
- Microbes in human welfare

Ecology

- Organisms and Environment
- Ecosystem
- Biodiversity and Conservation

Features of The Product

This study material is especially designed for NEET aspirants. The entire study material is arranged in such a way so that the learning process progresses gradually from the basic to advanced stages. This easy-to-grasp material enables students to apply the fundamentals they have learned and boost their confidence to tackle the problems asked in the NEET and other medical competitive examinations.

Theory & Concepts

Theory provides all the basic concepts in clear and precise manner. It comprises all the related and required diagrams, tables, graphs, real life examples, info graphics, conceptual questions that makes it more comprehensive. It also highlights tips and tricks, facts, notes, misconceptions, key points, and problem solving tactics.

ANATOMY OF FLOWERING PLANTS

Chapter Contents

- Plant anatomy
- Plant tissue
- Meristematic tissue
- Classification of meristematic tissue
- Simple Tissue - Parenchyma Collenchyma Sclerenchyma
- Complex permanent tissue – Xylem & Phloem
- Tissue system
- Internal structure of typical dicotyledon- Root
- Internal structure of monocotyledonous - Root
- Internal structure of typical dicotyledon - Stem
- Internal structure of monocotyledonous - Stem
- Internal Structure of Leaf
- Anatomy - Secondary Growth

(I) PRIMARY STRUCTURE OF PLANTS

Plant anatomy

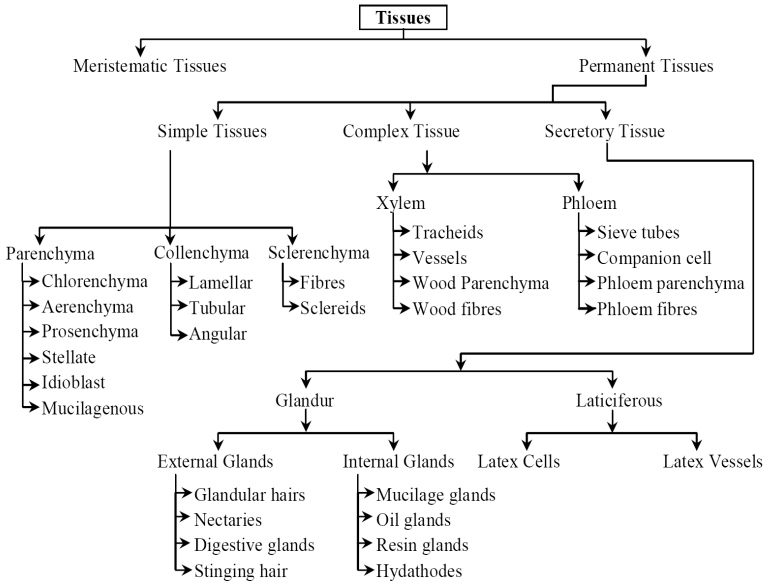
It is the branch of Botany which deals with study of internal structures and organization of plants by the section cutting is called **Plant anatomy.**

Anatomy is a Greek Word. Ana → asunder & temnein → to cut. Plant anatomy is also called as **Internal Morphology**.

N.Grew is known as father of plant anatomy. **K.A. Chaudhary** is known as father of Indian plant Anatomy.

Plant tissue

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



MERISTEMATIC TISSUE :

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

Practice Exercises

Exercise Level -1 : It contains single objective correct (SCQ) type concept building questions.

EXERCISE # 1

Q.1 A tissue is a group of cells which are -
(1) Similar in origin, but dissimilar in form and function
(2) Dissimilar in origin, form and function
(3) Dissimilar in origin, but similar in form and function
(4) Similar in origin, form and function

Q.2 A meristem may be defined as the group of cells which
(1) Add to the bulk of the Plants
(2) Conserve food
(3) Divide continuously to give rise to new cells
(4) Elongate and add to the group of cells

Q.3 Embryo of a seed is made up of –
(1) Meristematic tissue (2) Parenchyma
(3) Collenchyma (4) Sclerenchyma

Q.4 Epidermal cells are -
(1) Guard cells (2) Root hairs
(3) Trichomes (4) All of the above

Q.5 Bamboo, grass and mint stem elongate by the activity of -
(1) Primary meristem (2) Secondary meristem
(3) Intercalary meristems (4) Apical meristems

Q.6 Maximum growth in root occurs –
(1) At its tip (2) Towards light
(3) Behind the apex (4) Towards apex

Q.7 A. Generally absent in primary phloem
B. Elongated unbranched pointed needle shaped cell
C. Devoid of protoplasm at maturity
D. Can be used commercially
Above mentioned statement can belongs to -
(1) Sclereids (2) Xylem sclerenchyma
(3) Phloem fiber (4) Xylem trachied

Q.8 Monocot leaves grow by -
(1) Apical meristem (2) Lateral meristem
(3) Intercalary meristem (4) Dermatogen

Q.9 Which of the following is a well differentiated plant tissue ?
(1) Apical meristem (2) Cambium
(3) Parenchyma (4) All of the above

Q.10 Which of the following is a primary meristem ?
(1) Intra fascicular cambium
(2) Cork cambium
(3) Vascular cambium in roots
(4) Inter fascicular cambium

Q.11 In plants, during embryonic condition –
(1) All cells of the embryo divide
(2) Meristematic activity is confined to single apical cell
(3) Meristematic activity is confined to a group of apical cells
(4) Apical & lateral cells only divide

Q.12 The secondary meristem originates from -
(1) Promeristem (2) Primary meristem
(3) Permanent tissue (4) Secretory tissue

Q.13 Which of the following is secondary meristem?
(1) Protoderm (2) Procambium
(3) Cork cambium (4) All of the above

Q.14 The function of root cap is -
(1) Protection of root tip and control of geotropic movement
(2) Storage of food products
(3) Absorption of nutrients
(4) None of the above

Q.15 In quiescent zone, DNA content is -
(1) High (2) Low
(3) Very high (4) Balanced

Q.16 The cells of a permanent tissue do not divide because these are -
(1) Dead (2) Enucleate
(3) Arrested at G-1 stage (4) Arrested at prophase

Q.17 Which of the following is present in monocot leaves
A. Bulliform cell B. Leaf base
C. Bundle sheath D. Resin gland
E. Water cavity
(1) A, B, C & E (2) A, B, D, E
(3) A, B, E (4) A, B, C

Q.18 A parenchyma cell which stores ergastic materials or waste substance is -
(1) Phragmoblast (2) Conidioblast
(3) Idioblast (4) Blastomere

Q.19 In plants, which of the following would most likely show totipotency -
(1) Xylem Vessels (2) Meristem
(3) Cork (4) Sieve tube

Q.20 The tissue not having specifically thickened walls are -
(1) Parenchyma (2) Collenchyma
(3) Fibres (4) Sclereids

Q.21 Which of the following tissues form the main bulk of storage organ -
(1) Parenchyma (2) Collenchyma
(3) Sclerenchyma (4) Aerenchyma

Q.22 Flesh of a fruit is mostly made up of -
(1) Parenchyma (2) Collenchyma
(3) Sclereids (4) Meristem

Exercise Level -2: It contains single objective type good quality questions on all the concepts of the chapter in mixed manner.

EXERCISE # 2

Q.1 In plants maximum growth occurs during which season –
(1) Summer (2) Winter
(3) Autumn (4) Spring

Q.2 The tracheids differ from vessels in having –
(1) Thick wall
(2) Bordered pit
(3) Presence of pitted end wall
(4) Spiral thickening

Q.3 In Cucurbita stem vascular bundles are –
(1) Radial (2) Collateral
(3) Concentric (4) Bicollateral

Q.4 "Bast-fibers" obtained from which part of woody stem –
(1) Cork (2) Cortex
(3) Xylem (4) Phloem

Q.5 Thickness of stem increases due to activity of –
(1) Cambium (2) Xylem
(3) Phloem (4) Shoot apex

Q.6 Non-porous wood is found in which plants –
(1) Dicots (2) Monocots
(3) Gymnosperm (4) Cactus

Q.7 In dorsiventral leaf phloem is found in which side
(1) Adaxial
(2) Abaxial
(3) Lateral
(4) Adaxial and Abaxial both

Q.8 The leaves having stomata on both the surfaces are called as –
(1) Amphistomatic (2) Hypostomatic
(3) Epistomatic (4) Astomatic

Q.9 Most distinct annual rings are formed in which region -
(1) Tropical (2) Temperate
(3) Arctic (4) Equatorial

Q.10 Vessels and companion cells are characteristic feature of –
(1) Gymnosperm (2) Angiosperm
(3) Pteridophyta (4) Bryophyta

Q.11 Grafting is not possible in monocots because –
(1) Vascular bundles are scattered
(2) Vascular bundles are closed
(3) Hypodermis is sclerenchymatous
(4) Vascular bundles are open

Q.12 Companion cells are associated with –
(1) Tracheids of Angiosperms
(2) Vessels of Angiosperms
(3) Tracheids of Gymnosperms
(4) Sieve tubes of Angiosperms

Q.13 Lateral roots are arises from –
(1) Pericycle (2) Cortex
(3) Pith (4) Endodermis

Q.14 Bulliform cells are found in –
(1) Seeds of sunflower (2) Leaf of wheat
(3) Pod of pea (4) Tuber of potato

Q.15 In the T.S. of root –
(1) Protoxylem and metaxylem are not present on same radius
(2) Protoxylem is absent
(3) Protoxylem towards inside and metaxylem towards outside
(4) Metaxylem is towards inside and protoxylem towards outside

Q.16 The resin duct of Gymnosperm is an example of –
(1) Intracellular space
(2) Schizogenous cavity
(3) Lysigenous cavity
(4) Vacuole containing stored material

Q.17 Root cap is absent in –
(1) Mesophytes (2) Hydrophytes
(3) Epiphytes (4) Xerophytes

Q.18 Girth of dicot stem increases by the activity of –
(1) Apical meristem (2) Intercalary meristem
(3) Lateral meristem (4) Procambium meristem

Q.19 Which type of vascular bundles are found in monocot stem –
(1) Collateral, open, endarch
(2) Radial, open, diarch
(3) Radial, open, mesarch
(4) Collateral, closed, endarch

Q.20 The cells without nuclei are present in -
(1) Vascular cambium (2) Root hair
(3) Companion cell (4) Members of sieve tube

Q.21 The difference in phloem of Gymnosperms & Angiosperms is due to –
(1) Parenchyma (2) Sieve cell
(3) Companion cell (4) Fibres

Q.22 The position of protoxylem in leaf is –
(1) Adaxial
(2) Abaxial
(3) Surrounded by metaxylem
(4) Lateral

Q.23 Vascular cambium is more active towards -
(1) Outer side
(2) Inner side
(3) Sometime innerside, some time outside
(4) Equal on both side

Exercise Level -3 : It contains previous years NEET exam quesiotns from 2005 to upto to present year.

EXERCISE # 3

Q.1 In monocots, root cap is formed by - **[AIIMS 2000]**
(1) Dermatogen (2) Calyptrogen
(3) Wound cambium (4) Vascular cambium

Q.2 The quiescent centre in the root meristem serves as a - **[AIIMS 2003]**
(1) Site for storage of food which is utilized during maturation
(2) Reservoir of growth hormones
(3) Reserve for replenishment of damaged cells of the meristem
(4) Region for absorption of water

Q.3 Which one of the following statements pertaining to plant structure is correct ? **[AIIMS 2005]**
(1) Cork lacks stomata, but lenticels carry out transpiration
(2) Passage cells help in transfer of food from cortex to phloem
(3) Sieve tube elements posses cytoplasm but no nuclei
(4) The shoot apical meristem has a quiescent centre

Q.4 Grafting is successful in dicots but not in monocots because the dicots have - **[AIIMS 2006]**
(1) Vascular bundles arranged in a ring
(2) Cambium for secondary growth
(3) Vessels with elements arranged end to end
(4) Cork cambium

Q.5 In the sieve elements, which one of the following is the most likely function of P-proteins – **[AIIMS 2006]**
(1) Deposition of callose on sieve plates
(2) providing energy for active translocation
(3) Autolytic enzymes
(4) Sealing mechanism on wounding

Q.6 Extrastelar secondary growth takes place by – **[AIPMT 1998]**
(1) Vascular cambium (2) Phellogen
(3) Phellem (4) Phelloderm

Q.7 Growth of leaf primordia is – **[AIPMT 1998]**
(1) First apical then marginal
(2) Only apical
(3) Only marginal
(4) Lateral

Q.8 A plant stem is showing 40 spring ring and 40 autumn ring. What will be the age of plant – **[AIPMT 1999]**
(1) 80 years (2) 40 years
(3) 20 years (4) Can not determined

Q.9 What happens in plants during vascularisation **[AIPMT 2000]**
(1) Differentiation of procambium, formation of primary phloem followed by formation of primary xylem
(2) Differentiation of procambium followed by the formation of primary phloem and xylem simultaneously
(3) Formation of procambium, primary phloem and xylem simultaneously
(4) Differentiation of procambium followed by the formation of secondary xylem

Q.10 Main function of lenticel is – **[AIPMT 2002]**
(1) Transpiration (2) Guttation
(3) Gaseous exchange (4) Bleeding

Q.11 Vessels are found in – **[AIPMT 2002]**
(1) All angiosperms and some gymnosperm
(2) Most of the angiosperms and few gymnosperms
(3) All angiosperms, all gymnosperms and some pteridophyta
(4) All pteridophyta

Q.12 Four radial vascular bundles are found in – **[AIPMT 2002]**
(1) Dicot root
(2) Monocot root
(3) Dicot stem
(4) Monocot stem

Q.13 Which of the following statement is true – **[AIPMT 2002]**
(1) Vessels are multicellular and with wide lumen.
(2) Tracheids are multicellular and with narrow lumen.
(3) Vessels are unicellular and with narrow lumen.
(4) Tracheids are unicellular and with wide lumen.

Q.14 The cells of the quiescent centre are characterised by - **[AIPMT 2003]**
(1) Having dense cytoplasm and prominent nuclei
(2) Having light cytoplasm and small nuclei
(3) Dividing regularly to add to the corpus
(4) Dividing regularly to add to tunica

Q.15 The apical meristem of the root is present – **[AIPMT 2003]**
(1) Only in radicals
(2) Only in tap roots
(3) Only in adventitious roots
(4) In all the roots

Q.16 In a longitudinal section of a root, starting from the tip upward, the four zones occur in the following order - **[AIPMT 2004]**
(1) Root cap, cell division, cell maturation , cell enlargement
(2) Cell division, cell enlargement, cell maturation, root cap
(3) Cell division, cell maturation cell enlargement, root cap
(4) Root cap, cell division, cell enlargement, cell maturation

Q.17 A common structural feature of vessel elements and sieve tube elements is - **[AIPMT 2006]**
(1) presence of p-protein
(2) enucleate condition
(3) thick secondary walls
(4) pores on lateral walls

Q.18 For a critical study of secondary growth in plants, which one of the following pairs is suitable ? **[AIPMT 2007]**
(1) Wheat and maiden hair fern
(2) Sugarcane and sunflower
(3) Teak and pine
(4) Deodar and fern

Answer key

Above mentioned all exercises provided with answer key

EXERCISE # 1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	1	4	3	3	3	3	3	1	1	3	3	1	2	3	4	3	2	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	1	2	1	1	4	2	3	3	1	3	2	3	2	3	3	2	3	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	3	2	3	1	2	1	1	4	1	4	2	1	2	2	2	2	1	3	3	1
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	1	1	3	1	1	3	3	2	3	1	2	3	3	3	4	1	1	3	1
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	3	4	2	2	2	3	1	3	2	4	1	3	1	1	4	3	1	4	1
Ques.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	4	3	4	1	4	4	4	3	2	2	1	4	1	1	2	1	1	1	2	1
Ques.	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	
Ans.	2	2	2	1	4	4	3	2	3	1	3	2	2	4	2	4	1	2	2	

ANATOMY OF FLOWERING PLANTS

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- Internal Structure of Leaf
- Anatomy - Secondary Growth

(I) PRIMARY STRUCTURE OF PLANTS

Plant anatomy

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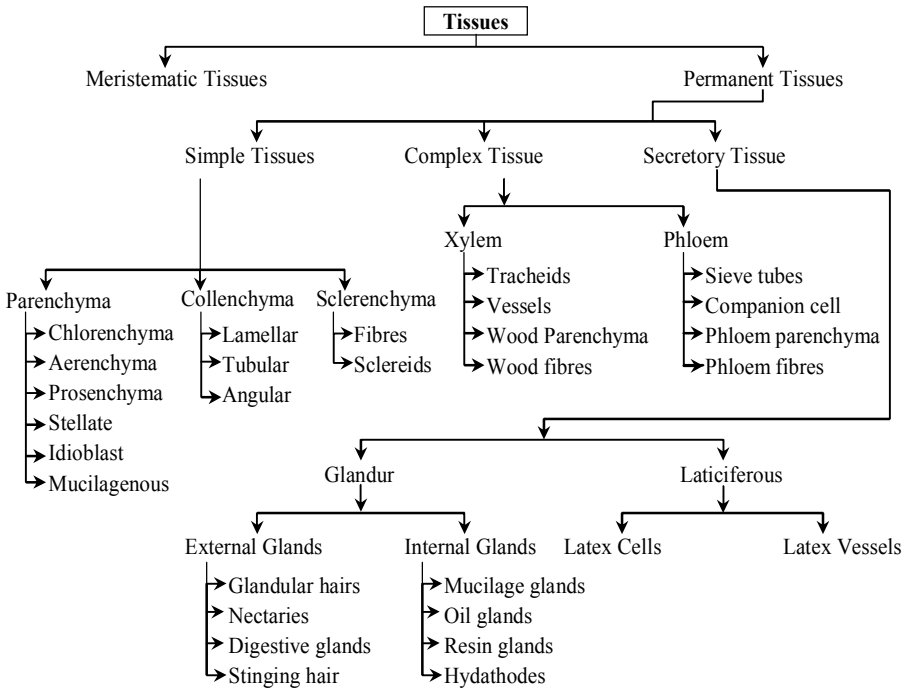
An organized group of cells which is having similar or dissimilar in shape, having a common origin and usually performing a common function is called **tissue.** The term tissue was coined by **Nehemiah Grew.**



MERISTEMATIC TISSUE :

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

Characteristics of meristematic tissues

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

Classification of meristematic tissue

Meristematic tissue based on origin and development

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

(i) Promeristem/embryonic meristem/primordial meristem :

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

(ii) Primary meristem :

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

(iii) Secondary meristem :

- These are the meristems developed from primary permanent tissues. They are not present in the embryonic stage of the plant. These are present in mature region of root and stem of many plants particularly those that produce woody axis.
- Some of the cells of primary permanent tissues become meristematic and constitute secondary meristem.
- By the activity of secondary meristems, **secondary growth** takes place.
- Cork cambium, Interfascicular cambium & root cambium are excellent examples of secondary meristems.

  Note : Formation of meristem from any permanent tissue is called **dedifferentiation.**

  or

  Formation of undifferentiated tissue from differentiated tissues is called **dedifferentiation.**
- Promeristem $\longrightarrow$ Primary meristem $\longrightarrow$ Permanent tissue

  $\downarrow$

  Secondary meristem

Meristematic tissues based on location (position) in plant body

On the basis of position, meristematic tissues are divided into three types :

(i) Apical meristem :

- The meristems which occur at the tips of roots and shoots and produce primary tissues are called apical meristems. They are responsible for increase in the length of plant organs. Example : **Root apex, Shoot apex.** They are responsible for primary growth.
- During formation of leaves and elongation of stem, some cells left behind, they form auxillary bud and from new branches or a flowers.
- Apical meristem in shoot and root is terminal and subterminal respectively.

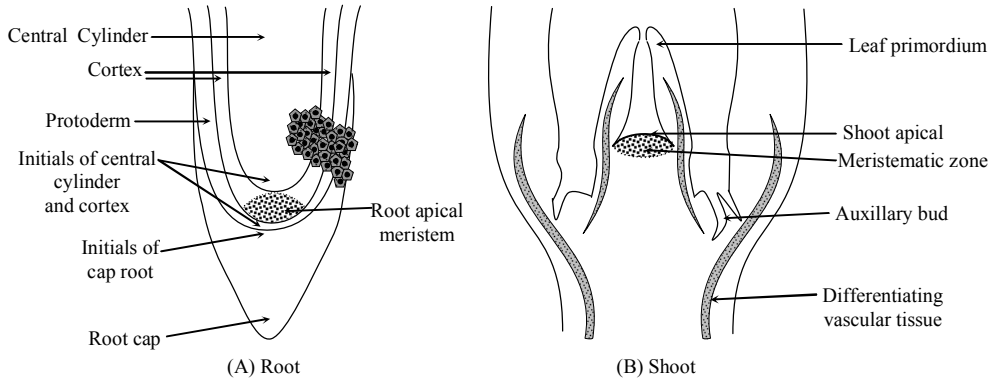


Fig.: Apical Meristem

(ii) Intercalary meristem :

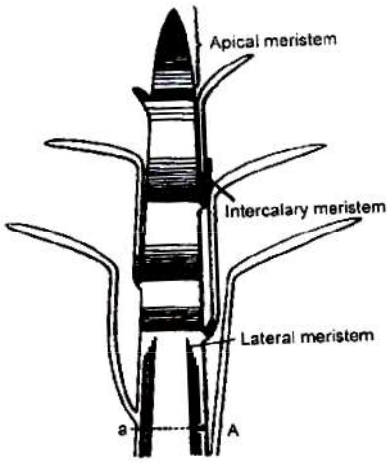
- The meristem which occurs between mature tissues.
- This is the separated region of apical meristem.
- By the activity of this meristem length of the plant organs increases.
- They are present in some plants stem.
- They are responsible for regeneration of parts removed by grazing herbivores in grasses.
- They may be present either at the base of internode e.g., **grasses, bamboo** and **Equisetum** etc. or at the base of node e.g., **Mint.** They are also present at the base of leaves e.g., **Pinus.** By the activity of this meristem, **length** of leaves increases.

  Note : They are short lived and convert into permanent tissue.

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

(iii) Lateral meristem :

- Lateral meristem occurs in **lateral side** of plant organs or parallel to the **longitudinal axis** (Tangential plane) of plant organs. They are cyllindrical meristem.
- Activity of lateral meristem increases the **girth of plant** organ, so it is **responsible** for **secondary growth** and **produce secondary tissue.**
- Lateral meristems are both primary and secondary in origin **(mostly secondary in origin).** There are two examples of **primary lateral meristem.**



1. **Marginal meristem :-** It occurs at the margin of leaf. Its activity increases the **width** of leaf so total growth of leaf is called **intercalary marginal growth.**

2. **Intra fascicular cambium or fascicular cambium :-** This cambium occurs inside the vascular bundle of the stem. Except intra fascicular cambium all cambia are secondary in origin.

Classification based on plane of division

(i) Rib-meristem/File meristem :

- Meristem in which anticlinal division occurs in **one plane**. For example, **tunica** is a type of rib-meristem. Formation of some cells of **cortex** and **pith** takes place by this meristem.

(ii) Plate-meristem :

- Meristem which divides anticlinally into **two plane** at right angle to each other. By this division a plate like structure is formed. Formation of leaf blade takes place by the activity of this meristem.

(ii) Mass-meristem :

- Meristem which divides in **all possible planes** resulting in the increase in the volume of plant body (organ). **Example :** The formation of embryo and endosperm takes place by this kind of meristem.

On the basis of function

- On the basis of function, **Haberlandt** divided meristem into three group.
  - (i) **Protoderm :-** It is the outer most layer of eumeristem. By the activity of protoderm **epidermal tissue system** is formed. It includes Epidermis, Root hair, Stem hair etc.
  - (ii) **Procambium :** These cells are long and it gives rise to the **vascular tissue system.** It includes Xylem and phloem.
  - (iii) **Ground meristem :** The cells of this region are large, thin walled and **isodiametric. Ground tissue system** is formed by the activity of these cells. It includes hypodermis, cortex, endodermis, pericycle, pith-rays and pith.

COMPOSITION OF APICAL MERISTEM IN DIFFERENT PLANTS

- **Apical meristem** is **absent** in lower **Algae** and **Fungi.** All the cells of these plants are divisible, So they do not show apical growth. Thus such type of growth in these plants is called diffused growth.
- Apical meristem in higher algae (eg., *Fucus, Dictyota & Sargassum*), Bryophytes and Some Pteridophytes (eg., *Selaginella*) is consist of **single cell.** This cell is known as **apical cell.**
- Apical meristem in **Ferns, Gymnosperms** and **Angiosperms** consist of **many cells.**

Apical cell theory

- This theory proposed by **Karl Nageli** and **Hofmeister** and supported by **Wolff.**
- According to Nageli and Hofmeister, the apical meristem is composed of single apical cell. This view is only applicable on Bryophytes and some Pteridophytes and some higher algae (*Fucus, Dictyota* & *Sargassum*).

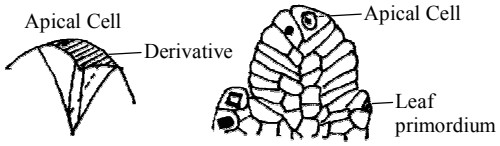
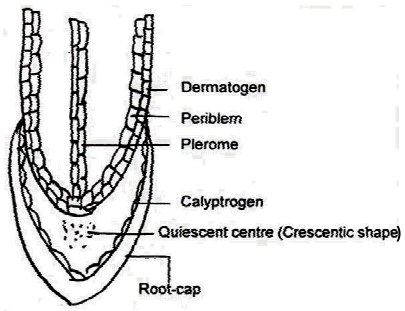


Fig.: Apical Cell

Histogen theory

- It was proposed by **Hanstein (1870).** According to him, the root and shoot apices are distinguished into three meristematic regions or three layers of histogen cells. These are as follows -
  - **(a) Dermatogen :** This is the outermost single layer of cells. These cells form **single layered epidermis** by anticlinal division.
  - **(b) Periblem :** This region is situated just below the dermatogen. It forms cortex **(Hypodermis, General cortex** and **endodermis).**
  - **(c) Plerome :** This is the innermost region. Stele formation takes place by division of these cells. It means formation of **pericycle, vascular bundles, pith rays or medullary rays** and **pith.**



Histogen theory - Organization of root apex

- This theory is only true for root apex. It is not applicable for shoot apex of higher plants because in most of the gymnosperms and angiosperms, shoot apex does not have distinct differentiation of three layers.
- Except above described three histogens, a fourth type of histogen is also present in **monocotyledon root apex.** This is known as **Calyptrogen.** Root cap is produced by Calyptrogen in monocots. Root cap is produced by dermatogen in dicotyledons.
- **Exception :** There is only **one histogen** present in **Ranunculus. Two** histogens occurs in **Casuarina.**
- Due to presence of root cap position of **root apex is sub terminal.** So maximum growth in root takes place **behind the apex.**

Note :

1. In hydrophytes root cap is absent.
2. Generally root cap is single layered but in ***Pandanus*** (Screw pine) root cap is multilayered.
3. Root cap contains large number of Golgibody which secrete mucilage which make the root slimy.

QUIESCENT CENTRE

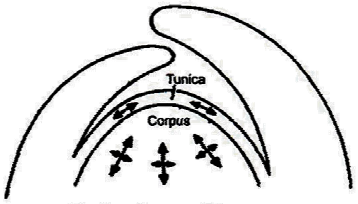
- A group of inactive or less active cells present **between the dermatogen** and **calyptrogen** is called **quiescent centre.**
- These cells contain **less amount of DNA, light cytoplasm, small nuclei** and **synthesis of protein is also less.** Quiescent centre name coined by **"Clowes ".**
- Quiescent centre was discovered in **Maize root** with the help of **autoradiography.**
- If calyptrogen get damaged, this zone becomes active to form new cells of calyptrogen.

Tunica corpus theory

☛ This theory was proposed by **Schmidt (1924).** This theory is **applicable on shoot apex.** According to this theory **two** types of layers are found in the shoot apex.

(a) Tunica :

- This is peripheral layer, **epidermis** is formed by this layer. In tunica cells, **anticlinal division** takes place only in one plane.
- Anticlinal division occurs at right angle to longitudinal axis (tangential plane) of cell.
- When division occurs in single anticlinal plane they do not increase the number of layers.
- Generally, tunica is **single** layered, but some times it is multilayered, then the outer most layer forms the epidermis and remaining layers form rest types of the tissue system with the association of corpus.



Tunica Corpus Theory
Organisation of shoot apex

(b) Corpus : The mass of cells present below the tunica is called **Corpus.** The cells of this zone divide in all direction (many planes) due to which, **volume** increases. It forms rest of the tissue system.

Permanent tissues

☛ Following division of cells in meristem the newly formed cells become structurally and functionally specialized and lose the division ability and they form permanent tissue. They are formed by division and differentiation of meristematic tissues.

☛ They are present either in permanent G_0 stage or in arrested G_1 stage. Their cells may be **living** or **dead.**

(A) SIMPLE TISSUES

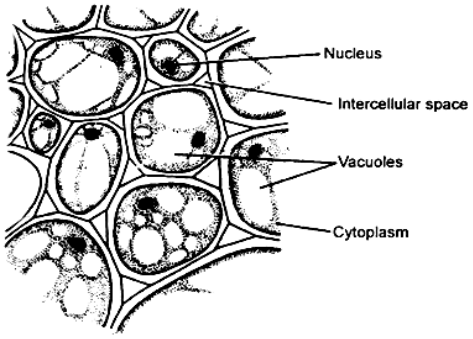
- These tissues are **made up of similar type of cells** that perform a common function and have common origin. Simple tissues are of three types :-
  (I) Parenchyma
  (II) Collenchyma
  (III) Sclerenchyma

(I) PARENCHYMA : It is very **primitive** type of tissue. It is first evolved tissue. Remaining all different type of tissues are derived from this tissue. So it is also called as **fundamental tissue**.

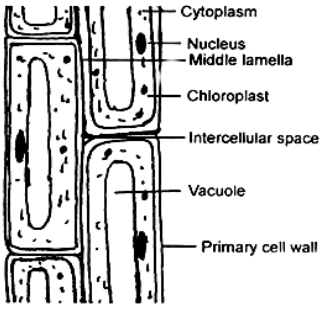
- It is a **universal tissue** and a major component of internal plant organs.
- Parenchyma name coined by **Grew.**

Characteristic features :

1. It is a living tissue.
2. Tissue first to be differentiated from meristem is parenchyma.
3. All the cells of parenchyma are thin walled. Cell wall is made up of pectocellulose. **(Mainly cellulose).** So parenchyma is a soft tissue.
4. Each cell containing large central vacuole.
5. Inter cellular spaces are present between cells of this tissue, it is a loose tissue. Intercellular spaces are **schizogenous** in origin.
6. Body of Bryophyte is mainly composed of parenchyma.
7. Flesh of a fruit is mainly composed of parenchyma.
8. The cells are **isodiametric.** The cells of parenchyma are spherical, oval or polygonal in shape. Each parenchymatous cell contains 14 planes of lateral line, which are maximum possible plane in a cell. These are known as **tetrakaidecahedron.**



T.S. of Parenchyma



L.S. of Parenchyma

Modification of parenchyma :

(a) Prosenchyma : The cells of this parenchyma are long with pointed ends. This parenchyma forms the **Pericycle of roots.**

(b) Aerenchyma : This parenchyma is made up of **rounded** cells. These cells surround the large **air chambers.** Air chambers are **lysigenous** in origin. It is found in cortex region. It provides **buoyancy** to **hydrophyte** plants.

(c) Stellate parenchyma : The cells of this tissue are stellate and branched. Air spaces are also present but they are less developed. Main function of this parenchyma is to provide **mechanical support.**

- It is found in the leaf bases of **banana** and **canna.** It provides strength to leaf bases.

(d) Chlorenchyma : Such type of parenchyma in which abundant quantity of chloroplasts are found. Two types of chlorenchyma are present in dorsiventral leaves :-

(i) Palisade tissues :- Inter cellular spaces are absent. Their cells are tightly fitted together. They are present towards adaxial/ventral/upper side of leaf. Numbers of chloroplasts are more in palisade tissue as compare to spongy tissue. So upper surface of a leaf appears more green as compared to lower surface.

(ii) Spongy tissues :- Large intercellular spaces are present. So they facilitate transpiration and gaseous exchange. They are present towards abaxial/dorsal/lower side of leaf.

(e) Mucilage parenchyma : In the mucilage parenchyma **large vacuoles** and Mucilage will be found. eg., Succulent xerophytic plants. e.g., ***Aloe.*** Function –storage of water.

(f) Idioblast : In this type of parenchyma non-living ergastic substances like tannins, oils, crystals etc. are present.

Functions of parenchyma :

The main function of this tissue is **storage of food, photosynthesis and secretion.**

(II) COLLENCHYMA : Term coined by **Schleiden.**

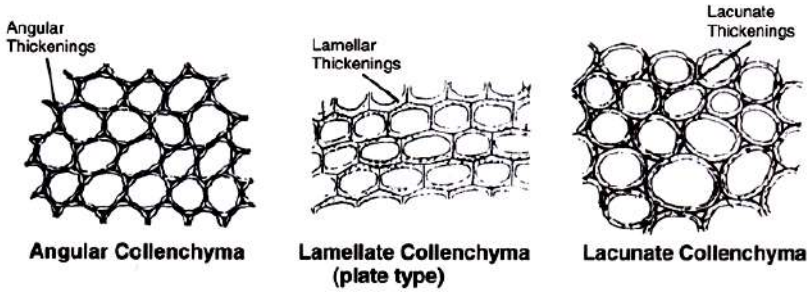
Main characteristics :

- Collenchyma is a **living mechanical tissue.**
- It is made up of **elongated (oval, spherical or polygonal** shape in section) cells.
- **Localized** deposition of pectocellulose (mainly **pectin**) & hemi cellulose is the characteristics feature of collenchyma.
- Vacuolated cytoplasm is found in the cells of collenchyma. Intercellular spaces are not present. These cell assimilate food when they contain chloroplast.
- **Origin of collenchyma :-** Collenchyma originates from **ground meristem.**

Occurance :

- It is found in the stems of **herbaceous dicotyledons.**
- Collenchyma is absent in woody plant parts, root and monocotyledons.
- Collenchyma forms the **hypodermis** of **dicotyledon** stems. It is found either as a homogenous layer or in patches.
- Collenchyma is absent in plants after the secondary growth because plant becomes woody.
- **Lamina margins** of leaves also bear collenchyma. This protects the cracking of lamina margin due to the action of wind.
- They are present in leaf petiole.

Type of Collenchyma :



Functions :

- **Mechanical** as well as **Physiological.**
- They provide mechanical support to growing parts of plant such as young stem and petiole of leaf.
- Due to the presence of chloroplast, it is also participates in the process of **photosynthesis.**

(III) SCLERENCHYMA : Name coined by **Mattenius.**

Main features :

- Sclerenchyma is the **main mechanical tissue.**
- These cells are long, narrow, thick walled and dead.
- Cell wall is **thick** and **lignified and have different types of pit.**

Function : It provide mechanical support/mechanical strength to plants.

Type of sclerenchyma :

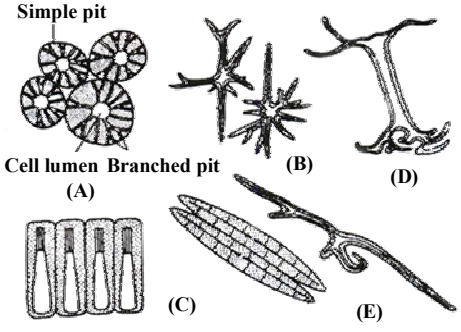
- On the basis of variation in form, structure, origin and development, sclerenchyma cells are of **two types.**

  (1) Sclereids

  (2) Sclerenchymatous fibres

(1) Sclereids : These cells are small, extremely thick walled and their ends are not pointed. Sclereids are isodiametric or **irregular** in shape. Sclereids cells have **more pits** and **lumen** is almost **very narrow.** There pit cavity is **branched.**

Sclereids are classify by **Tschierch,** on the basis of their shapes :



(A) Brachysclereid, (B) Astrosclereid, (C) Macrosclereid, (D) Osteosclereid, (E) Trichosclereid,

(a) Stone cells or Brachysclereids or Grit cells : These cells are spherical or oval in shape. They are found in endocarp of drupe fruits, so endocarp becomes hard.

- They are present in endocarp of **Coconut, Mango, Almond, and Walnut** etc.
- Brachysclereids are also present in **fleshy (edible) part of pear (*Pyrus*), Guava and Sapota.**

(b) Trichosclereids : These are also known as **internal hairs.** They are spines like, bifurcated cells. These are found in **floating leaves.**

- Also present in aerial roots of monstera.

(c) Astrosclereids or **Stellate sclerenchyma :** These cells are stellate (star) shaped. They are found in floating leaves.

Astrosclereids are also found in **tea leaves**.

Example : Both Astro and Tricho sclereids are present in floating leaves.

Victoria, Nelumbo (Lotus) and *Nymphaea* petiole.

(d) Macro-sclereids or Rod cells or Malpighi cells :

- They are small and rod like cells. They are present in **seed coats.**

Example :

- They form part of **seed coat in legume plants**. Due to their presence seed coat becomes hard and dormancy is present in legume seeds.
- In **leguminous plants** hardest seed coat is found in **French bean.**
- In plant kingdom, hardest **Seed coat** is found in lotus.

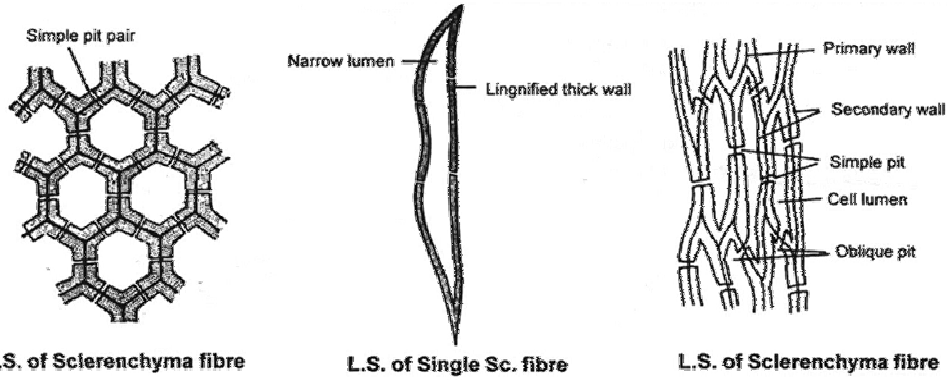
(e) Osteo-Sclereids or Bone cell :

- These are known as prop-cells. These are pillar like cells. Both end of pillar like cells spreads to form bone like structure.

Example : These cells are found in leaves of *Hakea* and *Osmanthus***.**

(2) Sclerenchymatous fibres :

- These cells are fibrous. They are longest cells in plant body. Their both ends are pointed (tapering). Due to thick wall, lumen is reduced. Fibers are generally occurring in groups.
- Their cell wall contains simple and bordered pits.



T.S. of Sclerenchyma fibre | L.S. of Single Sc. fibre | L.S. of Sclerenchyma fibre

☛ On the basis of structure fibres are classified into two groups :

(a) Libriform fibres : They are thickened long fibres. They posses **simple pits** and narrow lumen. Libriform fibres are found in phloem, xylem, pericycle and hypodermis **(Maximum in phloem).**

(b) Fibre tracheids : They are also highly thickened. **Bordered pits** are present in these fibres and lumen is broad. They are only found in **xylem.**

TYPES OF PLANT FIBERS :

☛ On the basis of position, fibres are divided into three types :

A. Surface fibres : They are present on the surface of plant. These fibres are also called as filling fibres.

(i) Seed surface fibres –

Example 1 : Cotton fibres : Cotton fibres are formed by the **out growth of seed coat.** They are not any type of tissue or cell.

Cotton fibres are composed of **cellulose** these fibres are **non-lignified.** So cotton fibres are **not true fibres.** Two types of fibres are found in cotton. Long fibres are called **'lint'** and small fibres are known as **'fuzz'.** Lint fibres are used in cloth industry. Fuzz are filling fibre. Cotton fibres are most pure form of cellulose in nature.

Cotton fibres are not an example of any type of cell because these fibres are formed by out growth of testa.

(ii) Coir of coconut is also a type of surface fibre. They are derived from the **mesocarp.** These are **true fibres.**

B. Xylary or wood fibres : These are hard fibres. These fibres are not flexible. They can not be knitted (weaved) easily so they are not useful. These are found in xylem. Ex. Munj fibre (*Saccharum munja*)

C. Bast fibres / Extra xylary fibres / Phloem fibre : These are known as **commercial fibres.** These fibres are flexible and can be **knitted (weaved)** easily. They have great economic value.

- These fibres are obtained from the phloem and pericycle of plants.
- The bast fibres of *Corchorus capsularis* (Jute), *Crotalaria juncea* (Sunn hemp) and *Hibiscus sabdariffa* (patua) are obtained from the secondary phloem of stem.
- The bast fibres of hemp (*Cannabis sativa*) and *Linum usitatissimum* (flax) are obtained from the pericycle. Fibres which are obtained from pericycle are called perivascular fibres.

Leaf fibres ⇒ Manila hemp (*Musa textilis*) and agave hemp (*Agave sislana*) : These are obtained from sclerenchymatous bundle sheath.

Special points

- Fibres are longest plant cell. Longest fibres occur in *Boehmeria nivea* (Ramie fibre) length – 55 cm.
- In plant kingdom hardest seed coat is found in *Nelumbo* (Lotus).
- In plant kingdom largest leaves are found in *Victoria regia.*
- Longest leaves are found in *Raphia vinifera*. Length 10-15 m.
- Longest commercial fibres – Jute fibres.
- Living sclerenchymatous fibres are present in *Tamarix***.**

(B) COMPLEX PERMANENT TISSUES

- The complex tissues are made up of more than one type of cells and these work as a unit. Complex tissue are heterogenous. Complex tissues are of two types : (a) Xylem (b) Phloem.
- During vascularisation in plants differentiation of procambium followed by the formation of primary phloem and primary xylem simultaneously. Complex tissues are absent in gametophytes.

(a) Xylem :

- The term 'Xylem' is coined by **Nageli.** (Greek xyles – wood.)
- The function of xylem is to conduct water and mineral salts upwards form the root to stem and leaves and to give mechanical strength to the plant body.
- For conduction of water, death of protoplasm is must. Dead tissues are more develop in water scares condition.
- On the basis of **origin,** xylem is divided into primary xylem and secondary xylem.

1. Primary xylem originates form **procambium.**

On the basis of development primary xylem divided into two parts.

(1) Protoxylem **(2) Metaxylem**

- Cells of protoxylem are small as compare to metaxylem. Metaxylem is more mature than protoxylem.

DEVELOPMENT OF WATER CONDUCTING ELEMENTS OF XYLEM :

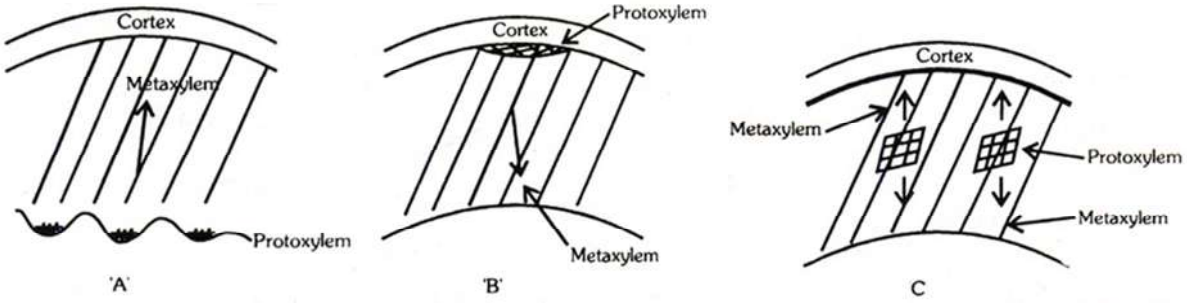
It is of three types:-

(i) Centrifugal : In this type of development, the protoxylem formed near the central axis and metaxylem is formed away from the centre it means towards the periphery.

- This condition is known as **endarch. Ex.-** stem of Angiosperm and Gymnosperm.

(ii) Centripetal : In which protoxylem is formed away from the centre it means near the pericycle and metaxylem is formed toward the centre. This condition is called **exarch.** Ex. Roots.

(iii) Centrifugal and Centripetal : In which elements of metaxylem is formed from both side of the elements of protoxylem. In this type of development protoxylem is surrounded by metaxylem. This condition is known as **Mesarch.** Ex.-Fern rhizome.



2. Secondary xylem originates from vascular cambium.

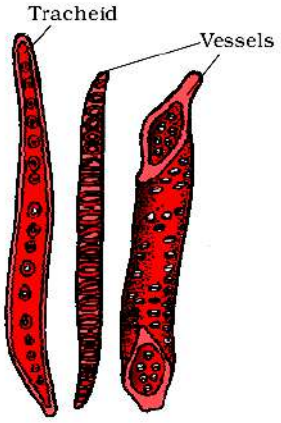
- The elements of xylem are :

(1) Tracheids, (2) Vessels or tracheae, (3) Xylem fibres & (4) Xylem parenchyma

Dead elements | Living elements

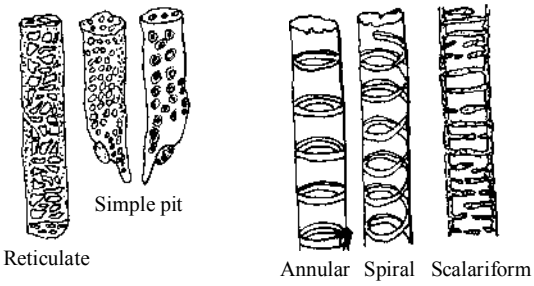
(1) Tracheids : Term was coined by **Sanio**.

- **Tracheids** are primitive **conducting elements** of xylem. They are present in all tracheophytes. They are elongated or tube like cell with thick and lignified wall and tapering end.
- **Tracheids** having a **narrow lumen**.
- Tracheids join together from **their ends** to form a **long row.** These rows extending form the root to leaves via stem.
- A **transverse septum** lies between each two tracheids. It bears **pits.** Water moves from one tracheid to another Tracheids through pits.
- Due to presence of transeverse septum lumen is discontinuous in tracheids.
- Tracheids are **dead** and **lignified** cells. The deposition of lignin on cell wall is responsible to form different type of thickenings. (Pits are nonlignified areas on lignified wall)



Note :

1. Usually broadered pits are present at end wall of tracheids.
2. The maximum bordered pits are found in the tracheids of Gymnosperm plants.
3. Maximum deposition of lignin is found in pitted type of thickening.
4. Annular and Spiral type of thickening of lignin is found in protoxylem.
5. Reticulate and Pitted (mainly) type of thickening of lignin is found in metaxylem.
6. In metaxylem tracheids of pteridophytes scalariform type of thickening is found.



Different lignified thickening in xylem (tracheids and vessels)

(2) Vessels :

- It is advance water conducting element of xylem. It is a long cylindrical tube like structure made up of many cell called vessel members each with lignified walls and large central cavity.
- The **lumen of vessels** is **wider** than tracheids and end wall is perforated **(Transverse septum** is absent between two vessel elements. If present then **porous.)** Thus vessles are more capable for conduction of water than tracheids. Due to presence of perforated end, vessels work as a pipe line during conduction of water.

- Vessels contain usually simple pits at their lateral wall. Thickening type of wall is the same as tracheids.

Note :

1. Vessels are only found in xylem of angiosperm but exceptionally it is also present in some Gymnosperms like *Ephedra, Gnetum* and *Welwitschia.*
2. Vessels are absent in some Angiospermic plants such as *Dracaena, Yucca, Dazinaria, Drimys.* There are some angiosperms families in which vesselless angiosperms are include. eg., Winteraceae, Tetracentronaceae and Trochodendronaceae.
3. Vessels are example of dead syncyte.

⇒ **Syncyte :** Cell which is formed by fusion of cells, called as syncyte.

(3) Xylem fibres :

- Xylem fibres **provides strength** to the tracheids and vessels. Mainly these fibres provide strength to the vessels. They have highly thickened walls and obliterated central lumen.
- They are present **more abundantly** in **secondary xylem.**

(4) Xylem parenchyma :

- It's cell wall is made up of cellulose. It store starch, fats and tannin etc.
- The **radial conduction of water** is the function of xylem parenchyma. (It conducts water to peripheral part of plant organs).
- They store food material in the form of starch, fat and other substance.
- Their wall possesses pits.

Hadrom :

Tracheids and **Vessels** are **collectively** known as **water conducting elements** or **"Hadrom".** Hadrom term was proposed by **Haberlandt.**

(b) <u>Phloem</u> :

- The term **'Phloem'** is coined by **Nageli.**
- The main function of the phloem is to conduct food materials, usually from the leaf to other plant parts (eg., storage organ and growing regions.)
- On the basis of origin, phloem is classified into two categories primary and secondary phloem.
- Primary phloem originates from procambium and secondary phloem originates from vascular cambium.
- On the basis of development primary phloem categorised into protophloem and metaphloem.
- The protophloem has narrow sieve tubes whereas metaphloem has bigger sieve tubes.
- Phloem remains active for less duration as compared to xylem.
- Phloem consist of **4 types** of cells.

1. Sieve cell / Sieve tube

↓ ↓

In Gymnosperms and pteridophytes — In Angiosperms

- Sieve elements was discovered by **Hartig.**
- Sieve cell/sieve tube element are living and thin **walled.**
- Mature sieve tube elements are **enucleated** living cells.
- **Central vacuole** is present in each sieve cells/sieve tube element.
- **In Angiosperm plants** sieve tube elements are arranged with their ends and form **sieve tube.**
- Sieve plate (oblique transverse perforated septa) is present between the two sieve tube elements. Materials are transported through these pores.
- **Callose** deposited on the radius of pores during **dropping season** (autumn) of leaves, to form a thick layer. This is called **Callus pad.**
- Sieve plate is protected by callus pad. It is also prevented from **bacterial infection** and drought.
- Callose dissolves during spring season by callase enzyme. Callose is a β-1-3 glucan.
- In Gymnosperms and pteridophytes sieve cells are arranged irregularly. Sieve cell have sieve plates on their lateral walls. Thus conduction of food takes place in zig-zag manner.

- In Angiosperms food conduction is erect and efficient.
- Sieve elements contain special type of protein **P-protein** (p-phloem)

Note :

1. Food conduction is **bidirectional** in sieve tube.
2. Sieve tube is an example of living enucleated syncyte.
3. Most likely function of p-protein is sealing mechanism on wounding.

2. Companion cell :

- The companion cells are specialized parenchymatous cell which are closely associated with sieve tube element. The sieve tube element and companion cells are connected by pits field present between their common longitudinal walls.
- Sieve tube element and companion cell originates together. Both of them originates from **a single mother cell**. So called as **sister cells.**
- Companion cell maintain pressure gradient in sieve tube. Functions of sieve tube are regulated by companion cell.
- Companion cells are only found in Angiosperms. (Exception – *Austrobaileya* is angiosperm plant but companion cells are absent).
- Special type of cells attached with the sieve cells in gymnosperm and pteridophytes in place of companion cells. These cells are called as albuminous cells/strassburger cell. It is analogous to companion cell.

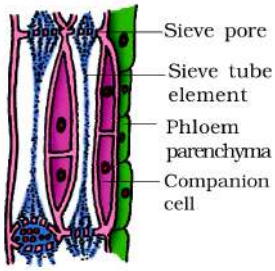
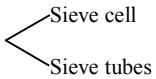


Fig. L.S. of Phloem Tissue

3. Phloem fibres :

- Fibres which are present in **phloem** are called bast fibres. These fibres are generally not found in primary phloem.
- These fibres provide mechanical support to the **conducting elements** (sieve cells and sieve tube.)

4. Phloem parenchyma :

- It is also known as bast parenchyma. It is made up of elongated tapering cylindrical cells which have dense cytoplasm and nucleus and connected through Plasmodesmata.
- It's cells are living and thin walled. It store various **material. eg.,** Resin, Latex, Mucilage etc.
- The main function of phloem parenchyma is **conduction of food in radial direction** and **storage of food.** The food conducting element of phloem is called **Leptom. Leptom** includes 

- **Leptom** term was proposed by **Haberlandt.**

Note :

1. Phloem parenchyma is absent in the stems of monocotyledon plants and in primary phloem of dicot plant.
2. Phloem parenchyma is absent in the stems of Ranunculaceae plants. (dicot family).

   e.g., *Thalictrum*.

Tissue system

☛ In higher plants several tissues work together in form of a unit to perform a particular function. These tissues have the same origin. Such tissues form a system which is called **tissue system.** On the basis of **their structure and location** tissue categorized by **Sachs** into three different system.

1. **Epidermal tissue system :** The epidermal tissue system forms the outermost covering of the plant body. It is made up of elongated compactly arranged cells which form a continuous layer. Epidermal cells are Parenchymatous cells. This system includes epidermis and its related structures. eg., Root hairs, trichomes, stomata and bulliform cells etc. It is developed from **protoderm.**

- The epidermis (Greek, Epi = upon ; Derma = skin) of most of plant organs is uniseriate, i.e. composed of single layer of epidermal cells but in some cases it may be multilayered e.g., *Ficus , Nerium, Peperomia.*
- Each cell has a large central vacuole & peripheral thin cytoplasm. They may contain anthocyanin pigments, tannins, oils and crystals etc.
- The outside of the epidermis is often covered with waxy thick layer cuticle. Cuticle is absent in roots.

  Stomata : Stomata are minute apertures in the epidermis. Each aperture is bounded by two kidney/ bean shaped cells, called as guard cells. Dumbell shaped guard cell are present in grasses.
- Guard cell contains chloroplasts. Inner wall of guard cell is thickened and outer wall are thin. There are different numbers of cells of variable size in the epidermis around the guard cells. These are called as subsidiary cells.

  Stomatal appertus = Guard cell + Stomatal pore + Subsidiary cell.
- Stomata are absent in roots, underground parts and submerged hydrophytes. Stomata regulate the process of transpiration and gaseous exchange.

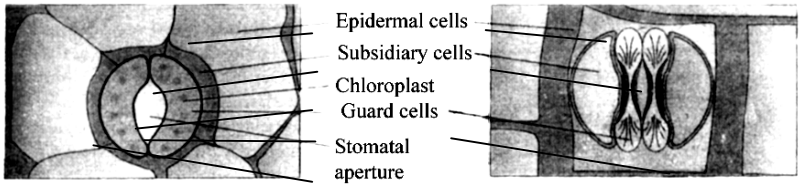


Fig.: Diagrammatic representation : (a) Stomata with bean-shaped guard cells.
(b) Stomata with dumb-bell shaped guard cell.

Trichomes : On the stem the epidermal hairs are called Trichome. These Trichome are usually multicellular. They may be branched or unbranched and soft and stiff.

Function : The trichomes help in protection, dispersal of seeds and fruits and preventing water loss due to transpiration.

Root hair : The root hairs are unicellular elongation of the epidermal cells. The thin wall is made up of cellulose and pectic materials. Root hairs are **endogenous** in origin.

Function : Root hairs play an important role in anchoring the plant body in the soil besides absorbing water and mineral solution from it.

Ground tissue culture

It is the largest tissue system. All the tissues except epidermis and vascular bundle form the ground tissue system. It includes hypodermis, general cortex, endodermis, pericycle pith and medullary rays (pith rays). It is also called as **fundamental tissue system.** In leaves ground tissue consist of chloroplast containing mesophyll.

Vascular bundles / Vascular tissue system

This tissue system originates from **pro-cambium.**

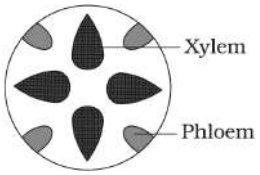
☛ Xylem and phloem are collectively termed as **Vascular bundles** or **Vascular tissues system**.

Type of vascular bundles :

☛ On the basis of arrangement of different parts, vascular bundles are divided into three categories.

I. Radial vascular bundles :

- When the xylem and phloem are present separately on different radii in alternate manner. Such vascular bundles are called **radial vascular bundle.**
- The order of development of xylem in these vascular bundles is **centripetal.** Thus, these vascular bundles are called exarch. Example : Most of the roots.
- **Exception :-** In Radish, Carrot, Turnip, Sugarbeet Conjoint-callateral, Vascular bundle are present.

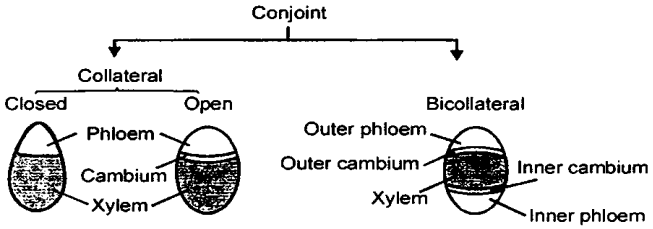


Radial vascular bundle

II. Conjoint vascular bundles :

- In this type of vascular bundle xylem and phloem are present on the same radius. These are of two types -

(1) Conjoint collateral : In this type of vascular bundle xylem and phloem are present on the same radius and phloem present towards the periphery. These are two types :



(i) Open – If the cambium is present between the xylem and phloem. It is known as **open** vascular bundle. Ex. Open vascular bundle is found in stem of **dicotyledons** and **gymnosperm.**

(ii) Close – When cambium is absent between the xylem and phloem, in conjoint vascular bundle, it is called as **closed vascular bundle.** Ex.- Closed vascular bundles are found in **monocotyledons stem.**

- In this type of vascular bundle, order of development of xylem is **centrifugal.** So **endarch** condition is found in xylem.

(2) Conjoint bicollateral and open vascular bundle – There are two patches of phloem, one on each side of xylem, are found. There are two strips of cambium (outer and inner), one on each side of xylem, are found. Such types of vascular bundles are known as conjoint, bicollateral and open vascular bundle.

- Order of development of xylem is centrifugal so endarch condition is found.

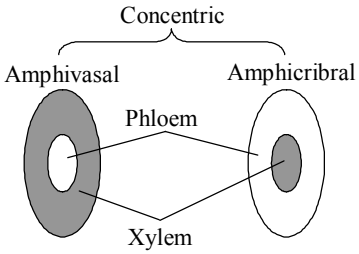
Ex.- Stem of family Cucurbitaceae, Apocynaceae and Solanaceae.

III. Concentric vascular bundles :

- In this type of vascular bundle either xylem surrounds the phloem or phloem surrounds the xylem. Concentric vascular bundles are always closed. They are of two types -

(a) Amphicribral or hadrocentric :

- In this type of vascular bundle xylem is completely surrounded by phloem. It means xylem is present in the centre of vascular bundle. Such type of vascular bundle is termed as **amphicribral.**
- The order of development of xylem in these vascular bundles both centripetal and centrifugal manner. In this type of vascular bundle protoxylem surrounded by metaxylem. These are known as mesarch vascular bundle. Such types of vascular bundles are found **ferns rhizomes**.



(a) Amphivasal or leptocentric :

- In this type of vascular bundle phloem is completely surrounded by xylem. It means phloem is present in the centre of the vascular bundle. In this type of vascular bundle, xylem is endarch. Eg., Stem of ***Dracaena, Yucca*** etc.

Internal structure of stems, roots & leaves

Internal structure of typical dicotyledon - root

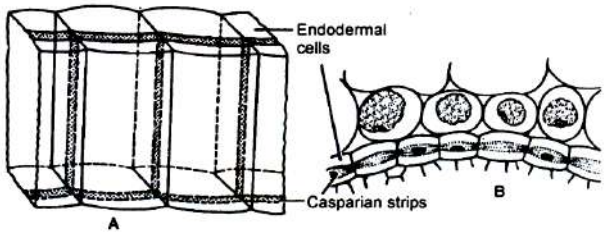
Internal structure of a typical dicotyledon root shows following features : -

1. **Epidermis : -** It is **uniseriate** outermost layer. It comprising tubular living components. Cuticle and stomata are absent. Unicellular root hairs are formed due to elongation of some cells of epidermis.
2. **Cortex : -** It is made up of parenchymatous cells with intercellular space.

Note : The cells of outer part of cortex are suberized in old root. It is called **exodermis.**

Exodermis found in some dicotyledon roots and most of the monocotyledon roots.

3. **Endodermis :** Inner most layer of cortex is known as endodermis. **Casparain strips** are present on radial and tangential wall of endodermis. These strips are made up of **suberin**. Casparian strips are discovered by **Caspari**.



Endodermal cells : Casparian strips in tangential and radial walls

- The cells of endodermis which are situated in front of protoxylem cells lack of casparain strips. These are called **passage cells.** The number of **passage cells** is equivalent to the **protoxylem cells** and number of rows of root hair equivalent to protoylem cells.
- Passage cells provide path to absorbed water from cortex to pericycle.

Note :

(1) Root hairs are linearly arranged on root apex.

(2) Casparian bands and passage cells are well developed in monocot root.

(3) Endodermis acts as a **water tight jacket** and prevents radial conduction of water

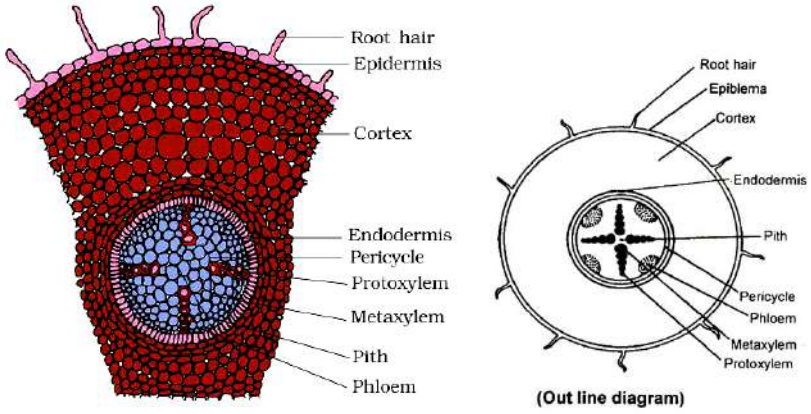


FIG.: T.S. OF TYPICAL DICOTYLEDON ROOT

4. **Pericycle :** It is few thick layered. It is composed of **prosenchyma**.
- **Lateral** roots are originated from the part of **pericycle** which is lying opposite to protoxylem. Thus lateral root are **endogenous** in origin.
- A few mature cells of pericycle usually opposite to protoxylem, become meristematic. these cells divide by periclinal divisions and form some layers of cells. these divisions are followed by anticlinal divisions forming a primordium which grows to form a lateral root.

  Note : Adventitious root are also **endogenous.** Because these are originated from stellar region.
- Some part of vascular cambium in root is originated from pericycle.

5. **Vascular bundles : -** Vascular bundles are **radial** and **exarch**. Xylem and phloems are separate and equal in number. The numbers of xylem bundles are usually two to four (**diarch** to **tetrarch upto hexarch**).
- But exceptionally, **Ficus** (Banyan tree) root is **polyarch.**
- Parenchyma which is found between xylem and phloem, called **Conjunctive tissue.**
- Vascular cambium is developed from it.

6. **Pith : -** In dicot root pith is **small or inconspicous.**

Internal structure of monocotyledonous – root

- The internal structure of a typical monocotyledon root is similar to dicotyledon root.

  But

  (1) Number of xylem bundles are **more than six** (Polyarch) in monocotyledon root (**exceptionally** the number of xylem bundles are two to **six** in **onion**).

  (2) Pith is **well developed** in monocotyledon root

  (3) Only lateral roots are originated from pericycle.

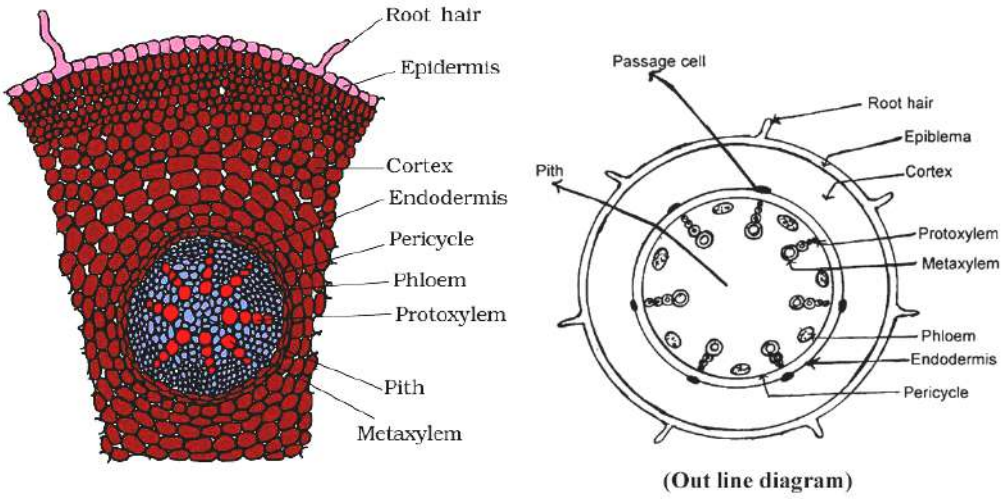


Fig.: T.S. of Monocotyledon Root

☛ **Difference between dicot root and monocot root**

S.No.	Character	Dicot root	Monocot root
1	Pericycle	Gives rise to secondary roots and lateral meristem	Gives rise to lateral roots only.
2	Vascular bundles	Diarch to hexarch	Polyarch
3	Cambium	Develops at the time of secondary growth	Absent
4	Pith	Absent or poorly developed	Fully developed

INTERNAL STRUCTURE OF DICOTYLEDONOUS STEM :

Internal structure of a typical dicot stem show following features :

1. **Epidermis :** Epidermis is the outermost layer of the stem. It is single layered. Multicellular hair (trichomes) and stomata are found on epidermis. Outer side of epidermis, a layer is present which is made up of cutin is called cuticle.
   - Epidermis plays a significant role in protection.
2. **Cortex :** In dicotyledon stem cortex divided into three parts :
   (a) Hypodermis (b) General cortex (c) Endodermis
   (a) Hypodermis : It is present just below the epidermis. It provides mechanical support to young stem. This layer is composed of **collenchyma** and their cells contain **chloroplast.** So hypodermis is **green** and **photosynthetic.**
   (b) General cortex : This part is composed of **parenchyma.** Storage of food is the main function of the cortex. Resin canal/mucilage canal are present in it. These are **schizogenous** in origin.
   (c) Endodermis : It is single celled thick layer. The cells of **endodermis are barrel shaped.** These cells accumulate **starch** in stem of dicot. Thus, it is known as **"starch sheath".**
3. **Pericycle :** Pericycle is present on the inner side of the endodermis and above the phloem in the form of semi lunar patches of sclerenchyma.
   Note : In **sunflower** stem, pericycle is made of alternate bands of **parenchymatous** and **sclerenchymatous** cells. In which pericycle which is present in front of the vascular bundle is made up of sclerenchyma and remaining is composed of **parenchyma.** Part of pericycle which is situated in front of vascular bundle is known as **Bundle cap.** Pericycle is **heterogenous** in sunflower stem.
4. **Vascular bundle :** Large number of vascular bundles **(wedge shaped)** are arranged in a ring. Each vascular bundle is **conjoint, collateral** and **open.** Each vascular bundle is made of phloem, cambium and xylem. **Eustele** is present in dicotyledon stems.
5. **Pith :** This is well developed region, spreading from ring of vascular bundle to the centre. The cells of this region mainly made up of **parenchyma.**
   Function of pith – Storage of water and food.
   Note : The part of pith which is radially arranged between the vascular bundles, called **pith rays or medullary rays.** The main function of pith rays is radial conduction of food and water.

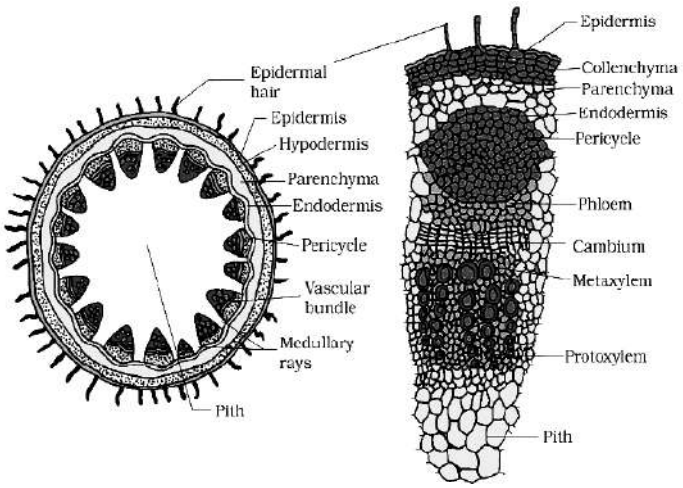


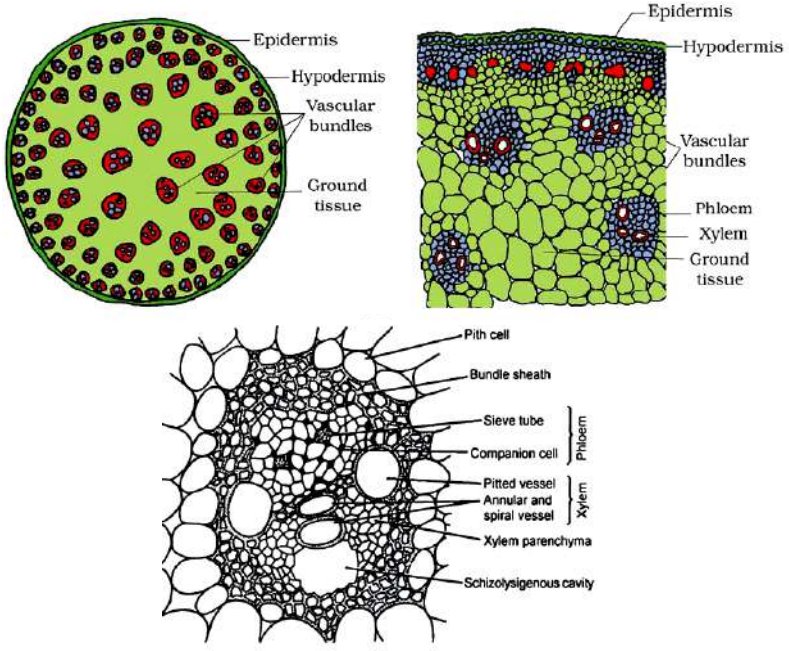
Fig.: T.S. of Stem

Internal structure of monocotyledonous stem

1. **Epidermis :** Epidermis is the outer most single celled thick layer. It is covered with thick cuticle. Multicellular hair are absent and stomata are also less.
2. **Hypodermis :** Hypodermis of monocotyledon is made up of **sclerenchyma.** It is 2-3 layered. It provides **mechanical** support to plant.
3. **Ground tissue :** The entire mass of parenchyma cells next to hypodermis and extending to the centre is called ground tissue. There is **no differentiation** of ground tissue in monocotyledon stem.
4. **Vascular bundle :** Many vascular bundle each surrounded by sclerenchymatous bundle sheath are scattered in the ground tissue and V.B. are generally oval shape. Each vascular bundle is conjoint collateral and closed. Peripheral vascular bundle are generally smaller than centrally located ones.
   - **(a) Xylem :** In xylem number of **vessels** is less. In metaxylem there are **two** large vessels while in protoxylem there are **one** or **two** small vessels. Vessels are arranged in **V** or **Y** shape. Just beneath protoxylem vessels, there are a **water cavity** which is schizolysigenous in origin but major part of water cavity is **lysigenous.** This cavity is formed by disintegration of the element present below the protoxylem and neighbouring parenchyma.

     Exception : In *Asparagus* water cavity and bundle sheath are absent.
   - **(b) Phloem :** It consist of sieve tube elements and companion cells. **Phloem parenchyma** is absent.

     Stele : Atactostele is found in monocotyledon. This is the most **developed stele.**



A Vascular Bundle

S.No.	Monocot stem	Dicot stem
1.	Epidermis with generally comparatively **smaller** cells.	Epidermis is made of comparatively **larger** cells.
2	Hairs are generally **absent**.	Multicellular hairs are **present**.
3.	Hypodermis is **sclerenchymatous**.	Hypodermis is **collenchymatous**.
4.	Cortex is generally absent, but from hypodermis to centre of stem there is **ground tissue** present.	Cortex is made of many layered parenchymatous cells.
5.	Endodermis is absent.	Endodermis is **present** but usually poorly developed.
6.	Pericycle is **absent**.	Pericycle is made of one or many layers of cells.
7.	Medullary rays are **absent**.	Medullary rays are **present** between vascular bundles.
8.	Pith is **absent**.	Pith is **present**.
9.	Vascular bundles :	
	(a) Scattered V.B.	(a) V.B. are arranged in a ring.
	(b) V.B. are conjoint, collateral and **closed**.	(b) V.B. are conjoint, collateral and **open**
	(c) There is differences in the size of V.B. in the centre and at periphery, i.e., V.B. in centre are larger in size and towards periphery are smaller.	(c) V.B. are of same size.
	(d) Bundle sheath is **present** around vascular bundle in monocot stem	(d) Bundle sheath is **absent**.
	(e) **Oval** vascular bundles.	(e) **Wedge shaped** vascular bundles.
	(f) Phloem parenchyma is **absent**.	(f) Phloem parenchyma is **present**.
	(g) Xylem vessels are 'Y' or 'V' shaped.	(g) Xylem vessels are radial.

Internal structure of leaf

Generally leaves divided into two categories – Dorsiventral leaves and isobilateral leaves. The differences in between them as follows :

Dorsiventral or Bi-facial	Iso-bilateral or Equifacial
1. Present at right angle to stem	**1.** Arranged parallel to stem.
2. Upper surface of leaf receive more sun light as compared to lower surface, so there are difference between internal structure of upper and lower surface of leaf.	**2.** Both surface of leaf receive equal amount of sun light so there are no difference between internal structure of upper & lower surfaces.
Examples : Dicots	Example : Monocots
Exception – *Eucalyptus*, *Nerium*.	Exception – *Lilium longiflorum*

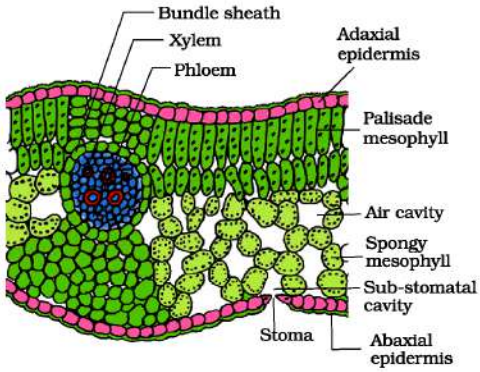
Difference between dicot leaf (dorsiventral) & monocot (isobilateral)

	Character	Dicot leaf	Monocot leaf
(i)	Leaf	Dorsiventral	Isobilateral
(ii)	Stomata	Usually more on lower epidermis (Hypostomatic)	Equal on lower and upper epidermis (Amphistomatic)
(iii)	Mesophyll	Made up of two types of tissues (A) Palisade parenchyma (B) Spongy Parenchyma with large intercellular spaces	Only spongy parenchyma is present which has very small spaces.
(iv)	Bundle sheath	Made up of parenchyma just above and below vascular bundle. Some parenchyma cells or collenchymatous cells are present upto epidermis	Just above and below the vascular bundles sclerenchymatous cells (up to epidermis) are found.
(v)	Bulliform Cells	Absent	Present

Internal structure of dorsiventral leaves

- Cuticle is present on both surfaces but cuticle of upper surface is thicker.
- Dorsiventral leaves are mostly **hypostomatic** i.e. stomata present on lower surface.

  Note : In amphistomatic dorsiventral leaves stomata are more on lower surface.
- Mesophyll of these leaves is divided into two regions – Palisade tissue and spongy tissue.
- Palisade tissue is found towards upper surface. These cells have more chloroplasts. Spongy tissues is found towards lower surface and have large intercellular space.

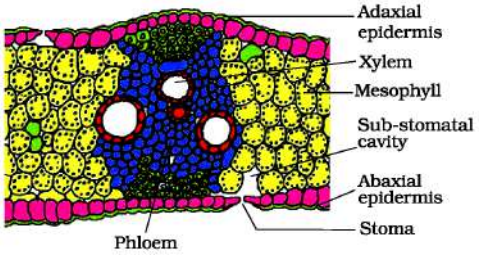


Internal structure of isobilateral leaves

- The thickness of cuticle on the both surface is equal.
- Distribution of stomata on both surface's are **equal**.

  Note : Isobilateral leaves are **Amphistomatic** i.e. stomata present on both sides.
- Mesophyll of isobilateral leaves is not differentiated into palisade and spongy tissues. It is completely made up of spongy tissues. **Palisade tissues are absent.**
- **Bulliform cells : -** Large cells are found in the epidermis of psammophytic (desert) grasses which are filled by liquid or empty (mostly) and colourless are called bulliform cells or motor cells. When the bulliform cells in the leaves have absorb water and become turgid the leaf surface is exposed. When they are flaccid due to water stress they make the leaf curl and minimize water loss.

  Example : - Ammophila, Poa, Empectra and **Agropyron** etc. are Psammophytic grasses



Vascular bundles of leaves

- Similar types of vascular bundles are found in both dorsiventral and isobilateral leaves. Vascular bundles of leaves are **conjoint, collateral** and **closed.** Protoxylem is situated towards the adaxial surface and protophloem towards the abaxial surface in the vascular bundle.
- The sizes of the vascular bundle are dependant on the size of vein. The veins vary in thickness in the reticulate venation. Thus different size vascular bundles are present in dicot while in parallel venation similar size vascular bundle are present.

  Vascular bundles are surrounded by a **bundle sheath**. Bundle sheath is **chlorenchymatous** in C-4 plants. Epidermis of **Nerium** (both upper & lower) and **Ficus** (only upper epidermis) becomes **multilayered**. This is an adaptation to reduce transpiration.

Anatomy – secondary growth

Secondary growth :

- By the activity of lateral meristems, increase in the **circumference/girth** of the plant organs due to the formation of secondary tissues in stelar & extra stelar regions called secondary growth.
- Normally secondary growth takes place in roots and stem of **dicotyledons & Gymnosperms**.
- Due to lack of cambium in monocotyledons, secondary growth is absent. But exceptionally secondary growth takes place in some monocotyledons. Such as- ***Palm, Yucca, Dracaena, Smilax, Agave, Coconut*** etc.
- Pteridophytes and monocots have only primary structure but gymnosperm and dicots soon start undergoing secondary growth.

Secondary growth in dicot stem

[A] Secondary growth in stelar region or secondary growth in vascular region

Secondary growth in stelar region begins earlier than the extra stelar region.

I. Formation of ring of vascular cambium : - A cambium which is present inside the vascular bundle is called **intrafascicular – cambium**. This is a type of primary meristem.

- First of all, cells of medullary rays become meristematic to form interfascicular cambium which is secondary lateral meristem.
- Intrafascicular and interfascicular cambium are collectively known as **vascular cambium**. Vascular cambium is formed in the form of a complete ring which is made up of single layer of cells.
- In dicot stem some part of vascular cambium is primary and some part is secondary.
- Two types of cells are found in the ring of this vascular cambium.

  (i) Fusiform initials

  (ii) Ray initials.
- Fusiform initials are long with **pointed ends**, while ray initials are **spherical** (oval).
- **Amount of fusiform initials** is more in **vascular cambium**.

II. Activity of vascular fusiform initials :

(a) Activity of fusiform initials :

- Continuous **periclinal** divisions or **tangential** division takes place in fusiform initials .
- This type of activity few cells are formed towards the periphery and these cells differentiate into secondary phloem or bast and some of the cells are formed towards the central axis and these cells are differentiated into secondary xylem or wood.
- Normally more secondary xylem is formed as compared to secondary phloem due to unequal distribution of hormones.

  (Secondary xylem is formed 8-10 times more as compared to sec. phloem).
- By the pressure of newly formed secondary phloem, primary phloem and initially formed secondary phloem is pushed towards the outside and get crushed.
- The primary xylem however remain less or more intact in or around centre.
- By the pressure of secondary xylem, all the primary tissues-such as primary xylem, pith etc and old secondary xylem degenerates in the centre of the stem. Due to this, central part of the stem becomes woody. These activities are going on continuously in plants throughout the life.

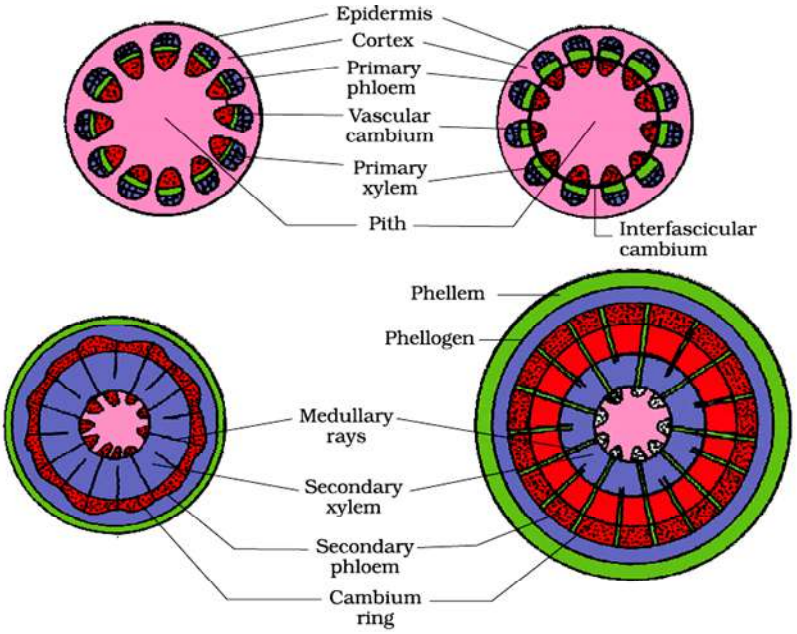


Fig.: Secondary growth in a dicot stem (diagrammatic) – stages in transverse views

- Secondary xylem forms in plant regularly and primary tissues degenerate continuously. This new secondary xylem also degenerate the old secondary xylem. Waste materials are formed in the stem such as **lignin, suberin, tannin, resin, gums** etc. due to degeneration of the cells. All these waste materials are filled in the **lumen** (cavity) of **tracheids** and **vessels of secondary xylem**.

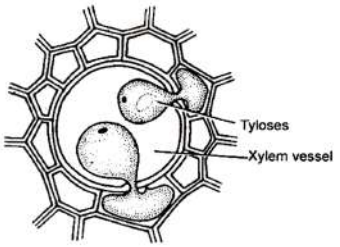
  Because of this, wood in the central region of the stem becomes dark coloured (Black brown). It is called **Heart wood or Duramen**. The peripheral or outer wood which looks light in colour is known as **Sap wood or Alburnum**. As a result of growth of secondary xylem, the **diameter** of **heart wood increases**.

  Physiologically active wood is sapwood. The main function of sap wood is water conduction. Heart wood provides maximum mechanical strength to stem.

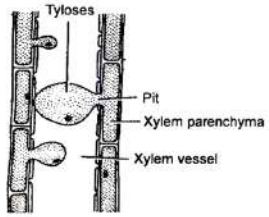
  Note : Conduction of water is not carried out by heart wood because : -

1. Cavities of tracheids and vessels are progressively filled by waste materials.
2. The bladder like ingrowth of parenchyma cells, which enter the lumen of vessels (mainly) & tracheids through the pits in their wall. Such bladders like ingrowth are called as **tyloses**. Tyloses blocks the **conduction** of water.

   Note: In gymnosperms **tylosoids** are formed in place of tyloses.



T.S. of Sec. xylem vessels showing tyloses



L.S. of Sec. xylem vessels showing tyloses

Special points

1. If the heart wood is destroyed in any stem, then there will be no effect on plants (any vital function is not effected), but if the sap wood is destroyed, then the plant will die because conduction of water will be blocked.
2. Study of wood is known as **Xylotomy**.
3. If a wood is exposed freely in air then **decomposition** of **sap wood** takes place **rapidly**.
4. Position of youngest layer of secondary phloem is just outside the vascular cambium.
5. Position of oldest layer of secondary phloem is just inside the primary phloem.
6. Position of youngest layer of secondary xylem is just inside the vascular cambium.
7. Position of oldest layer of secondary xylem is just outside the primary xylem.
8. If xylem is blocked then shoot will die first.

   Activity of ray initial : - Periclinal divisions are also going on continuously in ray intials of vascular cambium. Some of the cells are formed towards inside and some of the cells are formed towards outside through these divisions and these cells are made up of parenchyma. Radial lines of cells of parenchyma are formed in the stem. These are called **Vascular rays or Sec. medullary rays.** They conduct **water** and **food** in **radial direction**. Order of development of vascular rays is both centripetal and centrifugal manner. They pass through secondary xylem to secondary phloem in radial manner.

III. Formation of annual rings (spring wood and autumn wood)

Annual rings are formed due to unequal activity of vascular cambium.

- The activity of cambium does not remain same, it is **changeable** through out whole year. Activity of vascular cambium is affected by physiological and environmental factors.
- In **winter** or **autumn** season the activity of the cambium is less and forms fewer xylary elements. Cells formed during this period, are small, thick walled darker with higher density and have narrow lumens. This is called **autumn wood** or **late wood**.
- The vascular cambium is highly active in **spring** or **summer** season and produce a large number of xylary element and cells of secondary xylem are larger, thin walled lighter in colour with a lower density and have wider lumen. This wood is known as **spring wood** or **early wood**.

  (1) The **autumn** and spring wood are formed in the form of rings. The ring of any type of wood is called **growth ring**. Thus **two growth** rings are formed in one year and they collectively constitute annual ring.

  (2) The numbers of annual rings, formed in a tree give the idea of the age of the tree. The study of determination of age of the plant by this technique is called **Dendrochronology**.

  (3) The annual rings are counted from the base of the stem because basal part has maximum annual rings and upper part has less. Therefore counting from the basal region can give the correct idea.

- The width of annual ring is less in unfavorable conditions and more in favorable conditions. Thus the annual rings are also indicative of environment period, the tree has encountered perviously.

(4) A piece is taken from the stem from the base of stem with the help of **increment borer** instrument. The annual rings are counted from that piece and again inserted (fitted) into the same stem at the same place.

(5) More **distinct** annual rings are formed in that region where climatic variations are sharp.

(6) More distinct annual rings are formed in **temperate** plants.

(7) Distinct annual rings are not formed in tropical plants.

(8) Distinct annual rings are not formed in India except **Himalayan** regions.

(9) Least distinct annual rings are formed in **seashore** regions because the climate remains same through out the year.

(10) More clear annual rings are formed in **deciduous** plants as compared to **evergreen** plants. (In temperate region)

(11) In deserts annual rings are less distinct.

[B] Secondary growth in extra stelar region (cork cambium) :

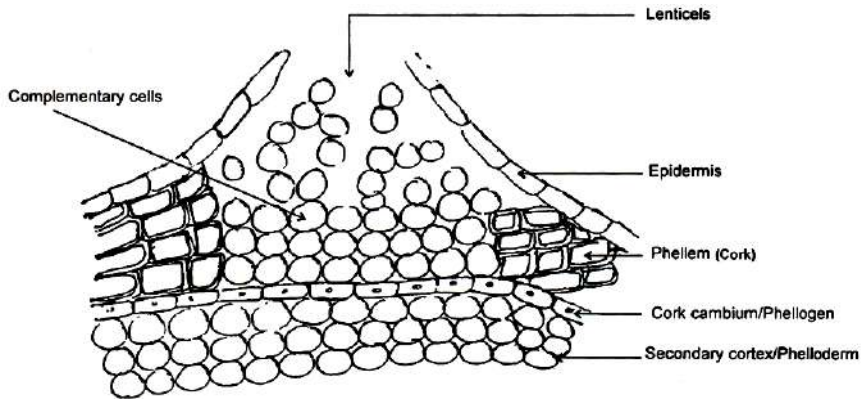
- Secondary growth takes place in extra stelar region due to the activity of cork cambium. Cork cambium is also known as Phellogen or Extrastelar cambium.
- Cork cambium arises from the hypodermis or from the outer layer of cortex because they become meristematic.
- Cork cambium forms some cells towards the outside (epidermis) and some cells towards the inside (cortex). Those cells formed towards outside, their middle lamella is suberized. Due to this, these cells become dead. These cells are known as Cork or Phellem. Those cells formed towards the inside, are differentiated into parenchyma and may contain chloroplasts. These are called secondary cortex or Phelloderm.

  Phellem (cork) + Phellogen (cork cambium) + Phelloderm (secondary cortex) = Periderm
- Cork is formed in more quantity and secondary cortex is in less quantity because activity of Cork cambium is more towards outside. The maximum activity of cork cambium is in **winter** (Autumn) season.

Bark :

- All the tissues situated out side the vascular cambium is called **Bark**. According to modern view bark includes both living and dead tissues. **Bark** has two parts. Outer layer of bark is called **Rhytidome** and inner layer of bark is **secondary** phloem.
- Bark that is formed early in the season is called early or soft Bark. Towards the end of season late or hard bark is formed.

Lenticels :



At certain region the phellogen cuts off closely arranged parenchymatous cell on the outer side of the cork cell instead of cork cell (complementary cell). These cell rupture and form lens shaped opening which is known as Lenticels.

Function :

1. The main function of lenticels is exchange of gases between plant and atmosphere.
2. Transpiration also takes place through the lenticles, is known as **Lenticular transpiration**.
3. Adventitious roots on cutting originate from the living cells of lenticels in vegetative reproduction.

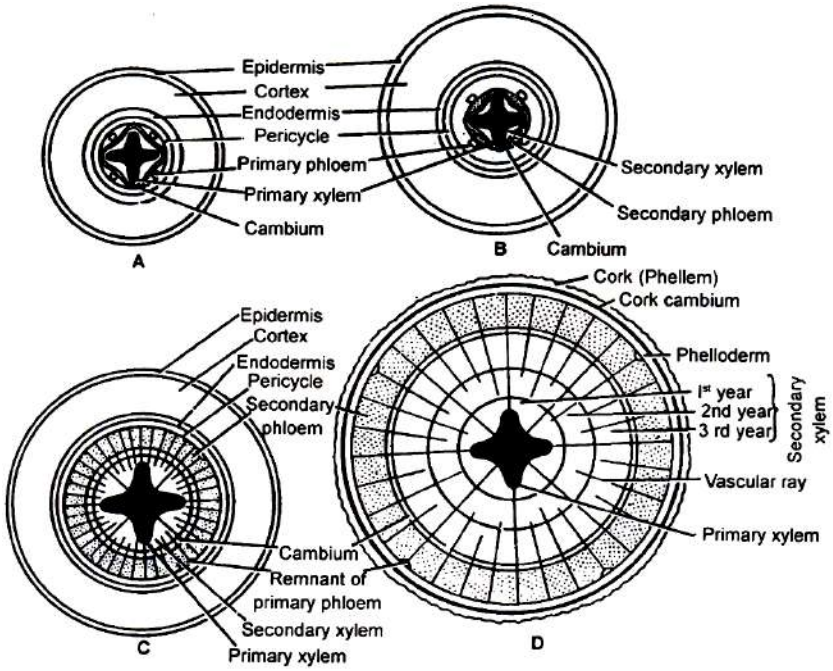
Note :

- Lenticels are found in most of the **woody trees** but absent in woody climbers.
- Lenticles are present all over the plant body. They are also present on **fruits**. They are never found on leaves.

SECONDARY GROWTH IN DICOT ROOT

- First of all, conjunctive tissue becomes meristematic during the secondary growth in a dicotyledon root and form separate **curved strips** of vasular cambium below phloem bundles. Then after, the cells of pericycle lying opposite to protoxylem also become meristematic to form additional strips of cambium. In this way a complete ring of vascular cambium is formed.

  The portion of vascular cambium formed by pericycle is less. The main portion of vascular cambium is formed by conjunctive tissue. Vascular cambiums in roots are secondary in origin.



Different Stages in Secondary Growth of Dicot Root

- The activity of vascular cambium of root is the same as the activity of vascular cambium of stem. Secondary xylem is formed towards the inner side and secondary phloem is formed towards the outer side by vascular cambium.
- The portion of vascular cambium which is formed by pericycle is responsible for the formation of **pith rays.** These are made up of parenchyma. These pith rays are known as **primary medullary rays** (Multiseriate).
- A few medullary or pith rays are also formed from remaining vascular cambium. These are called **secondary medullary rays** (uniseriate). Thus two types of medullary rays are found in the secondary structure of roots.

  Note : The presence of two types of medullary rays is basic characteristic feature of roots. Only secondary medullary rays are found in stem after the secondary growth. Both of them conduct **water** and **food in radial direction.**
- Cork cambium is developed from the **pericycle** in roots. Cork is formed towards the outside and secondary cortex is formed towards the inner side by the cork cambium. Lenticles are also found in roots but less in number as compared to stem. Cortex completely degenerate in roots after the secondary growth of one or two years. This falls down due to the pressure of cork, whereas in stem, it degenerates after the long duration.
  (i) Secondary growth is essential in roots to provide strength to the growing aerial parts of the plants and fulfill the requirement of water and minerals.
  (ii) Annual rings are not formed in roots because these are not effected by the changes of environment.
  (iii) Secondary growth is not found in monocot roots. Secondary growth present in *Yucca* and *Dracnea*.
  (iv) In roots, all cambia are secondary in origin.

Important Comparison Tables

Porous wood (Hard wood)	Non porous wood (Soft wood)
(i) This wood is found in angiosperms	It is found in Gymnosperms.
(ii) Vessels are present.	Vessels do not present.
(iii) This wood is hard.	It is soft.
(iv) Xylem fibres are present.	Xylem fibres are rarely present.
(v) Vessels are more in porous wood.	Xylem tracheids are dense.
(vi) It is also called heteroxylous wood	It is called homoxylous wood.

Duramen (Heart wood)	Alburnum (Sap wood)
(i) Duramen wood dark in colour.	Alburnum wood light in colour.
(ii) This wood does not conduct water.	Alburnum wood conduct the entire water.
(iii) In this wood, Tyloses are present.	In this wood tyloses are not present.
(iv) It gives the mechanical support to the plant.	It does not gives mechanical support.
(v) It is present in the central part of the tree stem.	It is found in outer part of stem.

Spring wood	Autumn wood
(i) Spring wood are generally light brown in colour.	Autumn wood are dark brown in colour.
(ii) In plant, its quantity is more.	In plant, its quantity is less.
(iii) Its vessel are broad and with large cavity.	Its vessels are small and with narrow cavity.
(iv) It is made up in favourable conditions.	It is made up in unfavourable conditions.
(v) It is produce from more activity of cambium.	It is produce from less activity of cambium.
(vi) In wood, the fibre are less present.	In wood, the fibre are more present.

Exercise 1

Question based on Introduction

Q.1 A tissue is a group of cells which are -
(1) Similar in origin, but dissimilar in form and function
(2) Dissimilar in origin, form and function
(3) Dissimilar in origin, but similar in form and function
(4) Similar in origin, form and function

Q.2 A meristem may be defined as the group of cells which
(1) Add to the bulk of the Plants
(2) Conserve food
(3) Divide continuously to give rise to new cells
(4) Elongate and add to the group of cells

Q.3 Embryo of a seed is made up of –
(1) Meristematic tissue (2) Parenchyma
(3) Collenchyma (4) Sclerenchyma

Q.4 Maximum growth in root occurs –
(1) At its tip (2) Towards light
(3) Behind the apex (4) Towards apex

Q.5 In plants, during embryonic condition –
(1) All cells of the embryo divide
(2) Meristematic activity is confined to single apical cell
(3) Meristematic activity is confined to a group of apical cells
(4) Apical & lateral cells only divide

Q.6 The function of root cap is -
(1) Protection of root tip and control of geotropic movement
(2) Storage of food products
(3) Absorption of nutrients
(4) None of the above

Q.7 In quiescent zone, DNA content is -
(1) High (2) Low
(3) Very high (4) Balanced

Question based on Plant Tissue

Q.8 Bamboo, grass and mint stem elongate by the activity of -
(1) Primary meristem (2) Secondary meristem
(3) Intercalary meristems (4) Apical meristems

Q.9 A. Generally absent in primary phloem
B. Elongated unbranched pointed needle shaped cell
C. Devoid of protoplasm at maturity
D. Can be used commercially
Above mentioned statement can belongs to -
(1) Sclereids (2) Xylem sclerenchyma
(3) Phloem fiber (4) Xylem trachied

Q.10 Which of the following is a well differentiated plant tissue ?
(1) Apical meristem (2) Cambium
(3) Parenchyma (4) All of the above

Q.11 Which of the following is a primary meristem ?
(1) Intra fascicular cambium
(2) Cork cambium
(3) Vascular cambium in roots
(4) Inter fascicular cambium

Q.12 The secondary meristem originates from -
(1) Promeristem (2) Primary meristem
(3) Permanent tissue (4) Secretory tissue

Q.13 Which of the following is secondary meristem?
(1) Protoderm (2) Procambium
(3) Cork cambium (4) All of the above

Q.14 The cells of a permanent tissue do not divide because these are -
(1) Dead (2) Enucleate
(3) Arrested at G-1 stage (4) Arrested at prophase

Q.15 A parenchyma cell which stores ergastic materials or waste substance is -
(1) Phragmoblast (2) Conidioblast
(3) Idioblast (4) Blastomere

Q.16 In plants, which of the following would most likely show totipotency -
(1) Xylem Vessels (2) Meristem
(3) Cork (4) Sieve tube

Q.17 The tissue not having specifically thickened walls are -
(1) Parenchyma (2) Collenchyma
(3) Fibres (4) Sclereids

Q.18 Which of the following tissues form the main bulk of storage organ -
(1) Parenchyma (2) Collenchyma
(3) Sclerenchyma (4) Aerenchyma

Q.19 Flesh of a fruit is mostly made up of -
(1) Parenchyma (2) Collenchyma
(3) Sclereids (4) Meristem

Q.20 Collenchyma is found in -
(1) Herbaceous climbers (2) Hydrophytes
(3) Woody climbers (4) Xerophytes

Q.21 A simple mechanical tissue devoid of lignin is -
(1) Parenchyma (2) Collenchyma
(3) Sclerenchyma (4) Chlorenchyma

Q.22 Collenchyma differs from sclerenchyma in -
(1) Retaining protoplasm at maturity
(2) Having thick walls
(3) Having a wide lumen
(4) Being meristematic

Q.23 Prosenchyma forms -
(1) Root-pericycle (2) Stem-pericycle
(3) Root-endodermis (4) Stem-hypodermis

Q.24 Which of the following tissue provide tensile strength against bending & swaying –
(1) Parenchyma (2) Collenchyma
(2) Sclerenchyma (4) Sclereids

Q.25 Sclerenchymatous cells in their cell walls have large percentage of -
(1) Cellulose (2) Pectin
(3) Lignin (4) Silica

Q.26 Fibre (longest plant cell), belongs to which tissue
(1) Parenchyma (2) Collenchyma
(3) Sclerenchyma (4) Aerenchyma

Q.27 Tissue which develops more due to scarcity of water –
(1) Sclerenchyma (2) Collenchyma
(3) Parenchyma (4) Meristem

Q.28 All the xylem elements, when mature are dead except -
(1) Tracheids (2) Vessels
(3) Xylem Parenchyma (4) Xylem Fibre

Q.29 Which of the following plant cells are without vacuoles and without nuclei -
(1) Cambium cells (2) Xylem vessels
(3) Root hairs (4) Companion cells

Q.30 Vessels differ from tracheids –
(1) In being living
(2) In being derived from a single cell
(3) In having vertical row of cells with cross walls dissolved
(4) Because they conduct water

Q.31 The tissue responsible for translocation of food material is –
(1) Parenchyma (2) Sieve tubes
(3) Vessels (4) Fibers

Q.32 Phloem of angiosperm is different from that of pteridophytes and gymnosperm in –
(1) The absence of enzymes
(2) Presence of endocytosis
(3) Presence of companion cells
(4) Presence of sieve tubes

Q.33 Cell which is functionally related to sieve tube
(1) Phloem fiber (2) Phloem parenchyma
(3) Companion cell (4) Collenchyma

Q.34 Mature sieve tube differs from vessels -
(1) Absence of functional nuclei
(2) Absence of lignified wall
(3) Almost Dead
(4) Absence in cytoplasm

Q.35 Vessels in xylem and companion cell in phloem is characteristic feature of -
(1) Gymnosperm (2) Pteridophyta
(3) Angiosperm (4) Bryophyta

Q.36 Sieve plate in angiosperm are present in
(1) Oblique and lateral wall
(2) Straight and end wall
(3) Oblique and end wall
(4) Straight and lateral wall

Q.37 Thickening in collenchyma occurs the due to deposition of
(1) Cellulose (2) Pectin
(3) Lignin (4) Suberin

Q.38 Complex tissue are not present in
(1) Some Bryophyta (2) Pteridophyta
(3) All gametophyte (4) All spermatophyta

Q.39 Main function of tracheids in plants are
(1) Sap conduction
(2) Only mineral transportation
(3) Loss of excess water in night
(4) Translocation of organic solute

Q.40 Presence of vessels in plant is
(1) A primitive character
(2) A progressive character
(3) A vestigial character
(4) None of the above

Q.41 End wall of tracheids and vessels are
(1) Pitted and porous
(2) Porous and pitted
(3) Both porous
(4) Both pitted

Q.42 Xylem fibers provide strength to
(1) Vessels
(2) Tracheids
(3) Parenchyma
(4) Storage tissue

Q.43 Sieve tube elements are ideal component for nutrients translocation because -
(1) End wall is not present
(2) Bordered pits are present
(3) Narrow lumen rich in cytoplasm
(4) Broad lumen with small quantity of peripheral cytoplasm

Q.44 Long pointed sclerenchyma cells are –
(1) Fibres (2) Tracheae
(3) Wood parenchyma (4) Sclereids

Q.45 Sieve tubes are characterised by –
(1) Absence of septa
(2) Simple oblique septa
(3) Perforated longitudinal walls
(4) Perforated oblique septa

Q.46 Sugar transport elements of gymnosperms & pteridophytes are –
(1) Sieve cells (2) Sieve elements
(3) Sieve tubes (4) Sieve tube elements

Q.47 Abscission layer is made up of –
(1) Cork cells (2) Sclerenchymatous cells
(3) Collenchymatous cells (4) Parenchymatous cells

Q.48 Gymnosperm wood is non porous because it –
(1) Lacks vessels
(2) Contains tracheae
(3) Has abundant fibres
(4) Contains no fibres

Q.49 Meristematic activity is at its maximum in the
(1) Shoot apex (2) Bud
(3) Leaf (4) Root hair

Q.50 Which of the following cell is not totipotent
(1) Pollen grain
(2) Sieve tube
(3) Pith cell
(4) Parenchyma

Question based on The Tissue System

Q.51 Epidermal cells are -
(1) Guard cells (2) Root hairs
(3) Trichomes (4) All of the above

Q.52 When xylem and phloem are on same radius, the vascular bundles are said to be –
(1) Radial (2) Conjoint
(3) Concentric (4) Exarch

Q.53 When a meristematic tissue "Cambium" is present inside a vascular bundle, the bundle is said to be –
(1) Conjoint (2) Open
(3) Closed (4) Collateral

Q.54 A vascular Bundle in which phloem is on both the sides of the xylem and separated from it by strips of cambium is said to be –
(1) Collateral open (2) Bicollateral open
(3) Concentric (4) Bicollateral closed

Q.55 A concentric Amphivasal vascular bundle is that in which -
(1) centrally located xylem is surrounded by phloem
(2) centrally located phloem is surrounded by xylem
(3) Phloem is flanked by xylem on interior sides only
(4) xylem is flanked by phloem on exterior sides only

Q.56 The basic difference between stem and root is that stem is –
(1) Endarch (2) Exarch
(3) Mesarch (4) Polyarch

Q.57 At certain region the phellogen cut off closely arranged parenchymatous cell on the outer side instead of cork cell, these cell rupture the epidermis and form
(1) Stomata (2) Hydathodes
(3) Lenticels (4) (2) & (3) both

Q.58 Bulliform cells are –
(1) Water filled and highly vacuolated epidermal cell
(2) Prokaryotic cell
(3) Eukaryotic cell
(4) Ball like parenchymatous cells

Q.59 In general, the cells of cortex lack –
(1) Chlorophyll (2) Nucleus
(3) Reserve food (4) Nucleous

Q.60 Which of the statement is correct
(1) Organic food movement up by phloem
(2) Organic food movement up and down by phloem
(3) Organic food movement up and down by xylem
(4) All of these

Q.61 In roots, the pericycle give rise to –
(1) Lateral roots and Cork cambium
(2) Cortex and Pith
(3) Xylem and Phloem
(4) Epidermis and Vascular bundles

Q.62 T.S. of a Material exhibits conjoint collateral endarch and closed bundles scattered in a ground tissue what should be the material –
(1) Monocot root (2) Dicot root
(3) Monocot stem (4) Dicot stem

Q.63 In which of the following order, an exarch xylem develops –
(1) Centripetal
(2) Centrifugal
(3) Both centripetal & centrifugal
(4) Irregular

Q.64 The function of hypodermis is –
(1) Protection (2) Hardness
(3) Support (4) Storage

Q.65 The hypodermis present in maize stem is –
(1) Parenchymatous (2) Collenchymatous
(3) Sclerenchymatous (4) Meristematic

Q.66 Pith is produced by –
(1) Ground meristem (2) Procambium
(3) Periblem (4) Dermatogen

Q.67 When protoxylem faces pericycle, it is called –
(1) Endarch (2) Mesarch
(3) Exarch (4) Polyarch

Q.68 Fatty substance found in epidermal cell walls is-
(1) Cutin (2) Suberin
(3) Wax (4) Both (2) & (3)

Q.69 Stomata in true hydrophyte are present on
(1) upper epidermis (2) lower epidermis
(3) not on any surface (4) Both surface

Q.70 Layer of cell which is present in between endodermis and vascular tissue -
(1) Cortex (2) Pith
(3) Pericycle (4) Exodermis

Q.71 Leaves of some grasses shows rolling and unrolling. It occurs due to -
(1) Parellel venation (2) Isobilateral nature
(3) Thin wall (4) Bulliform cell

Q.72 In older, woody tissue, the gaseous exchange takes place through –
(1) Lenticel (2) Hydathode
(3) Stomata (4) Aerenchyma

Q.73 Stomata are absent in the epidermis of
(1) Leaf (2) Stem
(3) Branch (4) Root

Q.74 Amount of secondary xylem as compared to secondary phloem formed every year is –
(1) Equal (2) 8-10 times
(3) Half (4) 4-5 times

Q.75 Lenticels and its complementary cells are developed through the activity of –
(1) Phellogen (2) Stelar cambium
(3) Dermatogen (4) Intercalary meristem

Q.76 External Protective tissues are –
(1) Cortex and epidermis (2) Cork and pericycle
(3) Cortex and pericycle (4) Cork and epidermis

Q.77 Which of the tissue is present in periderm ?
(1) Xylem (2) Bast
(3) Phellem (4) Duramen

Q.78 If a stem is girdled –
(1) Root dies first (2) Shoot dies first
(3) Both die together (4) None of the above die

Q.79 Vascular cambium cuts cells more actively -
(1) Towards centre (2) Towards periphery
(3) In winter (4) In roots

Q.80 Formation of vascular rays occurs in which order-
(1) Centripetal (2) Centrifugal
(3) Acropetal order (4) (1) & (2) both

Q.81 Youngest layer of secondary xylem is located –
(1) In centre of stem
(2) Just outside pith
(3) Just outside vascular cambium
(4) Just inside vascular cambium

Q.82 Formation of secondary xylem and phloem respectively –
(1) Centrifugal and centripetal
(2) Centripetal and centrifugal
(3) Both the centripetal
(4) Both the centrifugal

Q.83 Formation of which tissue is example of dedifferentiation -
(1) Inter fascicular cambium
(2) Apical meristem
(3) Intra fascicular cambium
(4) Inter calary meristem

Q.84 Cork cambium is –
(1) Always primary meristem
(2) Always secondary meristem
(3) May be secondary or primary meristem
(4) Partly primary & partly secondary meristem

Q.85 Lenticels are –
(1) Scars on old stem
(2) Special stomata
(3) Aerating pores in bark
(4) Special stomata on hydrophytic plants

Q.86 Intrafascicular cambium is situated –
(1) In between the vascular bundles
(2) Inside the vascular bundles
(3) Outside the vascular bundles
(4) In pith

Question based on Anatomy of Dicotyledonous and Monocotyledonous Plant

Q.87 Phloem parenchyma is absent in -
(1) Dicot stem (2) Dicot leaf
(3) Monocot stem (4) Dicot root

Q.88 Casparian strip are characteristic feature of .....A..... endodermis and it is made up of .....B..... . What is A and B respectively -
(1) Shoot, Suberin (2) Root, Lignin
(3) Root, Suberin (4) Root & shoot, Suberin

Q.89 Collenchymatous hypodermis is characteristic feature in –
(1) Dicot stem
(2) Monocot stem
(3) Monocot as well as dicot stem
(4) Hydrophytes

Q.90 Resin ducts are found in –
(1) Pine (2) Bamboos
(3) Teak (4) Sal

Q.91 Cortex and pith are not distinguished in –
(1) Monocot stem (2) Monocot root
(3) Dicot stem (4) Dicot root

Q.92 What is the characteristics of a vascular bundle of monocot stem ?
(1) Open and surrounded by a sclerenchymatous bundle sheath
(2) Closed and not surrounded by bundle sheath
(3) Closed and surrounded by bundle sheath
(4) Open and not surrounded by a bundle sheath

Q.93 In dicot Root –
(1) Vascular bundles are scattered with cambium
(2) Vascular bundles are open and arranged in a ring
(3) Xylem and pholem are radial
(4) Xylem is always endarch

Q.94 The dicot root is identify by the presence of –
(1) Exarch xylem
(2) 2-6 radial vascular bundles
(3) > 6 radial vascular bundles
(4) Absence of pith and endodermis

Q.95 Sclerenchymatous bundle sheath is present in –
(1) Grass (2) Sunflower
(3) Banyan (4) Grain

Q.96 Lysigenous cavity & Y-shaped xylem occurs in–
(1) Dicot stem
(2) Monocot root
(3) Monocot stem
(4) Dicot root

Q.97 Which would do maximum harm to a tree ?
(1) Loss of half of its leaves
(2) Loss of half of its branches
(3) Loss of all of its leaves
(4) Loss of all its bark

Q.98 Normal secondary growth takes place in –
(1) Dicots & Monocots
(2) Gymnosperms & Monocots
(3) Dicots & Gymnosperms
(4) Only in dicots

Q.99 Normally in dicot stems, phellogen develops from-
(1) Hypodermis
(2) Phellem
(3) Endodermal cells
(4) Epidermal & pericycle cells

Q.100 In monocot stems, secondary growth cannot occur because vascular bundles are –
(1) Scattered (2) open
(3) Closed (4) Radial

Q.101 The process by which the plant becomes woody is called -
(1) Calcification (2) Lignification
(3) Impregnation (4) Fossilization

Q.102 Passage cells are more distinct in endodermis of-
(1) Dicot stem (2) Monocot stem
(3) Dicot root (4) Monocot roots

Question based on Internal Structure of Leaf

Q.103 Monocot leaves grow by -
(1) Apical meristem (2) Lateral meristem
(3) Intercalary meristem (4) Dermatogen

Q.104 Which of the following is present in monocot leaves
A. Bulliform cell
B. Leaf base
C. Bundle sheath
D. Resin gland
E. Water cavity
(1) A, B, C & E (2) A, B, D, E
(3) A, B, E (4) A, B, C

Q.105 Position of protoxylem & protophloem in leaf respectively –
(1) Abaxial & Adaxial (2) Adaxial & Abaxial
(3) Both Adaxial (4) Both abaxial

Q.106 In leaves, the vascular bundles are –
(1) Bicollateral & open (2) Collateral & open
(3) Collateral & closed (4) Radial & exarch

Exercise 2

Q.1 In plants maximum growth occurs during which season –
(1) Summer (2) Winter
(3) Autumn (4) Spring

Q.2 The tracheids differ from vessels in having –
(1) Thick wall
(2) Bordered pit
(3) Presence of pitted end wall
(4) Spiral thickening

Q.3 In Cucurbita stem vascular bundles are –
(1) Radial (2) Collateral
(3) Concentric (4) Bicollateral

Q.4 "Bast-fibers" obtained from which part of woody stem –
(1) Cork (2) Cortex
(3) Xylem (4) Phloem

Q.5 Thickness of stem increases due to activity of –
(1) Cambium (2) Xylem
(3) Phloem (4) Shoot apex

Q.6 Non-porous wood is found in which plants –
(1) Dicots (2) Monocots
(3) Gymnosperm (4) Cactus

Q.7 In dorsiventral leaf phloem is found in which side
(1) Adaxial
(2) Abaxial
(3) Lateral
(4) Adaxial and Abaxial both

Q.8 The leaves having stomata on both the surfaces are called as –
(1) Amphistomatic (2) Hypostomatic
(3) Epistomatic (4) Astomatic

Q.9 Most distinct annual rings are formed in which region -
(1) Tropical (2) Temperate
(3) Arctic (4) Equatorial

Q.10 Vessels and companion cells are characteristic feature of –
(1) Gymnosperm (2) Angiosperm
(3) Pteridophyta (4) Bryophyta

Q.11 Grafting is not possible in monocots because –
(1) Vascular bundles are scattered
(2) Vascular bundles are closed
(3) Hypodermis is sclerenchymatous
(4) Vascular bundles are open

Q.12 Companion cells are associated with –
(1) Tracheids of Angiosperms
(2) Vessels of Angiosperms
(3) Tracheids of Gymnosperms
(4) Sieve tubes of Angiosperms

Q.13 Lateral roots are arises from –
(1) Pericycle (2) Cortex
(3) Pith (4) Endodermis

Q.14 Bulliform cells are found in –
(1) Seeds of sunflower (2) Leaf of wheat
(3) Pod of pea (4) Tuber of potato

Q.15 In the T.S. of root –
(1) Protoxylem and metaxylem are not present on same radius
(2) Protoxylem is absent
(3) Protoxylem towards inside and metaxylem towards outside
(4) Metaxylem is towards inside and protoxylem towards outside

Q.16 The resin duct of Gymnosperm is an example of –
(1) Intracellular space
(2) Schizogenous cavity
(3) Lysigenous cavity
(4) Vacuole containing stored material

Q.17 Root cap is absent in –
(1) Mesophytes (2) Hydrophytes
(3) Epiphytes (4) Xerophytes

Q.18 Girth of dicot stem increases by the activity of –
(1) Apical meristem (2) Intercalary meristem
(3) Lateral meristem (4) Procambium meristem

Q.19 Which type of vascular bundles are found in monocot stem –
(1) Collateral, open, endarch
(2) Radial, open, diarch
(3) Radial, open, mesarch
(4) Collateral, closed, endarch

Q.20 The cells without nuclei are present in -
(1) Vascular cambium (2) Root hair
(3) Companion cell (4) Members of sieve tube

Q.21 The difference in phloem of Gymnosperms & Angiosperms is due to –
(1) Parenchyma (2) Sieve cell
(3) Companion cell (4) Fibres

Q.22 The position of protoxylem in leaf is –
(1) Adaxial
(2) Abaxial
(3) Surrounded by metaxylem
(4) Lateral

Q.23 Vascular cambium is more active towards -
(1) Outer side
(2) Inner side
(3) Sometime innerside, some time outside
(4) Equal on both side

Q.24 A student prepared two slide of leaves, but forget to label these slide. A slide show variable size vascular bundle and differentiated leaf mesophyll while B slide show almost similar size vascular bundle and undifferentiated mesophyll.
What type of leaves are A & B
(1) A = Isobilateral, B = Dorsiventral
(2) A = Dorsiventral, B = Isobilateral
(3) Can not be determined
(4) A = Dorsiventral, B = Dorsiventral

Q.25 Function of cork cambium is to produce –
(1) Secondary xylem & secondary phloem
(2) Cork & secondary cortex
(3) Secondary phloem & secondary cortex
(4) Cork

Q.26 Mesophyll is differentiated in spongy and palisade tissue in -
(1) Isobilateral leaf (2) Dorsiventral leaf
(3) Both (1) and (2) (4) None of these

Q.27 Which of the following is not a character of dicot root -
(1) Radial vascular bundle
(2) Secondary growth
(3) Pith less developed or absent
(4) Vascular bundles 15-20

Q.28 The continuity of protoplasm from cell to cell is maintained through -
(1) Stomata (2) Tracheids
(3) Vessels (4) Plasmodesmata

Q.29 Which of the following is not adaptation of Xerophytes ?
(1) Spongy tissue
(2) Well developed mechanical tissue
(3) Well developed vascular tissue
(4) Thick cuticle

Q.30 Sieve tube differs from vessels in –
(1) Absence of nucleus
(2) Less deposition of lignin
(3) Being dead
(4) Lack of cytoplasm

Q.31 Periderm includes -
(1) Phellem
(2) Phelloderm
(3) Phellogen
(4) Phellem, phelloderm, phellogen

Q.32 Lignin is a major component of cell wall of -
(1) Xylem (2) Phloem
(3) Parenchyma (4) Cambium

Q.33 In a woody dicotyledonous tree, which of the following parts will mainly consist of primary tissues ?
(1) Stem and root
(2) All parts
(3) Shoot tips and root tips
(4) Flowers, fruits and leaves

Q.34 Which xylem element is living -
(1) Vessels (2) Tracheids
(3) Fibre (4) Parenchyma

Q.35 Monocot root is differ from dicot root in having-
(1) Open vascular bundle
(2) Scattered vascular bundle
(3) Large pith
(4) Radial vascular bundle

Q.36 Autumn wood can be differentiated from spring wood by -
(1) Broad vessels and tracheids
(2) Narrow vessels and tracheids
(3) Red colour of xylem
(4) Cambium

Q.37 Vascular cambium forms -
(1) Secondary xylem and Secondary phloem
(2) Primary xylem and Primary Phloem
(3) Only Secondary phloem
(4) Only Primary xylem

Q.38 There is no result of 'Girdling Experiment' in monocot plants, due to -
(1) Presence of wax layer on the surface of its stem
(2) Stem is comparatively thin
(3) Phloem is inside xylem
(4) Vascular bundles are not in specific position

Q.39 Radial vascular bundles are found in -
(1) Only dicot root
(2) Only monocot root
(3) Only Pteridophyta
(4) Root of all vascular plants

Q.40 Cork cambium represents -
(1) Secondary meristem (2) Primary meristem
(3) Intercalary meristem (4) Apical meristem

Q.41 Cambium is a lateral meristem, as it -
(1) Increases girth (2) Forms lateral branches
(3) Lies on nodes (4) Increases length

Q.42 Root apex has a zone of slow dividing cells in the middle of rapidly dividing cells, it is -
(1) Quiescent centre (2) Sluggish centre
(3) Dormant centre (4) Non meristematic zone

Q.43 Root apex is subterminal because it is -
(1) Covered by root hairs (2) Covered by root cap
(3) Covered by epidermis (4) Under the soil

Q.44 Apical, intercalary and lateral meristems are differentiated on the basis of -
(1) Development (2) Origin
(3) Function (4) Position

Q.45 Active divisions occur in the cells of -
(1) Xylem (2) Phloem
(3) Cambium (4) Collenchyma

Q.46 Plant grow in length is due to activity of -
(1) Apical meristem (2) Dermatogen
(3) Periblem (4) Lateral meristem

Q.47 Leaf primordium grows into adult lamina by means of -
(1) Marginal meristem
(2) Lateral meristem
(3) First apical and then marginal meristem
(4) Apical meristem

Q.48 Periblem form -
(1) Endodermis (2) Cortex
(3) Both (1) and (2) (4) Epidermis

Q.49 A living mechanical tissue having pecto cellulosic wall thickening is –
(1) Sclerenchyma (2) Collenchyma
(3) Parenchyma (4) Aerenchyma

Q.50 Laticiferous vessels are found in -
(1) Xylem tissue (2) Phloem tissue
(3) Cortex (4) None of the above

Q.51 Secondary growth occurs in -
(1) Formation and division of meristematic cells
(2) Vascular region
(3) Cortical region
(4) Both (2) and (3) regions

Q.52 A narrow thin-walled cell with large nucleus and lying on the side of sieve tube is absent in -
(1) Angiosperms (2) Pteridophytes
(3) Gymnosperms (4) Both (2) and (3)

Q.53 A bundle having phloem on either side of xylem is -
(1) Bicollateral (2) Collateral
(3) Radial (4) Concentric

Q.54 Longest fibres are found in -
(1) Jute (2) Cotton
(3) Sunn Hemp (4) Coir

Q.55 Chief function of phloem is conduction of -
(1) Food (2) Minerals
(3) Water (4) Air

Q.56 Transport of water and dissolved minerals occurs through -
(1) Phloem (2) Xylem
(3) Sieve tubes (4) Sclerenchyma

Q.57 Plants yields latex is -
(1) *Ficus* (2) *Sonchus/Euphorbia*
(3) *Calotropis* (4) All of the above

Q.58 Which one of the following comprises only simple tissues -
(1) Parenchyma, Collenchyma and Sclerenchyma
(2) Parenchyma, Xylem and Collenchyma
(3) Parenchyma, Xylem and Sclerenchyma
(4) Parenchyma, Xylem and Phloem

Q.59 Mesarch xylem occurs in -
(1) Monocots (2) Dicots
(3) Ferns (4) Bryophytes

Q.60 Vessel elements differ from other elements of xylem in having -
(1) Simple and bordered pits on end walls
(2) Simple perforation on their end walls
(3) Simple pits on their radial walls
(4) Bordered pits on their lateral walls

Q.61 Match items of column-I and column-II

Column-I	**Column-II**
(a) Collateral and open	(p) Cucurbita stem
(b) Radial	(q) Fern rhizome
(c) Bicollateral	(r) Maize root
(d) Concentric	(s) sunflower stem
	(t) Maize stem

(1) a-t, b-s, c-r, d-p (2) a-s, b-r, c-p, d-q
(3) a-s, b-p, c-r, d-q (4) a-s, b-r, c-q, d-p

Q.62 Function of vessels is -
(1) Conduction of water and minerals
(2) Conduction of food
(3) Mechanical strength
(4) All of the above

Q.63 Stele consists of -
(1) Phloem (2) Xylem
(3) Pericycle (4) All of the above

Q.64 Parenchyma with larger air spaces is -
(1) Stellate parenchyma (2) Aerenchyma
(3) Angular parenchyma (4) Prosenchyma

Q.65 Jute of commerce is got from –
(1) Primary phloem (2) Secondary phloem
(3) Secondary xylem (4) Primary xylem

Q.66 Sap-wood is -
(1) Outer functional part of secondary xylem
(2) Inner non functional part of secondary xylem
(3) Outer as well as inner part of secondary xylem
(4) None of the above

Q.67 Vascular bundles in dicot stem are -
(1) Open, collateral, endarch
(2) Closed, collateral, endarch
(3) Open, collateral, exarch
(4) Closed, collateral, exarch

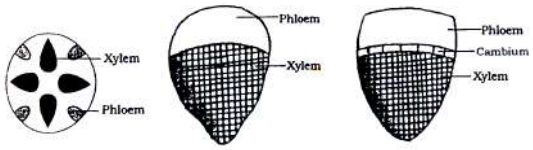
Q.68 The waxy substance associated with the walls of cork or the wall of cork cells are mostly impregenated with -
(1) Cutin (2) Suberin
(3) Lignin (4) Hemicellulose

Q.69 Function of cork cambium is to produce -
(1) Secondary xylem and secondary phloem
(2) Cork and secondary cortex
(3) Secondary cortex and phloem
(4) Cork

Q.70 Tyloses occur in -
(1) Secondary xylem (2) Secondary phloem
(3) Callus tissue (4) Cork cells

Q.71 Tyloses are -
(1) Tracheal plugs which plugs the lumen of the vessels and tracheids
(2) Compound sieve plates
(3) Specialized secretory cells
(4) Laticiferous channels

Q.72 What type of vascular bundles are A, B and C?



(1) Radial; close collateral cojoint; open collateral conjoint
(2) Close collateral conjoint; Close collateral conjoint; Radial
(3) Open collateral conjoint; Close collateral conjoint; Radial
(4) Bicollateral; Concentric; Radial

Q.73 Mesophyll is differentiated into palisade and spongy tissues in -
(1) Extremely xerophytic leaves
(2) Hydrophytic leaves
(3) Monocot leaves
(4) Dicot leaves

Q.74 Bulliform or motor cells occur in -
(1) Upper epidermis of dicot leaves
(2) Upper epidermis of monocot leaves
(3) Lower epidermis of monocot leaves
(4) Lower epidermis of dicot leaves

Q.75 Xylem is exarch in -
(1) Leaf (2) Petiole
(3) Stem (4) Root

Q.76 Sea shore trees do not show distinct annual rings because -
(1) There is little climatic variations
(2) They belong to monocots
(3) There is enough moisture
(4) Soil is sandy

Q.77 A narrow layer of thin walled cells found between phloem and wood of a dicot stem is -
(1) Cork cambium (2) Vascular cambium
(3) Endodermis (4) Pericycle

Q.78 If all the lenticels of stem are blocked, the first to die will be -
(1) Leaves
(2) Shoot tips
(3) Roots
(4) None of the above

Q.79 In a dicotyledonous stem, the sequence of tissues from the outside to the inside is -
(1) Phellem-pericycle-Endodermis-Phloem
(2) Phellem-Phloem-Endodermis-Pericycle
(3) Phellem-endodermis-Pericycle-Phloem
(4) Pericycle-Phellem-Endodermis-Phloem

Q.80 Vascular cambium forms xylem on inner side and phloem on outer side due to -
(1) Effect of gravity
(2) Shearing force of wind
(3) Intrafascicular nature
(4) Differential action of hormones

Q.81 Hard woods have -
(1) More of parenchyma (2) Vessels in abundance
(3) Tracheids mainly (4) Non-Porous nature

Q.82 Which one of the following the most durable wood -
(1) *Shorea robusta* (2) *Cedrus deodara*
(3) *Dalbergia sisso* (4) *Tectona grandis (Teak)*

Q.83 Which one is responsible for radial conduction of water and food in woody stems -
(1) Vessels (2) Vascular rays
(3) Endodermis (4) Xylem fibres

Q.84 Functional xylem of dicot tree is -
(1) Sap wood (2) Autumn wood
(3) Heart wood (4) Hard wood

Q.85 Vascular bundle with protoxylem towards the periphery is
(1) Radial (2) Endarch
(3) Exarch (4) Closed

Q.86 Secondary growth is absent in -
(1) Hydrophytes (2) Mesophytes
(3) Halophytes (4) Xerophytes

Q.87 Cell wall is impermeable to water and deposition of suberin occurs in -
(1) Bark (2) Cork
(3) Bast (4) Xylem

Q.88 In dicot root showing secondary growth, cork is found -
(1) External to primary cortex
(2) Inner to epidermis and outer to pericycle
(3) Outer to endodermis and inner to primary cortex
(4) Inner to endodermis and external to primary phloem

Q.89 In floating leaves plants stomata occur on -
(1) Lower surface (2) Upper surface
(3) Both surfaces (4) Absent

Q.90 Casparian strips occur in -
(1) Longitudinal and radial walls of epidermal cells
(2) Longitudinal walls of xylem
(3) All walls of endodermis
(4) Radial and tangential walls of endodermis

Q.91 Passage cells occur in –
(1) Epidermis (2) Cortex
(3) Endodermis (4) Pericycle

Q.92 Vascular bundles occur in a ring in -
(1) Monocot stem (2) Leaf
(3) Root (4) Dicot stem

Q.93 Predominant material present in cork cell walls is
(1) Lignin (2) Chitin
(3) Suberin (4) Pectin

Q.94 Vascular bundles of a root are -
(1) Radial (2) Concentric
(3) Collateral (4) Bicollateral

Q.95 Determination of age of a tree by counting annual rings is -
(1) Dendrochronology (2) Dendrology
(3) Countrochronology (4) Chronology

Q.96 Waxy coating on epidermis of young stem is -
(1) Suberin (2) Periderm
(3) Phellem (4) Cuticle

Q.97 Monocot root has -
(1) Conjoint, collateral, open, polyarch vascular bundles
(2) Suberized exodermis, casparian strip, passage cells, cambium
(3) Suberized exodermis, polyarch xylem, exarch xylem and pith
(4) Exodermis, endarch, tetrarch vascular bundles

Q.98 Passage cells are found in -
(1) Monocot root (2) Monocot stem
(3) Aerial root (4) Dicot stem

Q.99 Grass stem elongates after initial growth due to-
(1) Apical meristem (2) Secondary meristem
(3) Intercalary meristem (4) Lateral meristem

Q.100 A simple tissue with mechanical and physiological functions in a young dicotyledonous plant is -
(1) Sclerenchyma (2) Collenchyma
(3) Parenchyma (4) Meristematic tissue

Q.101 The cells are chlorophyllous, fewer in number, unique in shape and inner walls thick. The description fits into
(1) Guard cells (2) subsidiary cells
(3) Passage cells (4) Bulliform cells

Q.102 Dorsiventral leaf is identified by the presence of -
(1) Stomata on both the epidermis
(2) Stomata mainly present on the lower epidermis
(3) No stomata on the epidermis
(4) Sunken stomata on the upper epidermis

Q.103 Sclereids and stone cells are modified -
(1) Collenchyma (2) Sclerenchyma
(3) Fibres (4) Xylem vessels

Q.104 In the leaf, vascular bundles are found in -
(1) Veins (2) Palisade tissue
(3) Upper epidermis (4) Lower epidermis

Q.105 During the formation of leaf and stem elongation, some cell left behind from shoot apical meristem, They constitute -
(1) Node (2) Intercalary meristem
(3) Auxillary bud (4) Internode

Q.106 Aerenchyma provides -
(1) Flexiblity to plants
(2) Mechanical strength to plants
(3) Buoyancy to hydrophytic plants
(4) Promoting nature of photosynthesis

Q.107 Two cross-sections of stem and root appear similar, when viewed by naked eye, but under microscope, they can be differentiated by -
(1) exarch condition of root and stem
(2) endarch condition of stem and root
(3) endarch condition of root and exarch condition of stem
(4) endarch condition of stem and exarch condition of root

Q.108 The function of vessel is -
(1) Conduction of food
(2) Conduction of water and minerals
(3) To help in transpiration
(4) To help in respiration

Q.109 Which of the following is related to increase in girth of plant -
(1) Shoot apex
(2) Root apex
(3) Lateral meristem
(4) Intercalary meristem of stem

Q.110 Which of the following is enucleate at maturity-
(1) Cortical cell (2) Cambial cell
(3) Meristematic cell (4) Sieve tube cell

Q.111 the cambium which produces cork is called as -
(1) Phelloderm (2) Phellogen
(3) Periblem (4) Plerome

Q.112 Casparian strips are characteristic feature of endodermis, made up of -
(1) cutin (2) pectin
(3) suberin (4) cellulose

Q.113 Procambium produces -
(1) Epidermis
(2) Pith
(3) Vascular bundle
(4) Vascular bundle and pith

Q.114 Aerenchyma is a modification of -
(1) Sclerenchyma (2) Parenchyma
(3) Phloem (4) None of these

Q.115 Whose living cells provide tensile and mechanical strength -
(1) Collenchyma (2) Sclerenchyma
(3) Phloem (4) Sclereids

Q.116 Which of the following is a surface fibre ?
(1) Flax (2) Cotton
(3) Sunn hemp (4) Manila hemp

Q.117 Which of the following is not a plant fibre ?
(1) Cotton (2) Coir
(3) Sunn hemp (4) Silk

Q.118 From which plant part, cotton fibers are obtained
(1) Root hairs (2) Stem hairs
(3) Leaf (4) Seed coat

Q.119 A component of xylem is -
(1) Sieve tube (2) Medullary rays
(3) Sclereid (4) Tracheid

Q.120 A group of cells similar in forms, function and origin is called –
(1) Organ (2) Organelle
(3) Tissue (4) None of these

Q.121 Hard, lignified, thick walled, long and pointed cells in plants are –
(1) Parenchyma (2) Sclerenchymatous fibre
(3) Collenchyma (4) Sclereids

Q.122 Pith and cortex belongs to -
(1) Epidermis (2) Ground tissue
(3) Vascular tissue (4) Bundle sheath

Q.123 Specialized parenchymatous cells which are closely associated with sieve tube element is -
(1) Campanion cell (2) Albuminous cell
(3) (1) & (2) both (4) Phloem parenchyma

Q.124 Which of the following have sunken stomata -
(1) *Nerium* (2) *Mangifera*
(3) *Hydrilla* (4) *Zea mays*

Q.125 Which of the following is true regarding epidermal tissue system -
(1) It is usually multicellular
(2) It is parenchymatous cell with intercellular space
(3) It is meant for protection
(4) All of the above

Q.126 In a dicot stem, secondary growth occurs due to the activity of -
(1) Apical meristem (2) Lateral meristem
(3) Cork (4) Bark

Q.127 Exarch and polyarch condition found in -
(1) Monocot stem (2) Dicot stem
(3) Monocot root (4) Dicot root

Q.128 Leaves of grasses roll and unroll due to -
(1) Hormonal change
(2) Change in temperature
(3) Change in turgor pressure
(4) Presence of bulliform apparatus

Q.129 How many of the following are true regarding monocot root –
A. Pith is large and well developed
B. Conjunctive tissue is present between pericycle and phloem
C. Pericycle is made up of thick walled sclerenchyma
D. Hypodermis is made up of collenchyma
(1) Three (2) Four
(3) One (4) Two

Q.130 Primary growth is caused by -
(1) Apical meristem (2) Lateral meristem
(3) Dermatogen (4) Plerome

Q.131 The veins vary in thickness in …..A….. venation and it is present in …..B….. leaves. What are A & B.
(1) A = Parallel, B = Dorsiventral
(2) A = Reticulate, B = Isobilateral
(3) A = Reticulate, B = Dorsiventral
(4) 2 & 3 both

Q.132 In which plant part laticiferous gland are found -
(1) Cortex (2) Epidermis
(3) Endodermis (4) Vascular bundle

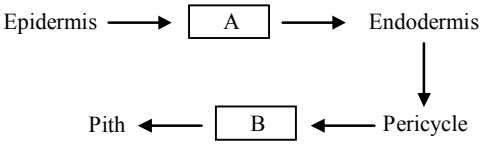
Q.133 Conjoint, collateral and closed vascular bundles are found in -
(1) Monocot stem (2) Monocot root
(3) Dicot stem (4) Dicot root

Q.134 Vascular bundles, in which phloem is found on both sides of xylem are called -
(1) Collateral (2) Bicollateral
(3) Radial (4) Amphicribral

Q.135 Complex tissue includes -
(1) Collenchyma (2) Apical meristems
(3) Conducting tissue (4) Idioblast

Q.136 Tyloses thickenings are seen in -
(1) Phloem cells
(2) Ray parenchyma only
(3) Collenchyma
(4) xylem tracheids and vessels

Q.137 In the given flow chart different layer of monocot root is shown. What is A & B –



(1) A=Hypodermis, B=Vascular bundle
(2) A=Cortex, B=Vascular bundle
(3) A=Cortex, B=Xylem
(4) A=Hypodermis, B=Xylem

Q.138 Lenticels and hydathodes are small pores with which of the following common attributes -
(1) They allow exchange of gases
(2) Their opening and closing is not regulated
(3) They always remain closed
(4) They are found on the same organ

Q.139 Which of the following is true regarding periderm -
(1) It is made up due to interstelar secondary growth
(2) It is protective covering of plant after secondary growth
(3) It consist of cork, cork cambium and primary cortex
(4) All of the above

Q.140 An example of monocot fibre yielding plant is -
(1) *Cocos* (2) *Corchorus*
(3) *Clematis* (4) *Crotalaria*

Q.141 Phloem conducts food by -
(1) Perforated sieve plates
(2) Bast fibres
(3) Xylem parenchyma
(4) Xylem fibres

Q.142 Quiescent centre is found in -
(1) Shoot tip (2) Root tip
(3) Both (1) & (2) (4) Meristematic

Q.143 Which of the following is correct sequence of layers in typical monocot root (from outer surface to inside)
(1) Pericycle, cortex, endodermis, epiblema
(2) Epiblema, endodermis, cortex, pericycle
(3) Epiblema, cortex, endodermis, pericycle
(4) Epiblema, pericycle, cortex, endodermis

Q.144 In old tree the greater part of secondary xylem is dark brown due to deposition of -
A. Tannin B. Cellulose
C. Lignin D. Essantial oil
(1) A, B, C & D (2) A, C & D
(3) A & D (4) A & C

Q.145 Endodermis mainly -
(1) Acts as water tight jacket
(2) Provides protection
(3) Maintains rigidity
(4) Help in transpiration

Q.146 Polyarch condition is found in -
(1) Monocot root (2) Dicot root
(3) Monocot stem (4) Dicot stem

Q.147 Most water absorption in plants takes place through -
(1) Root cap (2) Root apex
(3) Maturation zone (4) Meristematic zone

Q.148 Vascular bundles in Pinus stem are -
(1) Radial (2) Collateral and closed
(3) Collateral and open (4) Bicollateral

Q.149 Jute is obtained from -
(1) Primary phloem (2) Secondary phloem
(3) Primary xylem (4) Secondary xylem

Q.150 Parenchyma is commonly present in -
(1) Phelloderm (2) Pericycle of root
(3) Hypodermis (4) (1) & (2) both

Q.151 Lignin is the important component of the cell wall of -
(1) Phloem (2) Xylem
(3) Cambium (4) Parenchyma

Q.152 From which part of *Cocos nucifera*, coir is obtained -
(1) Endocarp (2) Mesocarp
(3) Epicarp (4) Any part of fruit

Q.153 Branch of Botany which deals with the internal organisation of plant is known as –
(1) Physiology (2) Ecology
(3) Cytology (4) Anatomy

Q.154 Cells of parenchymatous tissues are characterized by -
(1) Presence of uniform thickening
(2) Presence of thickening at the corner
(3) Presence of lignified walls
(4) Presence of intercellular spaces

Q.155 Wood is the common name of -
(1) Phloem (2) Vascular bundles
(3) Cambium (4) Secondary xylem

Q.156 From where the commercial jute fibers are obtained -
(1) Interxylary fibers (2) xylem fibers
(3) Phloem fibers (4) None of the above

Q.157 In a dicot root, the arrangement of xylem and phloem is-
(1) Collateral (2) Circular
(3) Radial (4) None of the above

Q.158 Fibres would have -
(1) Thick walled
(2) Thin walled
(3) Thickening of wall at corners
(4) Dense cytoplasm

Q.159 Annual growth rings are formed due to activity of
(1) Extra stelar cambium (2) Intra stelar cambium
(3) Inter stelar cambium (4) All of these

Q.160 The fibers associated with phloem are known as
(1) Wood fibres (2) Surfaces fibres
(3) Bast fibres (4) Hard fibres

Q.161 Meristematic tissue in vascular bundle is -
(1) Phellem
(2) Procambium
(3) Interfascicular cambium
(4) Intrafascicular cambium

Q.162 Age of plant can not be determined by counting annual ring in plant, which grow in-
(1) Temperate environment
(2) Tropical environment
(3) (1) & (2) both
(4) none of the above

Q.163 An old trunk of shisham (Dalbergia sissoo) tree would possess maximum amount of
(1) Primary xylem (2) Secondary xylem
(3) Primary phloem (4) Secondary cortex

Q.164 Vascular bundles are arranged in a ring in stem of
(1) Wheat (2) Rice
(3) Gram (4) Maize

Q.165 In higher plants transport of food material occurs through
(1) Companion cells
(2) Sieve elements
(3) Tracheids
(4) Transfusion tissue

Q.166 The term "Bark" refers to
(1) Phellem, Phelloderm and vascular cambium
(2) Periderm and Secondary xylem
(3) Cork cambium and Cork
(4) Phellogen, Phellem, Phelloderm and Secondary phloem

Q.167 A scientist who wish to study viral effect on plants should exclude -
(1) Cortex
(2) Pith
(3) Shoot apex
(4) Phloem

Q.168 Monocot root can be distinguished from dicot root by the
(1) Presence of cambium
(2) Number of vascular bundles 2 to 6
(3) Presence of pericycle
(4) Larger pith

Exercise 3

OLD EXAMINATION QUESTIONS [NEET]

Q.1 In monocots, root cap is formed by - **[AIIMS 2000]**
(1) Dermatogen (2) Calyptrogen
(3) Wound cambium (4) Vascular cambium

Q.2 The quiescent centre in the root meristem serves as a - **[AIIMS 2003]**
(1) Site for storage of food which is utilized during maturation
(2) Reservoir of growth hormones
(3) Reserve for replenishment of damaged cells of the meristem
(4) Region for absorption of water

Q.3 Which one of the following statements pertaining to plant structure is correct ? **[AIIMS 2005]**
(1) Cork lacks stomata, but lenticels carry out transpiration
(2) Passage cells help in transfer of food from cortex to phloem
(3) Sieve tube elements posses cytoplasm but no nuclei
(4) The shoot apical meristem has a quiescent centre

Q.4 Grafting is successful in dicots but not in monocots because the dicots have - **[AIIMS 2006]**
(1) Vascular bundles arranged in a ring
(2) Cambium for secondary growth
(3) Vessels with elements arranged end to end
(4) Cork cambium

Q.5 In the sieve elements, which one of the following is the most likely function of P-proteins – **[AIIMS 2006]**
(1) Deposition of callose on sieve plates
(2) providing energy for active translocation
(3) Autolytic enzymes
(4) Sealing mechanism on wounding

Q.6 Extrastelar secondary growth takes place by – **[AIPMT 1998]**
(1) Vascular cambium (2) Phellogen
(3) Phellem (4) Phelloderm

Q.7 Growth of leaf primordia is – **[AIPMT 1998]**
(1) First apical then marginal
(2) Only apical
(3) Only marginal
(4) Lateral

Q.8 A plant stem is showing 40 spring ring and 40 autumn ring. What will be the age of plant – **[AIPMT 1999]**
(1) 80 years (2) 40 years
(3) 20 years (4) Can not determined

Q.9 What happens in plants during vascularisation **[AIPMT 2000]**
(1) Differentiation of procambium, formation of primary phloem followed by formation of primary xylem
(2) Differentiation of procambium followed by the formation of primary phloem and xylem simultaneously
(3) Formation of procambium, primary phloem and xylem simultaneously
(4) Differentiation of procambium followed by the formation of secondary xylem

Q.10 Main function of lenticel is – **[AIPMT 2002]**
(1) Transpiration (2) Guttation
(3) Gaseous exchange (4) Bleeding

Q.11 Vessels are found in – **[AIPMT 2002]**
(1) All angiosperms and some gymnosperm
(2) Most of the angiosperms and few gymnosperms
(3) All angiosperms, all gymnosperms and some pteridophyta
(4) All pteridophyta

Q.12 Four radial vascular bundles are found in – **[AIPMT 2002]**
(1) Dicot root
(2) Monocot root
(3) Dicot stem
(4) Monocot stem

Q.13 Which of the following statement is true – **[AIPMT 2002]**
(1) Vessels are multicellular and with wide lumen.
(2) Tracheids are multicellular and with narrow lumen.
(3) Vessels are unicellular and with narrow lumen.
(4) Tracheids are unicellular and with wide lumen.

Q.14 The cells of the quiescent centre are characterised by - **[AIPMT 2003]**
(1) Having dense cytoplasm and prominent nuclei
(2) Having light cytoplasm and small nuclei
(3) Dividing regularly to add to the corpus
(4) Dividing regularly to add to tunica

Q.15 The apical meristem of the root is present – **[AIPMT 2003]**
(1) Only in radicals
(2) Only in tap roots
(3) Only in adventitious roots
(4) In all the roots

Q.16 In a longitudinal section of a root, starting from the tip upward, the four zones occur in the following order - **[AIPMT 2004]**
(1) Root cap, cell division, cell maturation , cell enlargement
(2) Cell division, cell enlargement, cell maturation, root cap
(3) Cell division, cell maturation cell enlargement, root cap
(4) Root cap, cell division, cell enlargement, cell maturation

Q.17 A common structural feature of vessel elements and sieve tube elements is - **[AIPMT 2006]**
(1) presence of p-protein
(2) enucleate condition
(3) thick secondary walls
(4) pores on lateral walls

Q.18 For a critical study of secondary growth in plants, which one of the following pairs is suitable ? **[AIPMT 2007]**
(1) Wheat and maiden hair fern
(2) Sugarcane and sunflower
(3) Teak and pine
(4) Deodar and fern

Q.19 Passage cells are thin-walled cells found in - **[AIPMT 2007]**
(1) Central region of style through which the pollen tube grows towards the ovary
(2) Endodermis of roots facilitating rapid transport of water from cortex to pericycle
(3) Phloem elements that serve as entry points for substance for transport to other plant parts
(4) Testa of seeds to enable emergence of growing embryonic axis during seed germination

Q.20 Vascular tissues in flowering plants develop from **[AIPMT 2008]**
(1) Pleurome (2) Periblem
(3) Dermatogen (4) Phellogen

Q.21 The length of different internodes in a culm of sugarcane is variable because of – **[AIPMT 2008]**
(1) Position of axillary buds
(2) Size of leaf lamina at the node below each internode
(3) Intercalary meristem
(4) Shoot apical meristem

Q.22 Angiospermic xylem consists of –
(1) Vessels + Tracheids only
(2) Tracheids + Fibres only
(3) Vessel, tracheids, fibres and xylem parenchyma
(4) Parenchyma and fibres only

Q.23 In barley stem vascular bundles are - **[AIPMT 2009]**
(1) Closed and Radial (2) Open and scattered
(3) Closed and scattered (4) Open and in a ring

Q.24 Palisade parenchyma is absent in leaves of - **[AIPMT 2009]**
(1) Gram (2) Sorghum
(3) Mustard (4) Soyabean

Q.25 Reduction in vascular tissue, mechanical tissue and cuticle is characteristic of - **[AIPMT 2009]**
(1) Hydrophytes (2) Xerophytes
(3) Mesophytes (4) Epiphytes

Q.26 Anatomically fairly old dicotyledonous root is distinguished from the dicotyledonous stem by **[AIPMT 2009]**
(1) Position of protoxylem
(2) Absence of secondary xylem
(3) Absence of secondary phloem
(4) Presence of cortex

Q.27 The annular and spirally thickened conducting elements generally develop in the protoxylem when the root or stem is - **[AIPMT-2009]**
(1) elongating (2) widening
(3) differentiating (4) maturing

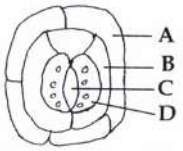
Q.28 The chief water conducting element of xylem in gymnosperms are : **[AIPMT 2010]**
(1) Vessels (2) Fibers
(3) Transfusion tissue (4) Tracheids

Q.29 Which of the following is not a lateral meristerm? **[AIPMT 2010]**
(1) Intrafasicular cambium
(2) Interfasicular cambium
(3) Phellogen
(4) Intercalary meristem

Q.30 Heartwood differs from sapwood in- **[AIPMT 2010]**
(1) Presence of rays and fibres
(2) Absence of vessels and parenchyma
(3) Having dead and non-conducting elements
(4) Being susceptible to pest and pathogens

Q.31 Transport of food material in higher plants takes place through- **[AIPMT 2010]**
(1) Companion cells (2) Transfusion tissue
(3) Tracheids (4) Sieve elements

Q.32 Given below is the diagram of a stomatal apparatus. In which of the following all the four parts labelled as A, B, C and D are correctly identified? **[AIPMT 2010]**



	A	B	C	D
(1)	Subsidiary cell	Epidermal cell	Guard cell	Stomatal aperture
(2)	Guard cell	Stomatal aperture	Subsidiary cell	Epidermal cell
(3)	Epidermal cell	Guard cell	Stomatal aperture	Subsidiary cell
(4)	Epidermal cell	Subsidiary cell	Stomatal aperture	Guard cell

Q.33 Ground tissue includes : **[AIPMT 2011]**
(1) All tissues internal to endodermis
(2) All tissues external to endodermis
(3) All tissues except epidermis and vascular bundles
(4) Epidermis and cortex

Q.34 In land plants, the guard cells differ from other epidermal cells in having : **[AIPMT 2011]**
(1) Chloroplasts (2) Cytoskeleton
(3) Mitochondria (4) Endoplasmic reticulum

Q.35 The cork cambium, cork and secondary cortex are collectively called : **[AIPMT 2011]**
(1) Phellem (2) Phelloderm
(3) Phellogen (4) Periderm

Q.36 Function of companion cells is : **[AIPMT 2011]**
(1) Loading of sucrose into sieve elements
(2) Providing energy to sieve elements for active transport
(3) Providing water to phloem
(4) Loading of sucrose into sieve elements by passive transport

Q.37 Some vascular bundles are described as open because these : **[AIPMT 2011]**
(1) are not surrounded by pericycle
(2) are surrounded by pericycle but no endodermis
(3) are capable of producing secondary xylem and phloem
(4) possess conjunctive tissue between xylem and phloem

Q.38 Water containing cavities in vascular bundles are found in - **[AIPMT 2012]**
(1) *Cycas* (2) *Pinus*
(3) Sunflower (4) Maize

Q.39 Closed vascular bundles lack **[AIPMT 2012]**
(1) Cambium (2) Pith
(3) Ground tissue (4) Conjunctive tissue

Q.40 Companion cells are closely associated with **[AIPMT 2012]**
(1) Trichomes (2) Guard cells
(3) Sieve elements (4) Vessel elements

Q.41 The common bottle cork is a product of **[AIPMT 2012]**
(1) Xylem (2) Vascular Cambium
(3) Dermatogen (4) Phellogen

Q.42 As compared to a dicot root, a monocot root has: **[AIPMT 2012]**
(1) Many xylem bundles
(2) Inconspicuous annual rings
(3) Relatively thicker periderm
(4) More abundant secondary xylem

Q.43 Gymnosperms are also called soft wood spermatophytes because they lack – **[AIPMT-2012]**
(1) cambium (2) phloem fibres
(3) thick-walled tracheids (4) xylem fibres

Q.44 Interfascicular cambium develops from the cells of : **[NEET - 2013]**
(1) Medullary rays (2) Xylem parenchyma
(3) Endodermis (4) Pericycle

Q.45 Lenticels are involved in - **[NEET-2013]**
(1) food transport (2) photosynthesis
(3) transpiration (4) gaseous exchange

Q.46 Meristematic tissue responsible for increase in girth of tree trunk is - **[NEET-2013]**
(1) intercalary meristem (2) lateral meristem
(3) phellogen (4) apical meristem

Q.47 Which of the following statements is not true for stomatal apparatus ? **[NEET-2013]**
(1) Guard cells invariably possess chloroplasts and mitochondria
(2) Guard cells are always surrounded by subsidiary cells
(3) Stomata are involved in gaseous exchange
(4) Inner wall of guard cells are thick

Q.48 Tracheids differ from other tracheary elements in- **[NEET-2014]**
(1) having casparian strips (2) being imperforate
(3) lacking nucleus (4) being lignified

Q.49 Select WRONG statement from the following **[RPMT 2014]**
(1) Bulliform cells are present in the leaves of monocots
(2) Intrafascicular cambium is present in monocots
(3) Phellem, phellogen and phelloderm constitute the periderm
(4) Spring wood and autumn wood constitute and annual ring

Q.50 A major characteristic of the monocot root is the presence of : **[NEET-2015]**
(1) Open vascular bundles
(2) Scattered vascular bundles
(3) Vasculature without cambium
(4) Cambium sandwiched between phloem and xylem along the radius

Q.51 In a ring girdled plant : **[NEET-2015]**
(1) The shoot dies first
(2) The root dies first
(3) The shoot and root die together
(4) Neither root nor shoot will die

Q.52 Read the different components from (a) to (d) in the list given below and tell the correct order of the components with reference to their arrangement from outer side to inner side in a woody dicot stem : **[NEET-2015]**
(a) Secondary cortex (b) Wood
(c) Secondary phoem (d) Phellem
The correct order is :
(1) (d), (c), (a), (b) (2) (c), (d), (b), (a)
(3) (a), (b), (d), (c) (4) (d), (a), (c), (b)

Q.53 Specialised epidermal cells surrounding the guard cells are called - **[NEET-I 2016]**
(1) bulliform cells (2) lenticels
(3) complementary cells (4) subsidiary cells

Q.54 Cortex is the region found between - **[NEET-II 2016]**
(1) epidermis and stele
(2) pericycle and endodermis
(3) endodermis and pith
(4) endodermis and vascular bundle

Q.55 The balloon-shaped structures called tyloses - **[NEET-II 2016]**
(1) originate in the lumen of vessels
(2) characterize the sapwood
(3) are extensions of xylem parenchyma cells into vessels
(4) are linked to the ascent of sap through xylem vessels

Q.56 The vascular cambium normally gives rise to - **[NEET-2017]**
(1) primary phloem (2) secondary xylem
(3) periderm (4) phelloderm

Q.57 Which of the following is made up of dead cells ? **[NEET-2017]**
(1) Collenchyma (2) Phellem
(3) Phloem (4) Xylem parenchyma

Q.58 Identify the wrong statement in context of heartwood - **[NEET-2017]**
(1) It is highly durable
(2) It conducts water and minerals efficiently
(3) It comprises dead elements with highly lignified walls
(4) Organic compounds are deposited in it

Q.59 Stomata in grass leaf are - **[NEET-2018]**
(1) dumb-bell shaped (2) kidney-shaped
(3) rectangular (4) barrel-shaped

Q.60 Secondary xylem and phloem in dicot stem are produced by - **[NEET-2018]**
(1) apical meristems (2) vascular cambium
(3) phellogen (4) axillary meristems

Q.61 Casparian strips occur in - **[NEET-2018]**
(1) epidermis (2) pericycle
(3) cortex (4) endodermis

Q.62 Plants having little or no secondary growth are- **[NEET-2018]**
(1) grasses (2) deciduous angiosperms
(3) conifers (4) cycads

Q.63 Grass leaves curl inwards during very dry weather. Select the most appropriate reason from the following - **[NEET-2019]**
(1) Tyloses in vessels
(2) Closure of stomata
(3) Flaccidity of bulliform cells
(4) Shrinkage of air spaces in spongy mesophyll

Q.64 Phloem in gymnosperms lacks - **[NEET-2019]**
(1) both sieve tubes and companion cells
(2) albuminous cells and sieve cells
(3) sieve tubes only
(4) companion cells only

Q.65 Which of the statements given below is not true about formation of annual rings in trees ? **[NEET-2019]**
(1) Annual rings are not prominent in trees of temperate region.
(2) Animal ring is a combination of spring wood and autumn wood produced in a year.
(3) Differential activity of cambium causes light and drak bands of tissue-early and late wood respectively.
(4) Activity of cambium depends upon variation in climate.

Q.66 In the dicot root the vascular cambium orginate from - **[NEET-2019]**
(1) Tissue located below the phloem bundles and a portion of pericycle tissue above protosylem.
(2) Cortical region.
(3) Parenchyma between endodermis and pericycle.
(4) Intrfascicular and interfascicular tissue in a ring.

Q.67 Regeneration of damaged growing grass following grazing is largely due to – **[NEET-2019]**
(1) Lateral meristem
(2) Apical meristem
(3) Intercalary metrsitem
(4) Secondary meristem

Q.68 Identify the incorrect statement. **[NEET-2020]**
(1) Sapwood is involved in conduction of water and minerals from root to leaf.
(2) Sapwood is the innermost secondary xylem and is lighter in colour.
(3) Due to deposition of tannins, resins, oils etc. heart wood is dark in colour.
(4) Heart wood does not conduct water but gives mechanical support.

Q.69 The transverse section of a plant shows following anatomical features: **[NEET-2020]**
(a) Large number of scattered vascular bundles surrounded by bundle sheath.
(b) Large conspicuous parenchymatous ground tissue.
(c) Vascular bundles conjoint and closed.
(d) Phloem parenchyma absent.
Identify the category of plant and its part:
(1) Monocotyledonous root
(2) Dicotyledonous stem
(3) Dicotyledonous root
(4) Monocotyledonous stem

Q.70 Match List-I with List-II **[NEET-2021]**

List-I		List-II	
(a)	Lenticels	(i)	Phellogen
(b)	Cork cambium	(ii)	Suberin deposition
(c)	Secondary cortex	(iii)	Exchange of gases
(d)	Cork	(iv)	Phelloderm

Choose the correct answer from the options given below.

	(a)	(b)	(c)	(d)
(1)	(iv)	(ii)	(i)	(iii)
(2)	(iv)	(i)	(iii)	(ii)
(3)	(iii)	(i)	(iv)	(ii)
(4)	(ii)	(iii)	(iv)	(i)

Q.71 Match List-I with List-II **[NEET-2021]**

List-I		List-II	
(a)	Cells with active cell division capacity	(i)	Vascular tissues
(b)	Tissue having all cells similar in structure and function	(ii)	Meristematic tissue
(c)	Tissue having different types of cells	(iii)	Sclereids
(d)	Dead cells with highly thickened walls and narrow lumen	(iv)	Simple tissue

Select the correct answer from the options given below.

	(a)	(b)	(c)	(d)
(1)	(iii)	(ii)	(iv)	(i)
(2)	(ii)	(iv)	(i)	(iii)
(3)	(iv)	(iii)	(ii)	(i)
(4)	(i)	(ii)	(iii)	(iv)

Q.72 Select the correct pair. **[NEET-2021]**

(1) Loose parenchyma cells rupturing the epidermis and forming a lens shaped opening in bark — Spongy parenchyma

(2) Large colorless empty cells in the epidermis of grass leaves — Subsidiary cells

(3) In dicot leaves, vascular bundles are surrounded by large thick-walled cells — Conjunctive tissue

(4) Cells of medullary rays that form part of cambial ring — Interfascicular cambium

Q.73 Hydrocolloid carrageen is obtained from: **[NEET-2022]**

(1) Phaeophyceae and Rhodophyceae
(2) Rhodophyceae only
(3) Phaeophyceae only
(4) Chlorophyceae and Phaeophyceae

Q.74 Interfascicular cambium is present between **[ReNEET-2022]**

(1) Secondary xylem and secondary phloem
(2) Primary xylem and primary phloem
(3) Pericycle and endodermis Two vascular bundles
(4) Two vascular bundles

Q.75 The type of tissue commonly found in the fruit wall of nuts is **[ReNEET-2022]**

(1) Sclereid (2) Parenchyma
(3) Collenchyma (4) Sclerenchyma

Q.76 Initiation of lateral roots and vascular cambium during secondary growth takes place in cells of **[ReNEET-2022]**

(1) Pericycle
(2) Epiblema
(3) Cortex
(4) Endodermis

Q.77 Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R** :

Assertion A : Late wood has fewer xylary elements with narrow vessels.

Reason R : Cambium is less active in winters

In the light of the above statements, choose the correct answer from the options given below : **[NEET-2023]**

(1) A is false but R is true
(2) Both A and R are true and R is the correct explanation of A
(3) Both A and R are true but R is NOT the correct explanation of A
(4) A is true but R is false

Q.78 Given below are two statements : **[NEET-2023]**

Statement I : Endarch and exarch are the terms often used for describing the position of secondary xylem in the plant body.

Statement II : Exarch condition is the most common feature of the root system.

In the light of the above statements, choose the **correct** answer from the options given below:

(1) **Statement I** is incorrect but **Statement II** is true
(2) Both **Statement I** and **Statement II** are true
(3) Both **Statement I** and **Statement II** are false
(4) **Statement I** is correct but **Statement II** is false

Q.79 Identify the **correct** statements: **[NEET-2023]**

A. Lenticels are the lens-shaped openings permitting the exchange of gases.
B. Bark formed early in the season is called hard bark.
C. Bark is a technical term that refers to all tissues exterior to vascular cambium.
D. Bark refers to periderm and secondary phloem.
E. Phellogen is single-layered in thickness.

Choose the correct answer from the options given below:

(1) B and C only (2) B, C and E only
(3) A and D only (4) A, B and D only

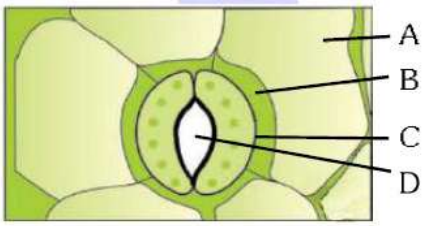
Q.80 Builiform cells are responsible for : **[NEET-2024]**

(1) Increased photosynthesis in monocots
(2) Providing large spaces for storage of sugar
(3) Inward curling of leaves in monocots
(4) Protecting the plant from salt stress

Q.81 Formation of interfascicular cambium from fully developed parenchyma cells is an example for : **[NEET-2024]**

(1) Dedifferentiation (2) Maturation
(3) Differentiation (4) Redifferentiation

Q.82 In the given figure, which component has thin outer walls and highly thickened inner walls? **[NEET-2024]**



(1) A (2) B (3) C (4) D

Q.83 Given below are two statements : **[NEET-2024]**

Statement I : Parenchyma is living but collenchyma is dead tissue

Statement II : Gymnosperms lack xylem vessels but presence of xylem vessels is the characteristic of angiosperms.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is true but Statement II is false.

(2) Statement I is false but Statement II is true.

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false

Q.84 Find the statement that is NOT correct with regard to the structure of monocot stem. **[NEET-2025]**

(1) Vascular bundles are conjoint and closed.

(2) Phloem parenchyma is absent.

(3) Hypodermis is parenchymatous.

(4) Vascular bundles are scattered.

Answer Key

EXERCISE -1

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	1	3	1	1	2	3	3	3	1	3	3	3	3	2	1	1	1	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	1	2	3	3	1	3	2	3	2	3	3	2	3	3	2	3	1	2
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	1	4	1	4	1	4	1	1	2	4	2	2	2	2	1	3	1	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	3	1	3	3	1	3	1	3	3	4	1	4	2	1	4	3	1	1	4
Ques.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	4	2	1	2	3	2	3	3	1	1	1	3	3	2	1	3	4	3	1	3
Ques.	101	102	103	104	105	106														
Ans.	2	4	3	4	2	3														

EXERCISE -2

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

EXERCISE -3

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	3	2	4	2	1	2	2	2	2	1	1	2	4	4	2	3	2	1
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	3	3	2	1	1	3	4	4	3	4	4	3	1	4	2	3	4	1	3
Ques.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	1	4	1	4	2	2	2	2	3	2	4	4	1	3	2	2	2	1	2
Ques.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	1	3	1	1	1	3	2	4	3	2	4	2	4	1	1	2	1	3	3
Ques.	81	82	83	84																
Ans.	1	3	2	3																

NOTES