ANATOMY OF FLOWERING PLANTS

INDEX

CONTENTS

Anatomy of Flowering Plants

Syllabus

Morphology and modifications; Tissues; Anatomy and functions of different parts of flowering plants: Root, stem, leaf, inflorescence- cymose and recemose, flower, fruit and seed (To be dealt along with the relevant practical of the Practical Syllabus).

Chapter Index

THE TISSUES

- The term **tissue** was coined by **Grew.**
- A group of similar or dissimilar cells that perform a common function and have a common origin is called **tissue**.
- The tissues are classified into two main groups, namely, **meristematic** and **permanent** tissues based on whether the cells being formed are capable of dividing or not.

A. Meristematic Tissues

- These tissues consist of cells that retain the power of division.
- The protoplasm within the cell is dense, the vacuole is smaller or absent.
- These cells are isodiametric, without intercellular spaces.
- The nucleus is bigger in size.
- These cells have thin cellulosic cell wall.

- Metabolically active cells with high surface area per unit volume and nucleo-cytoplasmic ratio.
- Ergastic substances are absent.
- Colourless proplastids are present in cells.

Concept Builder

Classification of meristems :

(1) On the basis of origin and development

(a) **Promeristems (Primordial meristem).** A group of cells which represent primary stages of meristematic cells. They are represented by few cells found at the apices of shoots and roots. They give rise to primary meristems.

(b) **Primary meristems.** They originate from promeristems. They are found below the promeristem at shoot and root apices, at the apex of leaves and in intercalary parts. They give rise to primary permanent tissues after differentiation.

(c) **Secondary meristems.** They are not present from the beginning of the formation of an organ but develop at a later stage. They give rise to secondary permanent tissues. They develop from primary permanent tissue as a result of dedifferentiation, *e.g.*, interfascicular cambium, cork cambium and cambium in dicot roots.

(2) On the basis of position

(a) **Apical meristem.** These cells or tissues are found at the apices of stem and root. Due to their continuous division the root and stem increase in length. The apical meristem helps the plants to grow in length.

(b) **Intercalary meristem.** These tissues are intercalated between permanent tissues. These are actually a part of the apical meristem which gets separated from it during the growth of stem in length. The most characteristic example is the stem of grasses and *Equisetum*. They are responsible for increase in the length of the stems of grasses especially. They are commonly located at the base of the leaves, above the nodes *(e.g.* grasses) or below the nodes *(e.g.* mint).

(c) **Lateral meristem.These** meristems are present along the lateral side of stem and roots. They divide in tangential plane, giving rise to the secondary permanent tissues to the inside and outside and lead to the increase in thickness or girth of the plant body, *e.g.*, intrafascicular cambium , interfascicular cambium and cork cambium.

(3) On the basis of plane of cell division

(a) **Rib or file meristem.** The cells divide anticlinally in one plane, so row or column of cells is formed, *e.g.*, formation of lateral roots.

(b) **Plate meristem.** The cells divide anticlinally in two planes, so plate like area is increased, *e.g.*, formation of epidermis and lamina of leaves.

(c) **Mass meristem.** The cells divide anticlinally in all planes, so that a mass of cells is formed, *e.g.*, formation of spores, cortex, pith, endosperm.

(4) On the basis of function

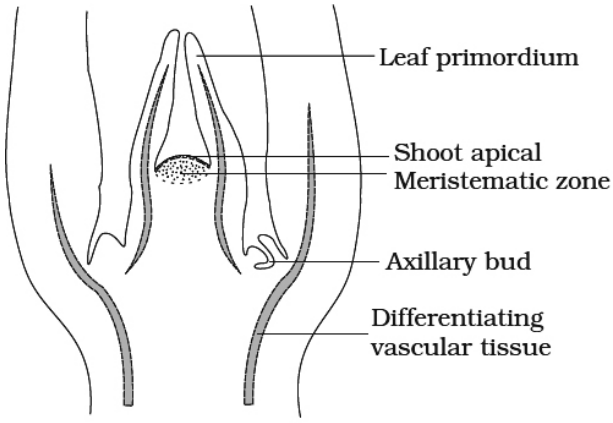
(a) **Protoderm.** These are outermost meristematic cells. They form skin or epidermis of plant and epidermal tissue system.

(b) **Procambium.** These are innermost meristematic cells. They form primary xylem, primary phloem and cambium.

(c) **Ground meristem.** They form ground or fundamental tissue such as hypodermis, cortex, pith, pericycle, etc.

Shoot Apex Organisation

- Shoot apex is present immediatley above the youngest leaf primordia. It consists of meristematic cells. Lateral branches of stem and leaves are formed by the activity of shoot apex.

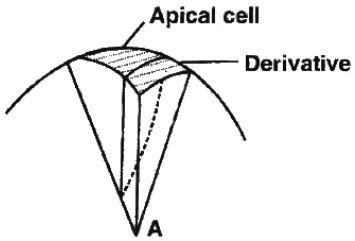


Shoot apex

Concept Builder

- Many theories have been given to explain shoot apex organisation, such as

(i) **Apical cell theory.** It was proposed by **Hofmeister and Nageli.** According to this theory a single apical cell leads to the development of entire plant body. This theory is applicable to algae, as well as to most of the bryophytes and pteridophytes.



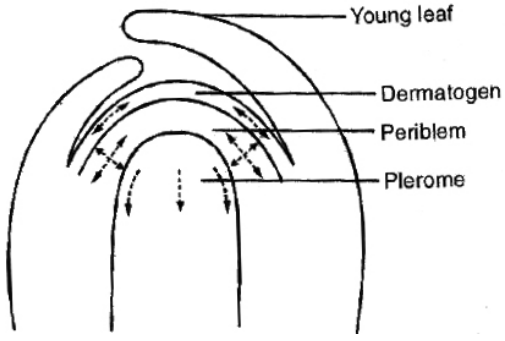
Single apical cell with its derivative

(ii) **Histogen theory.** It was proposed 'by Hanstein. According to this theory shoot apex consists of following histogens

(a) **Dermatogen.** Outermost layer. It forms epidermis (skin) and epidermal tissue system.

(b) **Periblem.** It gives rise to the tissues between epidermis and stele, *i.e.*, cortex and endodermis.

(c) **Plerome.** Innermost layer. The central mass of cells which gives rise to central stele.



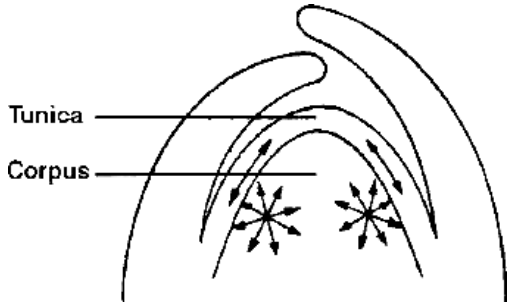
Organisation of shoot apex according to histogen theory

(iii) Tunica-Corpus theory. It was proposed by **Schmidt (**1924). It is based on plane of division of cells. According to this theory, shoot apex consists of two distinct layers as

(a) **Tunica.** It is mostly single layered and forms epidermis. The cells of tunica are smaller than corpus and divide by anticlinal divisions mostly.

(b) **Corpus.** It represents central core with larger cells. The cells divide in all planes (anticlinal and periclinal) .

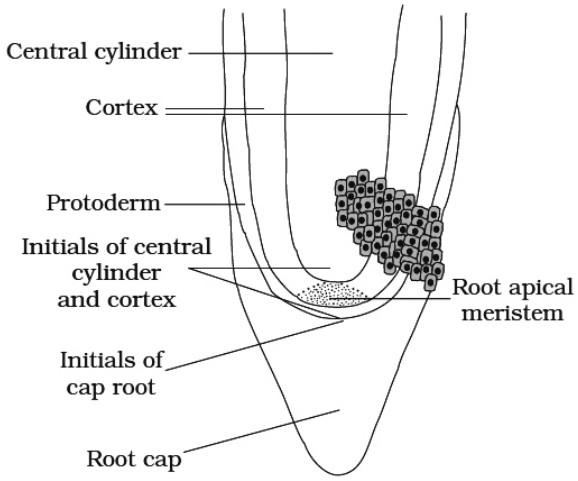
Sometimes, tunica is multilayered, then only outer layer forms epidermis and the remaining layers with corpus form cortex of shoot.



Organisation of shoot apex according to Tunica-Corpus theory

Root Apex Organisation

- Root apex consists of mass of meristematic cells.
- Root apex is not responsible for the formation of lateral roots.
- Root cap is present due to which root meristem becomes subterminal in position.
- If root cap is independent in origin, it arises from the calyptrogen.



Root apex

Concept Builder

Regarding the organisation of root apex, following theories have been put forward.

(i) Korper-Kappe theory. It was proposed by **Schuepp (1917)**. This theory is comparable with the tunica and corpus theory of shoot apex because it is also based upon plane of division. **Korper** means body and **Kappe** means cap.

(ii) Quiescent centre theory. It was proposed by **Clowes (1956-58) in maize**. According to this theory, root apex consists of an inverted cup like structure called the quiescent centre. The cells of this region show very low mitotic activity (quiescent) . They have low amount of RNA, DNA and protein. They are surrounded by layer of actively dividing cells which are responsible for formation of different structures of root. These cells divide only when the root apex gets injured.

Conceptual

The meristem found intercalated between permanent tissues is called.
Give one word for the meristem that is required for increase in girth of plant body.
Ergastic substances are absent in meristem cells (True / False).
Secondary meristem arises directly from primary meristem (True / False).
Inverted cup like structure in root apex is called _____.

Ans. 1. Intercalary meristem, **2.** Lateral meristem, **3.** True, **4.** False, **5.** Quiescent centre

B. Permanent Tissues

- They are composed of living or dead cells which are derived from the meristematic tissue but have lost their ability to divide.
- They are primary permanent tissues, if they are derived from apical or intercalary meristem.
- They are secondary permanent tissues if they are derived from lateral meristem.
- Permanent tissues are mature cells with permanent special structure and function.
- These are of three types:

(I) **Simple Tissues**

(II) **Complex Tissues** and

(III) Secretory Tissues

(I) Simple tissues

- They are made up of one kind of cells performing similar function.

(a) Parenchyma

- These cells are found almost in all parts of plants such as roots, stem, leaves, fruits and seeds.
- These cells are isodiametric, spherical, oval or polygonal with intercellular spaces.
- These cells are living with thin cellulosic cell wall.
- Elongated parenchyma with tapering ends is called

prosenchyma. Functions:

(i) The main function is storage of food , *e.g.,* fruits and endosperm.

(ii) Storage of water in fleshy stem and leaves *e.g., Opuntia.*

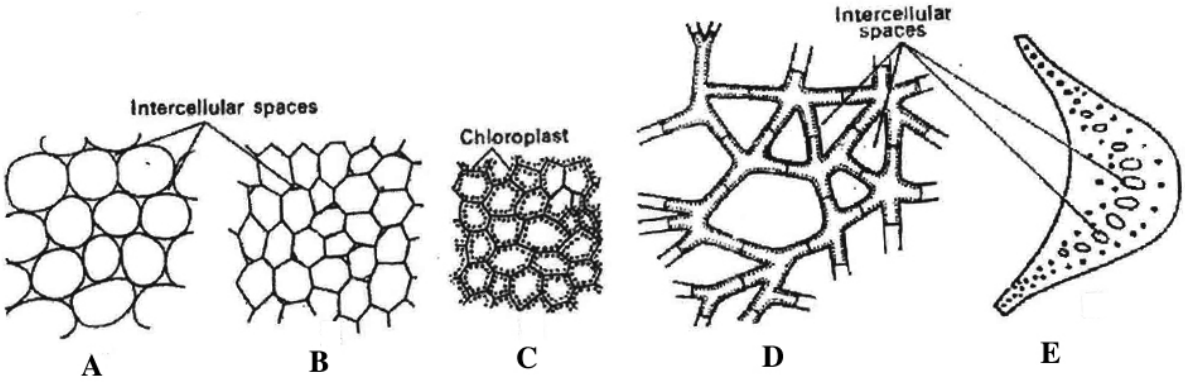
(iii) Sometimes, they store secretory substances **(ergastic substances)** such as tannins, resins and gums and they are called as **idioblasts.**

(iv) In hydrophytes, they have large intercellular spaces filled with air and are called **aerenchyma.**

They help in circulation of air as well as provide buoyancy to plants.

(v) Sometimes, parenchymatous cells have chloroplast to help in photosynthesis and are called

chlorenchyma.



Types of parenchyma : A, B. Thin walled parenchyma; **C.** Chlorenchyma; **D & E.** Aerenchyma

(b) Collenchyma

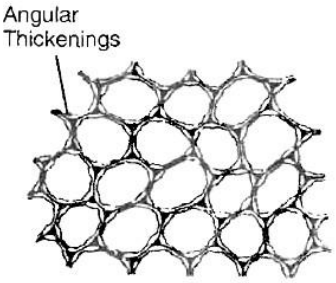
- The term **collenchyma** was coined by **Schleiden.**
- These cells have thickenings on the cell wall and in corners of intercellular spaces.
- It is living mechanical tissue.

- **They are not found in roots and monocot stems.**
  - These cells form hypodermis in stem and petiol.
  - The thickening material, in the cell wall contains high amount of pectin and cellulose.
- **Lignin is absent.**

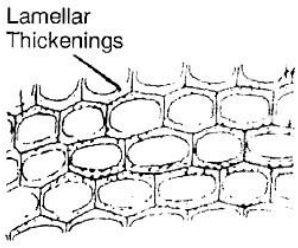
Concept Builder

Collenchyma is of three types :

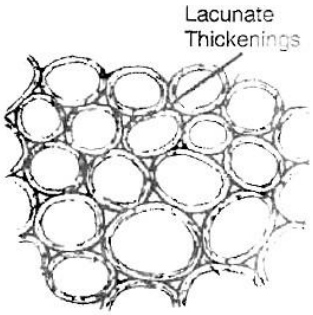
1. **Angular collenchyma** - Angular walls thickened *e.g.*, stem of Marigold, Tomato, **Datura.**
2. **Lamellate collenchyma** - Tangential walls thickened *e.g.*, stem of Sunflower.
3. **Lacunate collenchyma** - Lacunate thickening, intercellular spaces are present *e.g.*, stem of *Calotropis.*



Angular Collenchyma



Lamellate Collenchyma (plate type)



Lacunate Collenchyma

Function :

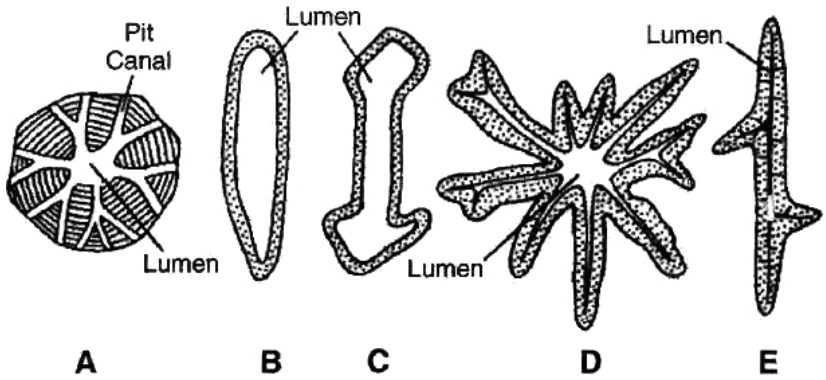
- It provide mechanical support, flexibility and elasticity to the organs and due to peripheral position in stems they resist bending and pulling action of wind . It is especially useful for young plants and herbaceous organs where it is an important supporting tissue.

(c) **Sclerenchyma.** These cells have thickened secondary walls due to **deposition of lignin**. maturity they become dead. These cells have simple pits. They are of two types:

(i) Sclereids

- They may be spherical, oval and cylindrical.
- They are lignified and extremely thick walled. So the lumen of the cells is almost obliterated.
- They are found in hard parts of the plant.

1. **Brachysclereids (Stone cells).** They are isodiametric and they are found in bark, pith, phloem, cortex, hard endocarp and fleshy portion of some fruits. The grittiness of the fruits like guava and pear is due to these.
2. **Macrosclereids (Rod cells).** These are elongated, rod like and found in seed coat of leguminous plants.
3. **Osteosclereids (Prop cells).** These are rod like with dilated ends or barrel shaped *e.g.,* leaves and seed coat of many monocots and seed coat subepidermis in legumes.
4. **Asterosclereids (Star cells).** These are stellate in form or star shaped. They are common in petiole of floating hydrophytes, like *Nymphaea,* Lotus and leaves of tea.
5. **Trichosclereids (Internal hair).** Long, hair like branched sclereids. They are common in hydrophytes and aerial roots of *Monstera.*



Types of sclereids : A. Brachysclereids (stone cells); **B.** Macrosclereids; **C.** Osteosclereid; **D.** Asterosclereid; **E.** Trichosclereid

(ii) Sclerenchymatous fibres

- They are long with tapering ends.
- These are thick walled cells (lignified).
- The fully developed fibre cells are always dead.
- The length of fibre varies from 2-550 mm in angiosperms and 1 to 12 mm in gymnosperms.
- The fibres are present in hypodermis of monocot stem, in pericycle of many dicots, in secondary wood and in vascular bundle sheath in monocot stems. *e.g.*, Jute, Flax, Hemp etc.

- **Living fibres are found in *Tamarix*.**

Function: The main function of sclerenchyma is to provide mechanical strength.

(II) Complex tissues

- They are made up of different types of cells working as a unit to perform a common function. It includes xylem and phloem.

A. Xylem (by Nageli) or Hadrome (by Haberlandt).

- It is chief water conducting element and also provides mechanical strength.
- On the basis of origin, xylem is of two types:

(i) Primary xylem

- It is derived from procabium during the formation of primary plant body.
- It is differentiated into **protoxylem** (first formed and consists of tracheary elements and xylem parenchyma) and **metaxylem** (later formed and consists of tracheary elements, xylem parenchyma and fibre).
- The cells of metaxylem are bigger in size than protoxylem.

(ii) Secondary xylem.

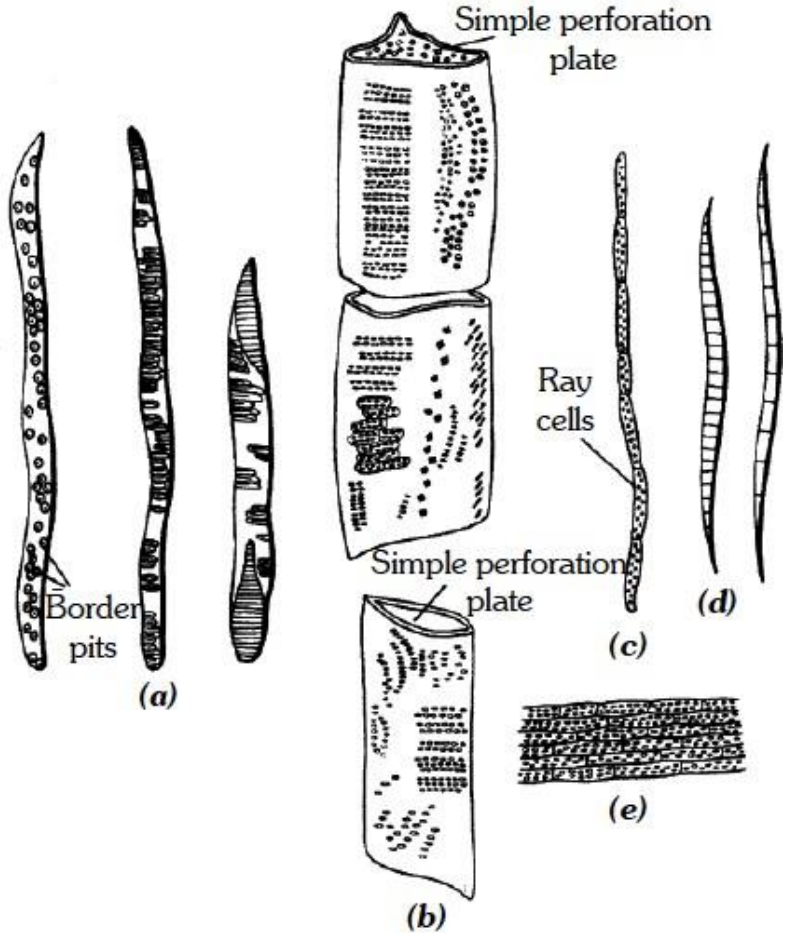
- It is formed from cambium during secondary growth. It is well differentiated into two systems.

(a) Axial or vertical system

1. Tracheary element (Tracheids and Vessels) → For conduction of water
2. Xylem or wood fibre → For support
3. Xylem parenchyma → For storage of food

(b) Ray or horizontal system

Ray parenchyma → For storage of food.



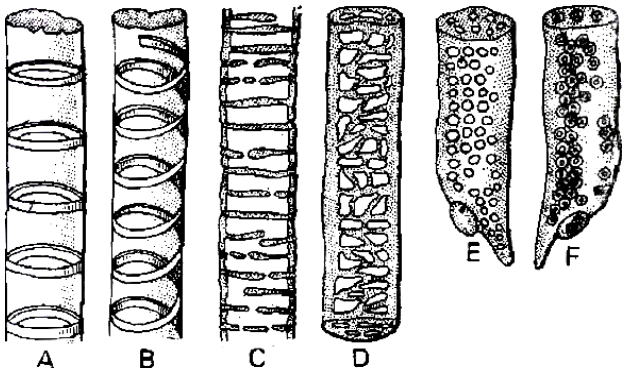
Components of xylem : a. Tracheids, **b.** Vessels,

c and e. -Xylem parenchyma, **d.** Wood fibres wood sclerenchyma)

Xylem consists of following types of cells:

(i) Tracheids.

- They are elongated cells with pointed chisel like ends, having no perforations.
- Their wall is tough, thickened, lignified and thickening may be **annular, spiral, reticulate, scalariform** or **pitted.**
- Cells are dead at maturity and have bordered pits.
- In **pteridophytes** and **gymnosperms,** wood mainly consists of tracheids (no vessels).
- In **angiosperms,** tracheids are associated with vessels.
- The main function is conduction of water.
- The tracheids are most primitive type of conducting elements in xylem.



Lignified thickenings in xylem tracheids and vessels

A. Annular **B.** Spiral **C.** Scalariform **D.** Reticulate **E. & F.** Pitted

(ii) Vessels

- They are also elongated and tube like, formed from a row of cells placed end to end.
- The partition walls are either perforated or disappear altogether, resulting in an elongated tube.
- Walls are thickened and lignified, may have annular, spiral, reticulate or scalariform thickenings.
- Vessels are dead at maturity and without nuclei.
- The main function is conduction of water.
- Vessels are advanced type of conducting elements.

Concept Builder

- In **pteridophytes** and **gymnosperms, vessels are absent (non porous wood).**
- Sometimes, primitive vessels are present in *Gnetum* and *Ephedra* (Gnetales).
- **Vessels are characteristic of angiosperms (porous wood)**, but they are absent in members of vesselless **families** like Winteraceae, Trochodendraceae and Tetracentraceae.

(iii) Wood or xylem fibre.

- These cells are elongated and pointed at both the ends.
- Lumen is completely obliterated.
- Cell wall is highly lignified with simple pits.

- They are commonly found in secondary xylem.
- They may be :

(a) Fibre tracheids. Fibre like tracheids with bordered pits.

(b) Libriform fibre. They have extremely thick walls and simple pits. They provide mechanical support.

(iv) Wood or xylem parenchyma.

- They are living parenchymatous cells associated with xylem.
- They may occur as **axial parenchyma or ray parenchyma.**

Concept Builder

When parenchyma is diffused or not associated with vessels, it is called **apotracheal parenchyma** and when parenchyma surrounds or is associated with vessels, it is called **paratracheal parenchyma.**

B. Phloem (by Nageli) or Bast or Leptome (by Haberlandt)

- It is the main food conducting tissue.

Types of phloem

(a) On the basis of position

(1) External phloem. It is of normal type and is present outside the xylem, *e.g.,* most angiosperms and gymnosperms.

(2) Internal or intraxylary phloem. It originates from procambium and is the primary phloem which occurs on innerside of primary xylem in bicollateral bundles. *e.g.,* Members of Apocyanaceae, Asclepiadaceae, Convolvulaceae, Solanaceae and Cucurbitaceae.

(3) **Included or interxylary phloem.** It originates from cambium and is secondary phloem which occurs in groups within the secondary xylem, *e.g., Leptadaenia, Salvadora, Chenopodium, Boerhaavia, Amaranthus.*

(b) On the basis of origin it is of two types:

(1) Primary phloem. It develops from procambium. It does not have radial differentiation or rays are absent. It is differentiated into protophloem (consists of sieve elements and parenchyma) and metaphloem (develops after protophloem and consists of sieve elements, parenchyma and fibre). During the primary growth the protophloem elements are crushed by the surrounding tissues and disappear. This process is known as obliteration.

(2) Secondary phloem. It develops from cambium during secondary growth. It shows radial differentiation. It consists of two distinct systems:

(a) Axial or Vertical system

1. Sieve elements (Sieve tube and companion cells) : For conduction of food

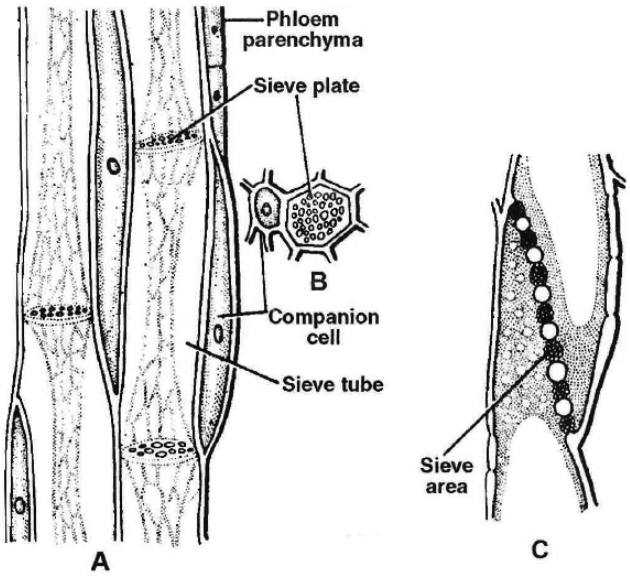
2. Bast fibre : For support
3. Bast Parenchyma: For storage of food

(b) **Ray** or **Horizontal system.** Consists of ray parenchyma for storage of food.

Phloem consists of following types of cells

(1) Sieve element.

- The sieve elements in angiosperms are sieve tubes which are cylindrical tube like cells with perforated cross walls called **sieve plate**.
- Sieve tubes are associated with companion cells and they are **without nuclei**.
- In pteridophytes and gymnosperms the sieve elements have sieve plates on their lateral walls and are called **sieve cells** and companion cells are absent.
- The walls of sieve tube elements are made up of cellulose and pectic substances.
- The cytoplasm is confined to a thin peripheral layer.
- **P-proteins (Phloem protein)** are proteinaceous structures present in sieve tubes and are believed to be responsible for (i) movement of materials and (ii) sealing of pores after wounding.



Components of phloem: A. L.S. of phloem tissue, **B.** T.S. of phloem tissue, **C.** L.S. of sieve plate

- At the end of growing season a callose plug (made of callose carbohydrate) is deposited on sieve plate in old sieve tubes which inhibits the activity of sieve tubes.
- In spring season the callose plug gets dissolved.

(2) Companion cells.

- They are elongated, living, parenchymatous, thin walled cells.
- They are associated laterally to sieve tubes and have dense cytoplasm and nuclei.
- Companion cells are absent in pteridophytes and gymnosperms.
- Both sieve tubes and companion cells are related ontogenetically because both develop from the same mother cell.

- So, these are called sister cells.

(3) Phloem or bast fibre.

- They are absent or fewer in primary phloem and abundantly found in secondary phloem.
- They are sclerenchymatous and unbranched fibres associated with phloem.
- Phloem fibres of plants like jute, flax and hemp are retted in water and extracted for making ropes and coarse textiles.

(4) Phloem parenchyma.

- They are parenchymatous living cells with cellulosic cell wall and nucleus.
- The main function is storage of food.
- They are not found in **monocotyledonous** plants.

Self Assessment

Intercalary meristem is related to all, except

(1) Present between permanent cells

(2) Part of apical meristem

(3) Increasing the girth of axis

(4) Regenerates part of grasses removed by grazing herbivores

Find odd one out W.r.t. histogens found in shoot apex according to Hanstein

(1) Tunica (2) Periblem (3) Plerome (4) Dermatogen

Thickening material in collenchyma is

(1) Pectin, cellulose, hemicellulose (2) Lignin, cellulose, hemicellulose

(3) Hemicellulose, suberin, cellulose (4) Suberin, pectin, cellulose

Q.4 Long hair like sclereids found in aerial roots of Monstera are known as

(1) Brachysclereids (2) Trichosclereids (3) Macrosclereids (4) Astrosclereids

Q.5 Interxylary phloem is not found in

(1) Potato (2) *Leptadaenia* (3) *Salvadora* (4) *Chenopodium*

Q.6 Which component is not found in phloem of angiosperms?

(1) Albuminous cells (2) Sieve tube (3) Companion cell (4) Bast fibre

Q.7 Major xylary element in wood of a gymnospermic plant is

(1) Vessel (2) Tracheid (3) Xylem fibre (4) Xylem parenchyma

Q.8 Which of the following cell helps in maintaining the pressure gradient in the sieve tubes?

(1) Phloem parenchyma (2) Bast fibre

(3) Companion cell (4) Wood fibre

Q.9 Select an incorrect match

(1) Tunica – Corpus theory –Schmidt (2) Histogen theory – Hanstein

(3) Quiescent centre theory – Clowes (4) Korper – Kappe theory – Hofmeister

Q.10 Sclerenchyma fibres are absent in :

(1) Protoxylem (2) Protophloem

(3) Metaxylem (4) More than one option is correct

Ans. Q.1 (3), Q.2 (1), Q.3 (1), Q.4 (2), Q.5 (1), Q.6 (1), Q.7 (2), Q.8 (3), Q.9 (4), Q.10 (4)

(III) Secretory Tissues

- These tissues perform special function in the plants e.g., secretion of resin, gum, oil and latex.

Concept Builder

- **These tissues are of two types :**

(1) Laticiferous tissues.

- They are made up of thin walled, elongated, branched and multinucleate (coenocytic) structures that contain colourless, milky or yellow coloured heterogenous substance called **latex**.
- These are irregularly distributed in the mass of parenchymatous cells.
- These tissues are of two types –

(a) **Latex cells.** They do not fuse and do not form network. Such tissues are called simple or non-articulated laticifers *e.g., Calotropis* (Asclepiadaceae), *Nerium, Vinca* (Apocyanaceae), *Euphorbia* (Euphorbiaceae), *Ficus* (Moraceae).

(b) **Latex vessels.** They are formed due to fusion of cells and form network like structure. Such tissues are called compound or articulated laticifers, *e.g., Argemone Papaver* (Papaveraceae), *Sonchus* (Compositae), *Hevea* (rubber plant), *Manihot* (Euphorbiaceae).

- The latex of some plants is of great commercial importance such as

(i) Source of commercial rubber is latex of *Hevea brasiliensis, Ficus elastica, Cryptostegia, Manihot glaziovii.*

(ii) Source of chewing or chickle gum is latex of *Achras sapota.*

(iii) Source of enzyme papain is latex of *Carica papaya.* .

(iv) Source of alkaloid opium is latex from immature capsules of *Papaver somniferum* (Poppy) .

(2) Glandular tissues.

- They include different types of glands which secrete oils, gums, mucilage, tannins and resins.
- They may be :

(a) **External glands.** They generally occur on the epidermis of stem and leaves *e.g.,* glandular hair in *Utricularia,* nectar secreting glands in flowers, digestive enzyme secreting glands) in *Drosera, Nepenthes* (insectivorous plants).

(b) **Internal glands.** These are present internally, *e.g.,* oil glands in *Citrus* and *Eucalyptus,* resinous ducts in *Pinus* (schizogenous origin) and mucilage secreting glands in leaves, of *Piper betel.* The glands which secrete essential oils are called **osmophores**.

THE TISSUE SYSTEM

- In response to division of labour, tissues are classified into three systems:

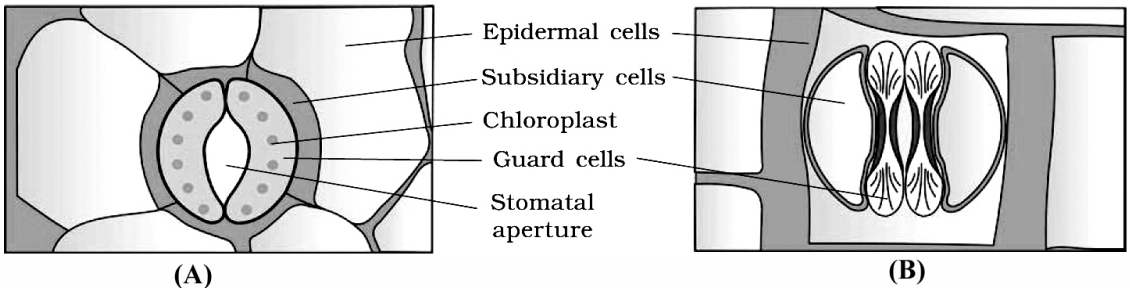
A. Epidermal tissue system

- It consists of epidermis and its associated structures.
- The epidermal cells are living, parenchymatous and compactly arranged (without

intercellular spaces).

- In aerial parts, epidermis is covered by **cuticle**.
- The epidermal cells secrete a waxy substance called **cutin**, which forms a layer of variable thickness (the cuticle) within and on the outer surface of its all walls.
- It helps in reducing the loss of water by evaporation.

- **Cuticle is absent in roots.**
  - **Stomata** are structures present in the epidermis of leaves.
  - Stomata regulate the process of transpiration and gaseous exchange.
  - Each stoma is composed of two bean shaped cells known as **guard cells**.
  - In grasses, **the guard cells are dumb-bell shaped**.
  - The outer walls of guard cells (away from the stomatal pore) are thin and the inner walls (towards the stomatal pore) are highly thickened.
  - The guard cells possess chloroplasts and regulate the opening and closing of stomata.
  - Sometimes, a few epidermal cells, in the vicinity of the guard cells become specialised in their shape and size and are known as **subsidiary cells**.
  - The stomatal aperture, guard cells and the surrounding subsidiary cells are together called **stomatal apparatus**.



Stomata: A. With bean-shaped guard cells **B.** With dumb-bell shaped guard cells

- Mostly epidermis is single layered parenchymatous, but is multilayered in leaf of *Ficus* and *Nerium*.
- Epidermis is mainly protective in nature (external protective tissue).
- In grass leaves, motor or **bulliform** cells are present in upper epidermis.
- On stem, the epidermal hairs are called **trichomes**, which are usually multicellular.
- They may be branched or unbranched and soft or stiff. They may even be secretory. These help in preventing water loss due to transpiration.

Concept Builder

- In grasses and *Equisetum*, silica is present in the epidermal cells.
- The epidermal cells containing cystoliths are called **lithocysts**, these are found in *Ficus* leaves.

B. Ground or fundamental tissue system

- It extends from epidermis upto the centre of axis (excluding vascular tissue).
- The ground tissue constitutes the following parts :

(a) **Cortex.** It lies between epidermis and the pericycle. It is further differentiated into

(i) **Hypodermis.** It is collenchymatous in dicot stem and sclerenchymatous in monocot stem. It provides strength.

(ii) **General cortex.** It consists of parenchymatous cells. Its main function is storage of food.

(iii) **Endodermis** (called starch sheath in dicot stem)**.** It is mostly single layered and is made up of parenchymatous, barrel shaped, compactly arranged cells. The inner and radial wall of root endodermis cells have **casparian strips**. These thick walled endodermal cells are interrupted by thin walled cells just outside the protoxylem patches. These thin walled endodermal cells are called **passage cells**.

Endodermis behaves as water and air tight dam to check the loss of water and entry of air in xylem elements.

(b) **Pericycle.** It lies between endodermis and vascular tissue. It is mostly single layered and parenchymatous in roots and sclerenchymatous (mixed with parenchyma) in stem. **The pericycle cells just opposite the protoxylem are the seat for the origin of lateral roots.** In dicot roots, pericycle form a part of cambium and whole of cork cambium.

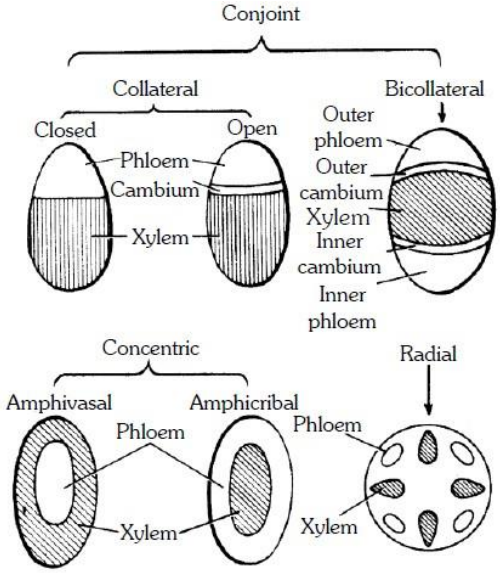
(c) **Pith.** It occupies the central part in dicot stem and monocot root. It is mostly made up of parenchymatous cells. In dicot root, pith is completely crushed by the metaxylem elements. In dicot stem the pith cells between the vascular bundles become radially elongated and are known as **primary medullary rays or pith rays**. They help in lateral translocation.

C. Vascular tissue system

- Vascular bundles found in stelar part constitute vascular tissue system.
- Xylem, phloem and cambium forms the major part of the vascular bundle.
- Vascular bundles may be of following types -

(a) **Radial.** When the xylem and phloem are arranged on different radii, alternating with each other, *e.g.,* roots.

(b) **Conjoint.** When xylem and phloem combine in the same bundles and are present on the same radius, *e.g.,* stem. Conjoint vascular



Different types of vascular bundles

bundles may be:

(i) **Collateral.** Xylem is towards innerside and phloem towards outside.

(ii) **Bicollateral.** When xylem is surrounded on its both sides by the phloem and cambium *e.g.,*
members of **Cucurbitaceae** and **Solanaceae**.

- **Open.** Cambium is present between xylem and phloem, *e.g.,* **dicot stem.**
- **Closed.** Cambium is absent between xylem and phloem, *e.g.,* **monocot stem**.

Concept Builder

Concentric. When one vascular tissue surrounds the other. They are of two types:

(i) **Amphicribal or Hadrocentric.** The xylem is surrounded on all sides by phloem e.g., ferns.

(ii) **Amphivasal or Leptocentric.** The phloem is surrounded on all sides by xylem *e.g., Yucca, Dracaena.*

Conceptual Questions

Source of enzyme papain is latex of_____.

The epidermal cells containing cystoliths are called_____.

Main function of general cortex is storage of food (True/False).

Name the type of vascular bundles, when the xylem and phloem are arranged on different radii, alternating with each other.

Bicollateral vascular bundles are present in the stem of sunflower (True/False).

Ans. **1.** *Carica papaya*, **2.** Litocysts, **3.** True, **4.** Radial, **5.** False

ANATOMY OF DICOT AND MONOCOT PLANTS

Anatomy of Root

- Anatomically, three zones can be distinguished in a root. These are:

(i) **Epidermis.** It is single layered (uniseriate) and consists of tightly placed, thin walled, uncutinised cells. This epidermis layer is called as **epiblema** or **rhizodermis**. Epiblema in younger roots bears **unicellular root hairs** (water absorbing organs), and is also called **piliferous layer**.

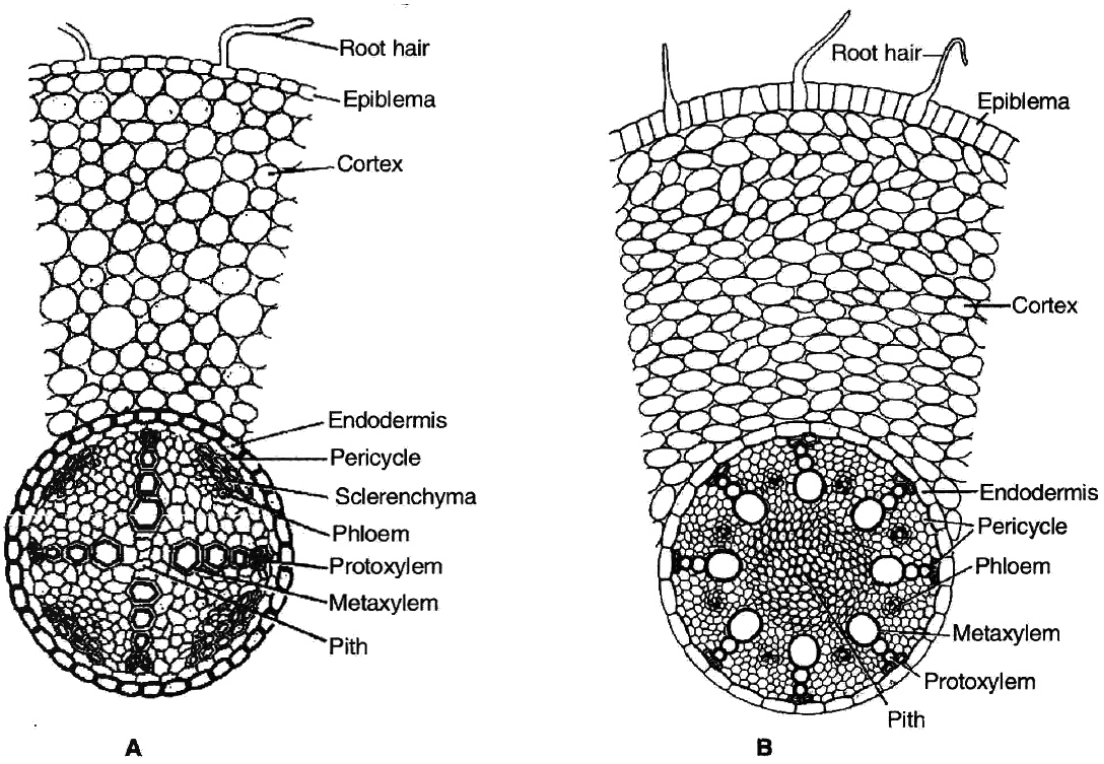
(ii) **Cortex.** It consists of thin walled parenchymatous cells with intercellular spaces. In most monocots and some dicots the cortex layer below epidermis becomes suberised to form protective tissue called **exodermis**. The cells of cortex store food material *(e.g.,* carrot). The innermost layer of cortex develops into **endodermis**. It is made up of closely packed living cells characterised by the presence of band like thickenings **made of lignin and suberin on their radial** and **tangential walls**. These bands or strips are called **casparian bands** or **strips**. Some cells of endodermis lying opposite to protoxylem remain thin walled and are called **passage cells** which allow radial diffusion of water.

(iii) **Vascular bundles.** Vascular bundles are **radial and exarch**. The centre of monocot

root is occupied by parenchymatous cells called pith.

Differences between dicot and monocot root

Characters	Dicot root	Monocot root
1. Vascular bundles	Diarch to hexarch (2 to 6).	Hexarch to polyarch (more than 6).
2. Pericycle	Gives rise to secondary (lateral) root and lateral meristem (cork cambium).	Gives rise to lateral roots only.
3. Cambium	Develops at the time of secondary growth	It is altogether absent.
4. Pith	Small or absent.	Large and well developed.



Part of transverse sections of young roots: A. Gram (dicot), B. Maize

(monocot) Anatomy of Stem

1. **Primary structure of dicot stem**

- Dicot stem consists of following layers:

(i) **Epidermis:** It is the outermost layer consisting of single layer of closely arranged cells with cuticle (cutinized). It bears **multicellular hairs**.

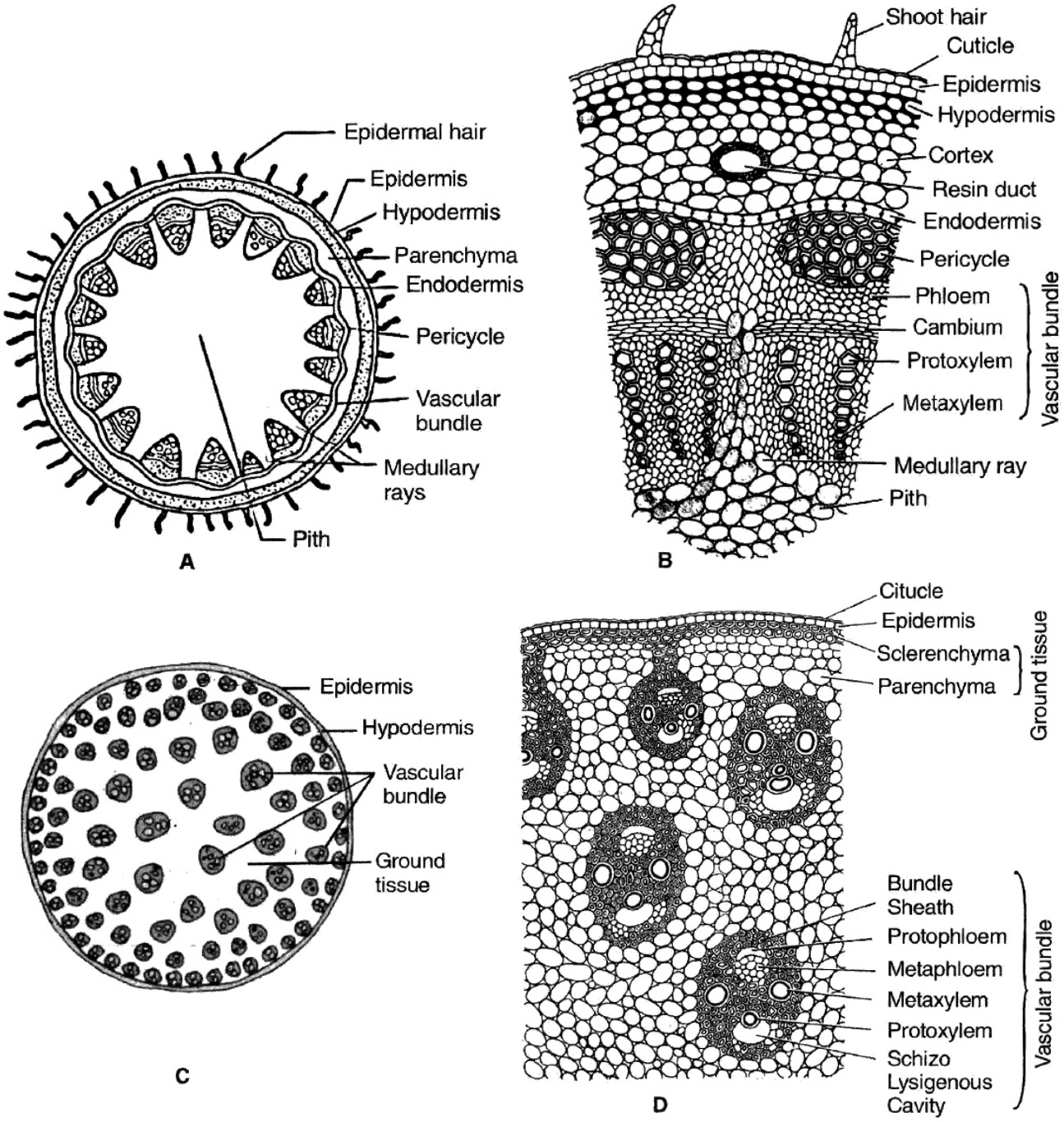
(ii) **Cortex:** It is differentiated into hypodermis, general cortex and endodermis. **Hypodermis is collenchymatous**. General cortex is parenchymatous. Endodermis is wavy. It has starch grains hence it is called **starch sheath or endodermoid**.

(iii) **Pericycle :** It lies inner to endodermis. Pericycle is few layered thick. Above vascular bundle, it is **sclerenchymatous** and outside medullary rays it is **parenchymatous**.

(iv) **Vascular bundles:** These are in the form of a ring or **eustele**. They are **conjoint**, **collateral** and **open**. In the **family Cucurbitaceae**, the stem is wavy, having five ridges and five furrows and vascular bundles are present in ridges and furrows. Vascular bundles are bicollateral and open.

(v) **Medullary or pith rays:** These are radial strips of parenchyma present between adjacent vascular bundles. They help in radial conduction of food.

(vi) **Pith :** It is the central portion of stem consisting of parenchymatous cells with intercellular spaces. Narrow, radially elongated parenchymatous cells extend from pith toward the periphery are called **medullary rays**. The main function is food storage.



Part of transverse sections of stem: A-B. Dicot stem C-D. Monocot stem

2. Primary structure of monocot stem

Monocot stem consists of following layers:

(i) **Epidermis:** It is the outermost layer and consists of compactly arranged parenchyma

cells which are usually covered with cuticle.

(ii) **Hypodermis:** Cells of **hypodermis are sclerenchymatous,** providing mechanical strength to the stem.

(iii) **Ground tissue:** All the tissues inner to hypodermis represents the ground tissue. It is made up of parenchymatous cells rich in food reserve, like starch.

(iv) **Vascular bundles:** They lie **scattered** in the ground tissue. Each vascular bundle is surrounded by 2 or 3 layered **sclerenchymatous sheath** called as bundle sheath. The vascular bundles are conjoint, colateral, closed and endarch **(Atactostele).** Vessels are arranged in V shaped manner. Schizolysigenous water cavity or canals are present below protoxylem.

Differences between dicot and monocot stem anatomy

Characters	Dicot Stem	Monocot Stem
1. Epidermis	Single layered with multicelled hair (trichome)	Single layered without hair
2. Hypodermis	Collenchymatous	Sclerenchymatous.
3. Cortex	Made up of several layers of parenchymatous tissue	Absent, but parenchymatous ground tissue present from hypodermis to centre of stem
4. Endodermis	Single layered which is usually not well differentiated	Absent
5. Pericycle	Made up of one or more layers of parenchymatous or sclerenchymatous or both cells	Absent
6. Medullary rays	Found between the vascular bundles	Absent
7. Pith	Made up of parenchymatous cells situated in the centre of stem	Absent (pith cavity is present)
8. Vascular bundles	(a) Vascular bundles arranged in ring	(a) Scattered, throughout the ground tissue
	(b) Conjoint, collateral or bicollateral, endarch and open	(b) Conjoint, collateral, endarch and closed
	(c) Almost all of them are uniform in size	(c) Larger towards centre and smaller towards outer side
	(d) Wedge shape	(d) Oval in shape
	(e) Bundle sheath absent	(e) Bundle sheath present
	(f) Vessels arranged in rows (radial)	(f) Vessels arranged in V or Y shaped manner
	(g) Phloem parenchyma present	(g) It is absent,
	(h) Schizolysigenous cavity absent	(h) Schizolysigenous water canal or cavity present (formed by disintegration of protoxylem).

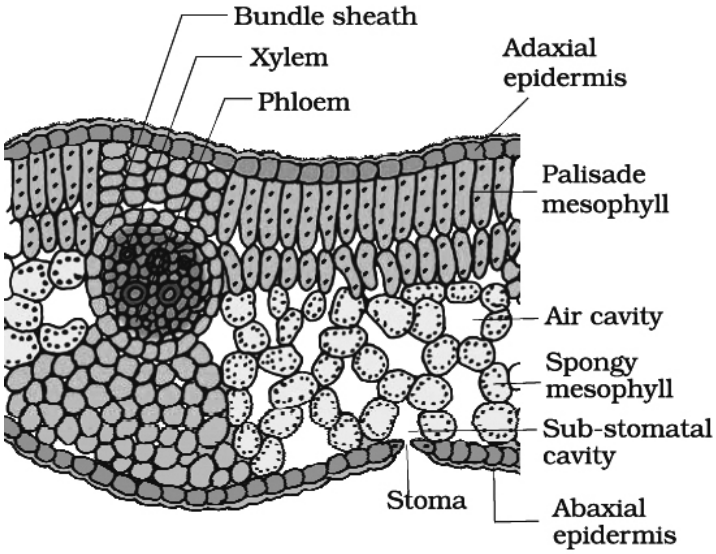
Anatomy of Leaf

1. Structure of dorsiventral leaf (dicot) :

- In cross section of dicot leaf, following parts can be observed

(i) Epidermis.

- The upper and lower surfaces are covered by the epidermis.
- Cells of epidermis are parenchymatous and are closely packed together without any intercellular spaces.
- Mostly the stomata are restricted to lower surface of leaf. Such leaves are called **hypostomatic.**
- The outer walls of the epidermal cells are thickened and cutinized which prevents the loss of water.



T.S. of a dorsiventral leaf

(ii) Mesophyll.

- Between the two epidermal layers, there are numerous parenchyma cells which constitute the mesophyll.
- In dicots, there are two distinct layers of mesophyll-the **palisade** (upper layer consisting of closely arranged column shaped cells containing abundant chloroplasts) and **spongy tissue** (the lower layer of irregularly shaped cells containing fewer chloroplasts).

(iii) Vascular bundles.

- Vascular bundles in the leaf are located in the midrib and the veins.
- Vascular bundles are conjoint, collateral and closed. Bundles are surrounded by a compact layer of parenchymatous cells which is called **bundle sheath.**
- The xylem (protoxlem) is towards upper epidermis (adaxial) and the phloem on the lower epidermis (abaxial).

2. Structure of isobilateral leaf (monocot) :

- Like the dicot leaf, it can also be differentiated into three types of tissues:

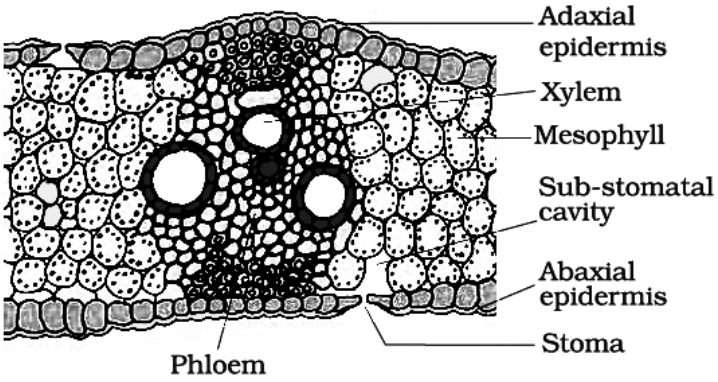
(i) Epidermis.

- It consists of upper and lower epidermis, both of which may be interrupted by equal number of stomata.
- Both the epidermal layers are cutinized. In some grasses *e.g., Poa, Agropyron* Maize,

Psamma,

epidermal cells are large with thin flexible walls which are called **motor** or **bulliform cells**.

- These cells help in the rolling and unrolling of leaves.



T.S. of an isobilateral leaf

(ii) Mesophyll. Mesophyll cells are not differentiated into palisade and spongy parenchyma. Mesophyll cells are made up of parenchyma cells which have chloroplasts.

(iii) Vascular bundles. They are arranged in parallel manner. Vascular bundles are conjoint, collateral, closed and enclosed by a bundle sheath. The xylem is towards the upper side (adaxial surface) and phloem on the lower side (abaxial surface).

Self Assessment

Q.11 Latex vessels are found in
(1) Ficus (2) Vinca (3) Euphorbia (4) Hevea

Q.12 Epidermal tissue system is derived in dicot root from
(1) Calyptrogen (2) Dermatogen (3) Periblem (4) Plerome

Q.13 Multilayered epidermis is found in the leaves of
(1) Nerium and Ficus (2) Ficus and Vanda
(3) Equisteum and Grasses (4) Vanda and Nerium

Q.14 Atactostele is found in the stem of
(1) Mango (2) Maize (3) Capsella (4) Sunflower

Q.15 Carsparian strips are found on radial and inner walls of
(1) Stem endodermis (2) Root endodermis (3) Pericycle (4) Outer cortex

Q.16 Dicot root is similar in all given characters with monocot root, except
(1) Radial, exarch vascular bundles (2) Unicelled root hairs
(3) Pericycle forms the lateral roots (4) Well developed pith

Q.17 Stem of barley is related to
(1) Presence of collenchyma in hypodermis (2) Scattered vascular bundles
(3) Presence of parenchymatous pericycie (4) Presence of wedge shaped vascular bundles

Q.18 a. Palisade tissue is present towards upper epidermis in monocot leaves.
b. Lower layer of mesophyll cells is loosely packed with few chloroplasts in dicot leaves.
c. Dicot leaves have conjoint, collateral and closed vascular bundles
(1) All are incorrect (2) Only B is incorrect
(3) Only A is incorrect (4) Only C is incorrect

Q.19 Conjoint, collateral, endarch and closed vascular bundles are
(1) Monocot root (2) Monocot (3) Dicot (4) Dicot

Q.2 Bulliform cells
are
(2) Colourless
(3) Found in grass

Ans. Q.11 (4), Q.12 (2), Q.13 (1), Q.14 (2), Q.15 (2), Q.16 (4), Q.17 (2), Q.18 (3), Q.19 (2),

SECONDARY GROWTH

- Increase in girth or thickness or diameter of the axis occurs due to formation of new tissues as a result of joint activity of vascular cambium and cork cambium in steler and extrasteler region respectively.
- It occurs in the root and stem of gymnosperms and dicots.
- Secondary growth in dicot stem completes in following steps :

A. Formation of vascular cambium ring :

(i) **Intrafascicular cambium :** It is primary in origin and is present between primary phloem and primary xylem.

(ii) **Interfascicular cambium :** It is true secondary meristem. It originates from parenchyma cells of medullary rays region. It lies in between the vascular bundles.

(iii) **Vascular cambium ring:** Both intrafascicular and interfascicular cambia join together and form a cambium ring.

- Cells of cambium are of two types:

(a) **Fusiform initials :** They form tracheids, vessels, fibres and axial parenchyma in secondary xylem and sieve tubes, companion cells, fibres and axial parenchyma in secondary phloem.

(b) **Ray initials :** These are isodiametric and form ray parenchyma (vascular rays).

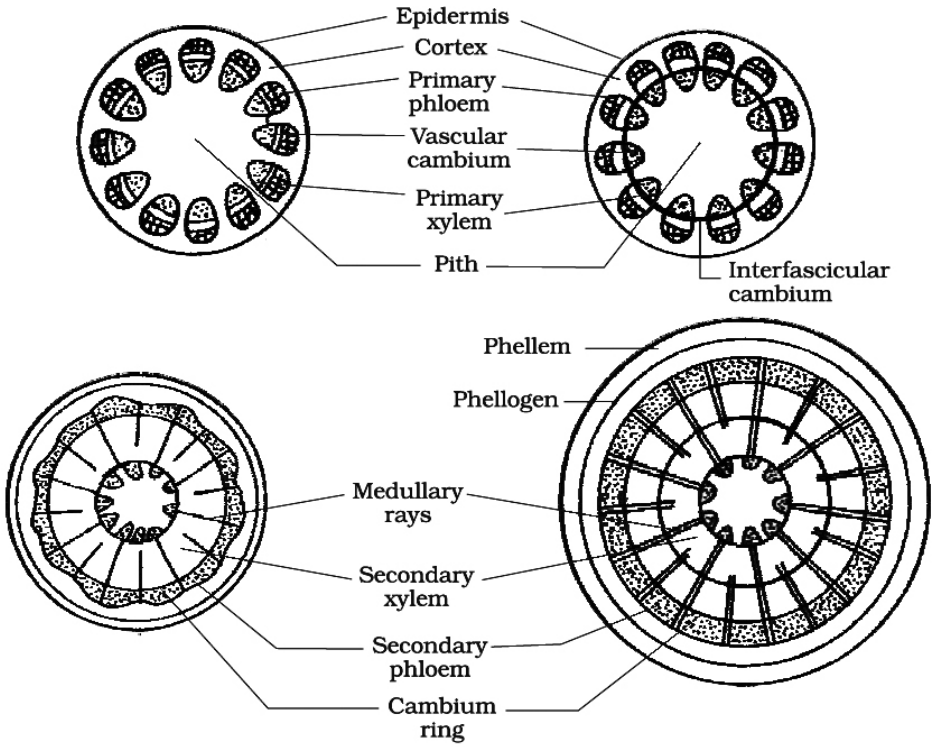
(iv) Periclinal division in cells of vascular cambium ring.

(v) Formation of secondary phloem (outside the vascular cambium) and secondary xylem (inner to vascular cambium). The amount of secondary xylem produced is 8-10 times greater than secondary phloem.

(vi) Due to formation of secondary phloem primary phloem is crushed to death, known as **obliteration**. Primary xylem being dead and lignified, persists in the pith region by replacing the pith cells.

(vii) At some places, the cambium forms a narrow band of parenchyma, which passes through the secondary xylem and the secondary phloem in the radial directions. These are the secondary medullary rays.

(viii) Formation of secondary structures *i.e.* annual rings, sapwood and heart wood, hardwood and softwood etc.



Different stages of secondary growth in a typical dicot stem

(a) Annual rings:

- These are formed by the seasonal activity of vascular cambium.
- Cambium is not uniformly active throughout the year.
- In spring or summer cambium is more active and form large sized xylem elements (vessels) which constitute **spring** or **early wood**.
- In Autumn or winter, cambium is less active and cuts off small sized xylem elements (vessels) and constitute **autumn wood** or **late wood**.
- Both autumn and spring wood constitute a growth or annual ring.
- In one year only one growth ring is formed.
- In successive years numerous growth rings are formed.
- Thus by counting the number of annual rings in the main stem at the base we can determine the age of a tree.
- This branch of science is known as **dendrochronology**.

Concept Builder

- **Growth rings are distinct or sharply demarcated in the plants of temperate climate** *e.g.,* Shimla, Nainital, Mussourie due to presence of contrasting seasonal variations.
- **Growth rings are not distinct or sharply demarcated in the trees of tropical climate (near equator)** *e.g.,* Calcutta, Bombay, Madras due to absence of contrasting seasonal variations.

(b) Heart wood and sap wood:

- The young elements of secondary xylem in the peripheral region constitute sap wood or **alburnum**.
- It is **light in colour and physiologically active**.
- The water conduction takes place through sap wood.
- Sap wood is converted into **heart wood** or **duramen** in the central region.
- It is dark in colour due to deposition of tannins, gums, resins and is physiologically inactive (almost dead) and provides only mechanical support.
- During the conversion of sap wood into heartwood, the most important change is development of tyloses in the heart wood.
- **Tyloses** are balloon like structures in lumen of vessels, developing **from xylem parenchyma.**
- These tyloses block the passage of xylem vessels and are also called **tracheal plug.**
- The heart wood is commercially used as wood.
- When the plant is made hollow, it will not die because the water conduction takes place through sap wood.
- The heart wood is well developed in *Morus alba* (Mulberry).
- The heart wood is absent in *Populus* and *Salix* plant.
- The wood of *Tectona grandis* is termite resistant.
- As a tree grows older thickness of heartwood increases and sap wood remains same.
- **Heart wood** is much more durable and resistant to microorganisms, insects and pests etc. than sap wood.

Concept Builder

- Wood of dicot trees is called **porous or hard wood** because it consists of vessels (pores).
- The wood of gymnosperms does not contain vessels (pores) and is known as **soft or non porous wood.**
- Such wood consists of 90 to 95% tracheids and 5 to 10% of ray cells.
- Sap wood will decay faster if exposed freely to the air.
- On the basis of distribution and size of vessels, porous wood is of two types:

(a) **Diffuse porous wood (primitive) :** Vessels of same size are uniformly distributed throughout the growth, *e.g., Pyrus, Betula.*

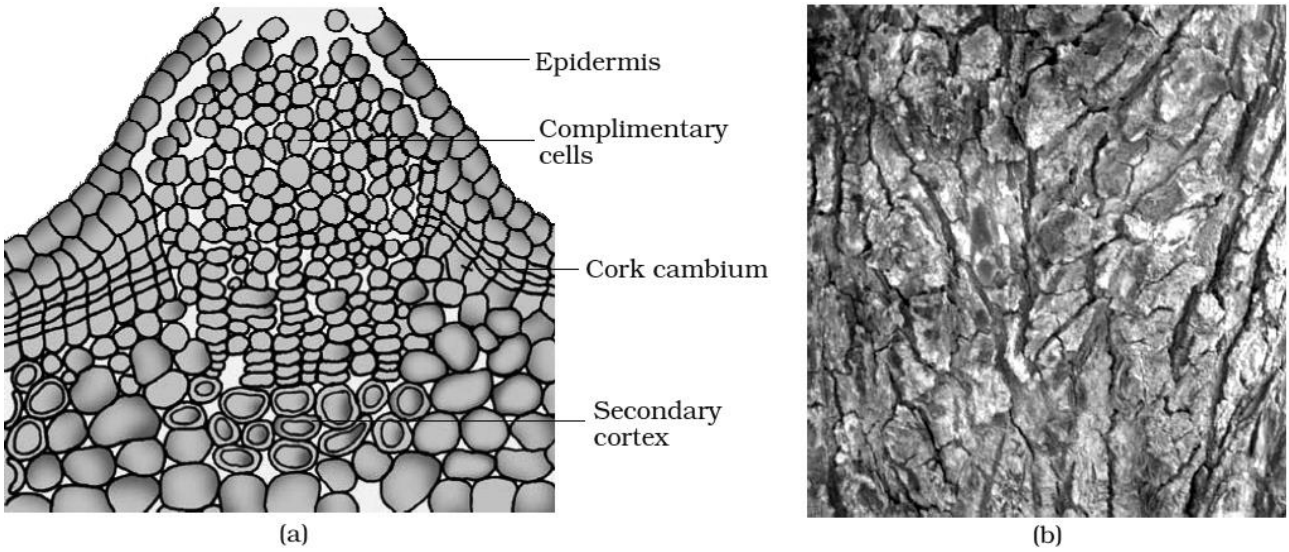
(b) **Ring porous wood** (advanced) : Large vessels are formed in early wood when the need of water is great and small vessels are formed in late wood, *e.g., Quercus, Morus.*

B. Formation of cork cambium:

- Cork cambium or **phellogen** develops from outer layer of cortex.
- It produces secondary cortex or **phelloderm** on innerside and cork or **phellem** on outer side.
- The cells of phellem are dead, suberized and impervious to water.

- Cork cells are airtight and used as bottle stopper or cork.
- The bottle cork is prepared from the cork of *Quercus suber* (Oak tree).

- Cells of phelloderm are thin walled, living and store food. Phellem, phellogen and phelloderm are collectively called **periderm.**
- Periderm is secondary protective tissue.
- Due to pressure of secondary tissues, epidermis ruptures and cortex is largely lost after two or three years of secondary growth.
- In the cork layer the **lenticels** are present which are meant for gaseous exchange.
- In cork, lenticels have loosely arranged cells called **complementary cells** with intercellular spaces.
- For bottle corks the cork, is processed in such manner, so that lenticels come in vertical direction.



Structure of (a) Lenticel and (b) Bark

Bark is a non-technical term for all the dead and living tissues outside the vascular cambium. Bark formed early in the season is called **soft** or **early bark**. Towards the end of the season **late** or **hard bark** is formed.

Concept Builder

(i) **Scaly bark:** Develops in strips *e.g., Acacia, Psidium.*

(ii) **Ring bark:** Develops in the form of sheet or ring, *e.g., Betula* (Bhojpatra).

The outermost layer of bark is dead and called as **rhytidome.**

The bark of *Betula* was being used as substitute of paper in ancient time to write manuscript.

Conceptual Questions

Balloon like structures in vessels of heart wood are called_____.

Complimentry cells are cut off by phellogen towards outside (True / False).

Meristematic layer that is responsible for cutting off xylem and phloem is called vascular cambium (True/False).

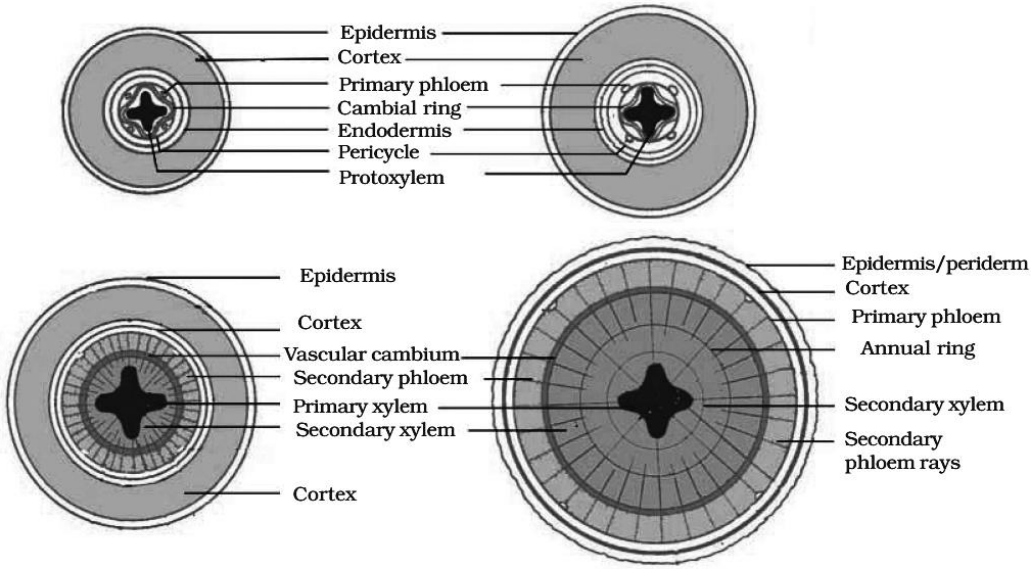
The outermost layer of bark is dead and called as_____.

___of vascular cambium are isodiametric and form ray parenchyma.

Ans. **1.** Tyloses, **2.** True, **3.** True, **4.** Rhytidome, **5.** Ray initials

Secondary Growth in Dicot Root

- Vascular bundles in dicot root are radial, exarch and mostly triarch.
- Vascular cambium is formed secondarily from **conjuctive parenchyma** cells lying just below each phloem strand.
- Thus, the number of cambium strips formed equals the number of phloem strands.
- The cells of pericycle lying outside the protoxylem also become meristematic to form part of strips of cambium.
- These cambial strips join the first formed cambium strips to form complete, but wavy ring of vascular cambium.
- This cambium ring produces secondary xylem on inner side and secondary phloem on outer side.
- In roots, the growth rings are not distinct because there is no seasonal variation under the soil.
- From the outer layers of pericycle arises the phellogen which cuts phellem (cork) on the outer side and secondary cortex or phelloderm toward the inner side.



Diagrams showing secondary growth in dicot root

Self Assessment

Q.21 Vascular cambium in dicot stem is

(1) Primary meristem in origin

(2) Secondary meristem in origin

(3) Promeristem in origin

(4) Both primary and secondary meristem in origin

Q.2 Dendrochronology deals with the study of
(1) Phylogeny (2) Numerical taxonomy
(3) Age of trees

Q.2 Heart wood is characterised by all, except
(2) Presence of tannins, resins, oils, gums etc.

Q.24 Bark is a non-technical term that does not include
(1) Secondary xylem (2) Secondary phloem (3) Phellem (4) Secondary cortex

Q.25 Which of the following tissue makes phellogen during the secondary growth in dicot roots?
(1) Endodermis (2) Hypodermis (3) Epidermis (4) Pericycle

Concept Builder

(i) Dicots with scattered vascular bundles in stem, *e.g., Podophyllum, Peperomia, Piper, Papaver.*

(ii) Cortical vascular bundles, *e.g., Nyctanthus, Kalanchoe, Casuarina.*

(iii) Medullary bundles, *e.g.; Mirabilis, Bougainvillea, Amaranthus, Achyranthus.*

(iv) Polystelic condition, *e.g., Primula, Dianthera*

(v) Anomalous or abnormal secondary growth occurs in *Bougainvillea, Boerhaavia, Chenopodium, Aristolochia.*

(vi) Some monocots show abnormal secondary growth by meristematic tissue which develops around vascular bundles, *e,g., Dracaena, Yucca, Agave* .

(vii) Virgin cork is first formed periderm.

(viii) Wound cork: It is secondary meristem; formed below injured area. It forms cork on outer side and callus below; which heals the wound.

(ix) Abnormal secondary growth in dicot root occurs in Beet root *(Beta vulgaris)* and Sweet potato *(Ipomoea batatas)* by the formation of numerous accessory rings of cambium which cut more storage parenchyma in secondary phloem and less secondary xylem.

(x) Homoxylous wood-wood of vesselless dicots, *e.g.,* Ranales (Winteraceae, Tetracentraceae, Trochodendraceae) .

(xi) Heteroxylous wood is wood of vessel bearing dicots.

(xii) Polyderm is a special type of protective tissue occurs in roots and underground stems of members of Rosaceae and Myrtaceae. Its outermost layer is dead and suberized.

Summary

- Anatomically, a plant is made of different kinds of tissues. The plant tissues are broadly classified into meristematic (apical, lateral and intercalary) and permanent (simple and complex).
- Assimilation of food and its storage, transportation of water, minerals and photosynthates, and mechanical support are the main functions of tissues.
- There are three types of tissue systems -epidermal, ground and vascular.
- The epidermal tissue systems are made of epidermal cells, stomata and the epidermal appendages.
- The ground tissue system forms the main bulk of the plant. It is divided into three zones cortex, pericycle and pith.
- The vascular tissue system is formed by the xylem and phloem,
- On the basis of presence of cambium, location of xylem and phloem, the vascular bundles are of different types. The vascular bundles form the conducting tissue and trans locate water, minerals and food material.
- Monocotyledonous and dicotyledonous plants show marked variation in their internal structures. They differ in type, number and location of vascular, bundles.
- The secondary growth occurs in most 6fthe dicotyledonous roots and stems and it increases the girth (diameter) of the organs by the activity of the vascular cambium and the cork cambium.
- The wood is actually a secondary xylem. There are different types of wood on the basis of their composition ,and time of production.

EXERCISE – 1

Section–A

Tissue is the group of cells which are

(1) Similar in origin, but dissimilar in form and function

(2) Similar in origin and form, but dissimilar in function

(3) Similar in origin, form and function

(4) Dissimilar in origin, but similar in form and function

Father of plant anatomy who also coined the term tissue is

(1) Marcello Malpighi (2) N. Grew (3) Schleiden (4) Hanstein

Meristem is characterised by

(1) Isodiametric cells with cellulosic thin wall

(2) Absence of intercellular space and vacuole

(3) Absence of reserve food material, plastids and ER

(4) All of these

Secondary meristems are derived from

(1) Primordial meristem (2) Primary meristem

(3) Primary permanent tissues (4) Lateral meristem

The intercalary meristerms are infact portions of

(1) Lateral meristem (2) Secondary meristem

(3) Apical meristem (4) Permanent tissue that becomes meristematic

According to Haberlandt, cortex and pith are derived from

(1) Periblem (2) Plerome (3) Procambium (4) Ground meristem

Which one of the following theory of root apex organisation is equivalent to Schmidt's theory?

(1) Tunica-Corpus theory (2) Histogen theory

(3) Korper-Kappe theory (4) Quiescent centre theory

The plane of division in tunica is

(1) Anticlinal (2) Periclinal

(3) Both anticlinal and periclinal (4) Peripheral division

Root cap in monocots is derived from

(1) Calyptrogen (2) Dermatogen (3) Protoderm (4) Periblem

Primary growth in *Equisetum* stem occurs due to the activity of

(1) Apical meristem (2) Intercalary meristem

(3) Lateral meristem (4) Primordial meristem

Quiescent centre in root apex acts as

(1) Waiting meristem (2) Reserve meristem

(3) Reservoir of growth hormones (4) Both (1) & (2)

The grass stem elongates by the activity of

(1) Apical meristem (2) Intercalary meristem

(3) Lateral meristem (4) Primordial meristem

The term meristem was coined by

(1) C. Nageli (2) Mettenius (3) Schuepp (4) Schmidt

The primary growth is affected by

(1) Primary cambium (2) Apical meristem (3) Cambium (4) Secondary cambium

The intercalary meristem is present in

(1) Mint (2) Grasses (3) Bamboo (4) All of these

The organization of shoot apex into tunica and corpus is determined largely on the basis of

(1) Regions of meristematic activity (2) Planes of cell division

(3) Rate of shoot tip growth (4) Phase of cell division

The central region of root apex containing less active cells is known as

(1) Plerome (2) Dermatogen (3) Periblem (4) Quiescent zone

The velamen of orchid root is derived from the

(1) Phellogen of root (2) Plerome of root

(3) Dermatogen of root (4) Periblem of root

According to the histogen theory plerome gives rise to the

(1) Epidermis (2) Cortex (3) Pith (4) Central stele

Collenchyma differs from parenchyma in having

(1) Living protoplasm (2) Cellulosic walls

(3) Vacuoles (4) Pectin and cellulose deposits at corners

Collenchyma is a type of mechanical tissue but it is not as efficient as sclerenchyma. However, it has certain advantages like

(1) It offers no resistance to the growing organs

(2) It has the power of growth

(3) It is flexible

(4) It has the power of growth, it offers no resistance to the growing organs and is not flexible

Walls of sclerenchyma are

(1) Rigid (2) Lignified (3) Pectinised (4) Suberised

Which one of the following is not a fundamental tissue?

(1) Parenchyma (2) Collenchyma (3) Chlorenchyma (4) Aerenchyma

Plasmodesmata maintains cell to cell cytoplasmic connection and are quite common in

(1) Parenchyma (2) Collenchyma (3) Sclereids (4) Sclerenchyma fibres

A parenchyma cell that stores ergastic substances is called

(1) Phragmoplast (2) Idioblast (3) Leucoplast (4) Amyloplast

Mechanical tissue with high refractive index is

(1) Collenchyma (2) Prosenchyma (3) Sclerenchyma (4) Sclereids

Which one of the following acts as water storage tissue in succulent plants?

(1) Parenchyma (2) Aerenchyma

(3) Angular collenchyma (4) Meristem

Collenchyma is absent in

(1) Root (2) Dicot stem (3) Monocots (4) Both (1) & (3)

Cell wall in dead mechanical tissue shows

(1) Lignified nature (2) Cutinised nature

(3) Pectose deposition (4) Hemicellulose deposition

Find correct match

Column I	Column II
a. Brachysclereids	(i) Rod cells
b. Macrosclereids	(ii) Grit cells
c. Bast fibres	(iii) Cotton fibres
d. Asterosclereids	(iv) *Nelumbo*
	(v) *Corchorus* fibres

(1) a(ii), b(i), c(v), d(iii) (2) a(ii), b(i), c(v), d(iv)

(3) a(i), b (ii), c(v), d(iv) (4) a(ii), b(i), c(iv), d(v)

Bordered pits are very common in

(1) Monocotyledons (2) Gymnosperms (3) Dicotyledons (4) All of these

Sieve tubes are better suited for translocation because they

(1) Possess a broader lumen and perforated cross walls

(2) Are broader than long

(3) Possess bordered pits

(4) Possess no end walls

The presence of lignin in a cell is characteristic of

(1) Phloem (2) Woody tissues (3) All soft tissue (4) Cork

Main water conducting element of xylem in homoxylous plants is

(1) Tracheary element (2) Vessel (3) Tracheid (4) Xylem parenchyma

Vesseless angiosperms are

(1) Tetracentraceae (2) Trochodendraceae (3) Winteraceae (4) All of these

Centripetal and centrifugal xylem are the important feature of

(1) Root and stem respectively (2) Exarch and endarch respectively

(3) Endarch and exarch respectively (4) Both (1) & (2)

Callose plug and P-proteins are associated with

(1) Companion cells (2) Sieve tube

(3) Phloem parenchyma (4) Tracheal plugs

Phloem parenchyma is absent in

(1) Dicots and few monocots (2) Monocots

(3) Monocots and dorsiventral leaf (4) Gymnosperms

The wood of gymnosperms is known as soft wood becuase

(1) It is very soft (2) It appears like a sponge

(3) It can be bent easily (4) It does not possess vessels

Percentage of tracheids in soft wood is

(1) 5-10% (2) 90-95% (3) 15-25% (4) 35-45%

Articulated laticifers

(1) Are formed by fusion of cells

(2) Forms network like structure

(3) Are found in the plants which are source of commercial rubber

(4) All of these

Secretory tissues that secrete proteolytic enzymes are found in

(1) *Nepenthes* (2) *Plumbago* (3) *Urtica* (4) *Polygonum*

In plants having longest vessel, oil glands are formed

(1) Lysigenously (2) Schizogenously

(3) Schizolysigenoulsy (4) Both (1) & (2)

In trees, the death of protoplasm is essential for a vital function such as

(1) Food transport (2) Water transport (3) Both (1) & (2) (4) Stomatal movements

Pericycle of the roots is never sclerenchymatous because it

(1) Does not act as a mechanical tissue in roots

(2) Is the place of origin of root branches

(3) Gives rise to root hairs

(4) Gives rise to root hairs (when the root is young), and to root branches (at maturity)

Choose the correct statement regarding pericycle in dicot root

(1) It is parenchymatous (2) It gives rise to cork cambium

(3) It gives rise to lateral roots (4) All of these

Tissue commonly known as passport point or biological check post is characterised by

(1) Bulliform cells and raphides (2) Cystolith and motor cells

(3) Casparian bands and passage cells (4) Passage cells and Fats

Girdling experiment is not possible in maize and sugarcane because of

(1) Scattered Vascular Bundles (2) Open Vascular Bundles

(3) Closed Vascular Bundles (4) Absence of Pericycle

Vascular bundle with 2:1 ratio of phloem and xylem is

(1) Collateral (2) Bicollateral (3) Amphivasal (4) Amphicribal

Root differs from stem in having

(1) Parenchymatous cortex (2) Pith

(3) Exarch xylem (4) Pericycle

Find the correct match

Column I	**Column II**
a. Dicots with scattered V.Bs.	(i) *Podophyllum* and *Peperomia*
b. Cortical V.Bs.	(ii) *Amaranthus* and *Boerhaavia*
c. Medullary V.Bs.	(iii) *Nyctanthus* and *Casuarina*
d. Polystelic condition	(iv) *Primula* and *Dianthera*

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

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

The vascular bundles in dicot root are

(1) Radial and endarch (2) Conjoint and exarch

(3) Concentric and exarch (4) Radial and exarch

A collateral vascular bundle is that

(1) Which has either phloem strand or xylem strand

(2) In which both xylem and phloem are present at the same radius

(3) In which both xylem and phloem are present with the xylem towards periphery

(4) In which both xylem and phloem are present on different radius

The vascular bundles in the stems of most of dicots are conjoint, collateral and open. In each of these bundles

(1) Xylem and phloem are on the same radius with phloem towards the pith and xylem towards the pericycle without a strip of cambium between them

(2) Xylem and phloem are on the same radius with xylem situated towards the pith and phloem situated towards the pericycle and a strip of cambium separates the two

(3) Xylem completely surrounds the phloem on all sides but the two are separated by the cambium

(4) Phloem completely surrounds the xylem and a strip of cambium separates the two

In dicot root with tetrarch vascular bundles, lateral roots arise from the pericycle cells which lies

(1) Opposite to phloem (2) Opposite to protoxylem

(3) In between protoxylem and phloem (4) Distributed anywhere

Which is not true for monocot stem?

(1) Sclerenchymatous hypodermis

(2) Presence of water canals in pith

(3) Conjoint, collateral closed vascular bundles

(4) Presence of bundle sheath

In leaf anatomy, phloem is directed towards

(1) Upper epidermis (2) Lower epidermis

(3) Middle part of V.Bs. (4) Lateral side

A leaf showing stomata and cuticle on upper epidermis, raphides in the mesophyll and diaphragm cells, belongs to a plant that probably is a

(1) Mesophyte (2) Floating hydrophyte

(3) Submerged hydrophyte (4) Succulent xerophyte

Knots in stems are formed due to

(1) Bacterial infection of wounds

(2) Injury caused by insects

(3) Outgrowth of secondary tissues over wounds caused by falling of branches

(4) Formation of callose plugs

Vascular cambium is a meristematic layer that cuts off

(1) Primary xylem and primary phloem

(2) Xylem vessels and xylem tracheids

(3) Primary xylem and secondary xylem

(4) Secondary cells of xylem, phloem and medullary rays

Balloon like swellings formed by xylem parenchyma inside the xylem vessels through pits are called

(1) Tracheal plugs (2) Tyloses (3) Callose plugs (4) Both (1) & (2)

Secondary phloem is formed by

(1) Procambium (2) Plerome (3) Vascular cambium (4) Apical meristem

Derivatives of the secondary meristem in the steier region are

(1) Phellem and phelloderm (2) Alburnum and primary phloem

(3) Duramen and alburnum (4) Primary xylem and secondary phloem

Secondary medullary rays are produced by

(1) Fusiform initials (2) Interfascicular cambium

(3) Phellogen (4) Ray initials

What is the position of oldest secondary phloem?

(1) Just outside the pericycle (2) Just outside the vascular cambium

(3) Just below the pericycle (4) Below the vascular cambium

Heart wood or duramen

(1) Is oldest secondary xylem ring (2) Lies near pith

(3) Is not active for conduction (4) All of these

Phelloids are

(1) Synonymous to phellem (2) Lignified cork cells

(3) Suberised cork cells (4) Non-suberised cork cells

Virgin cork is

(1) First formed periderm (2) Lenticellate phellem

(3) Non-lenticellate periderm (4) Last periderm

Annual rings are distinct with early wood and late wood in the plants growing in

(1) Tropical region (2) Temperate region (3) Grasslands (4) Arctic region

As the secondary growth takes place (proceeds) in a tree, thickness of

(1) Heart wood increases (2) Sap wood increases

(3) Both heart and sap wood increases (4) Both heart and sap wood remain the same

Cork is commerce is derivative of :

(1) Cork cambium (phellogen) or extrafascicular cambium

(2) Vascular cambium

(3) Fascicular cambium

(4) Interfascicular cambium

Growth rings are well marked in trees growing in :

(1) Simla (2) Chennai (3) Mumbai (4) Kolkata

The youngest layer of secondary xylem in the wood of dicot plant is located

(1) Between pith and primary xylem (2) Just outside vascular cambium

(3) Just inside vascular cambium (4) Just inside cork cambium

One cannot calculate the age of a tree by its annual rings if that tree is located in which of the following forests?

(1) Tropical deciduous (2) Tropical evergreen

(3) Temperate deciduous (4) Temperate evergreen

When secondary growth is initiated in a dicot root, which of the following happens first?

(1) Anticlinal division occurs so that cambium becomes circular

(2) Parenchyma just below phloem becomes meristematic

(3) Cambium initial between lateral sides of xylem and phloem divides

(4) Pericycle strands outside primary xylem divide

Abnormal secondary growth is found in

(1) *Dracaena* (2) *Triticum* (3) *Helianthus* (4) *Cucurbita*

Bark that is formed early in the season is called

(1) Hard bark (2) Soft bark (3) Ring bark (4) Late bark

Find the incorrect matching

(1) Haematoxylin -Heart wood of *Haematoxylon campechianum*

(2) Santalin -Heart wood of *Pterocarpus santalinus*

(3) Brasilin -Pith of *Caesalpinia sappan*

(4) Tannins -Heart wood of *Acacia catechu* (Katha)

Section–B

All given tissues are formed as a result of redifferentiation process, except

(1) Phellem cambium (2) Phelloderm (3) Secondary xylem (4) Interfascicular

A. According to Clowes root apex consists of an inverted cup like structure.

B. Low amount of RNA, DNA and protein is characteristic to waiting meristem.

C. Cells of reserve meristem can divide only when the root apex gets injured.

(1) All are correct (2) A & C are incorrect

(3) A & B are incorrect (4) B & C are incorrect

Isodiametric sclereids, found in hard endocarp of coconut and fleshy portion of some fruits are

(1) Brachysclereids (2) Asterosclereids (3) Osteosclereids (4) Trichosclereids

Members of winteraceae, tetracentraceae and trochodendraceae

(1) Do not have tracheids (2) Do not have albuminous cells

(3) Do not have vessels (4) More than one option is correct

Find set of cells connected by pit fields between their common longitudinal walls

(1) Companion cell and pholem fibres (2) Companion cell and sieve tube

(3) Sieve cell and albuminous cell (4) Sieve tube and pholem fibre

Seat of origin of late.ral root and formation of cork cambium are features related to

(1) Endodermis (2) Pericycle (3) Hypodermis (4) Pith rays

Vascular bundles are conjoint, collateral, endarch and lack cambium between xylem and pholem in all, but not in

(1) Maize (2) Barley (3) Wheat (4) Sunflower

Select a set having correct match

	Dicot stem	Monocot stem
(1)	Sclerenchymatous hypodermis	Collenchymatous hypodermis
(2)	Parenchymatous pericycle	Sclerenchymatous pericycle
(3)	Epidermis with trichomes	Water containing cavities in vascular bundles
(4)	Oval bundles	Wedge shaped bundles

A. Heart wood is durable, dark and central in position.

B. Tyloses are balloon like structures of xylem parenchyma in vessel lumen

C. Late wood is formed during spring season

(1) All are correct (2) Only A is correct

(3) Only B is incorrect (4) Only C is incorrect

Vascular cambium of dicot root is purely secondary in origin and arise from

(1) Cells of conjuctive parenchyma just below phloem

(2) Cells of pericycle just outside protoxylem

(3) Cells of parenchyma between xylem and phloem

(4) More than one option is correct

Maximum absorption of water by the roots takes place through the region of.....

(1) Root cap (2) Meristematic zone (3) Root hair (4) Mature cells

How many histogens are found in monocot root apex-

(1) One (2) Two (3) Three (4) Four

Which of the following is not a sec. lateral meristem-

(1) Vascular cambium of root (2) Cork cambium

(3) Wound cambium (4) Intra-fascicular cambium

Dividing tissue present in between xylem and phloem of primary stem in plants is-

(1) Secondary cambium (2) Apical meristem

(3) Intrafascicular cambium (4) Interfascicular cambium

In stem vascular cambium & cork cambium form sec. tissues respectively in which region-

(1) Cortical region & vascular region (2) Intrastelar region & extrastelar region

(3) Both in stelar region (4) Both in extra region

Position of sieve plates in Angiosperm and Gymnosperm respectively-

(1) Lateral wall and end wall (2) Lateral wall and lateral wall

(3) End wall and lateral wall (4) End wall & end wall

Which of the following statement is true-

(1) Epidermis is always single layered

(2) Flank zone is more active in reproductive shoot apex

(3) Parenchyma and collenchyma tissues act as potential meristem

(4) Well developed vacuoles are found in sclerenchyma

Fibre tracheids are-

(1) Libriform fiber (2) Phloem fiber (3) Xylem fiber (4) Sclereids

Which of the following is not the character of stem-

(1) Conjoint, collateral V.B. (2) Endarch condition

(3) Exarch condition (4) Presence of cuticle

Ectophloic siphonostele means-

(1) A condition in which xylem and phloem absent

(2) A condition when phloem ring present outside the xylem

(3) A condition when pericycle is not present in plant

(4) When phloem ring is present both the side of xylem

External protective tissues are-

(1) Cortex and epidermis (2) Cork and pericycle

(3) Cortex and pericycle (4) Cork and epidermis

The Cambium is made up of -

(1) Fusiform initials and Ray initials (2) Secondary xylem and secondary phloem

(3) Hard bast and soft bast (4) Bulliform cells and Periderm

Identifying features in T.S. of stem and root-

(1) Presence of cortex and position of protoxylem

(2) Type of V.B. and presence of cambium

(3) Types of V.B. and position of protoxylem

(4) Presence and absence of epidermis

Formation of sec. xylem and sec. phloem in which order (respectively)-

(1) Centripetal and centrifugal (2) Centrifugal and centripetal

(3) Both centrifugal (4) Both centripetal

Bulliform cells are found in the leaves of-

(1) Solanum tuberosum (2) Tinospora cordiflolia

(3) Triticum aestivum (4) Helianthus annus

Dermatogen, periblem, and plerome are-

(1) Intermediate tissue (2) Meristematic tissue

(3) Permanent tissue (4) Secondary tissue

The correct situation of mesophyll in isobilateral grass leaf is-

(1) Palisade towards adaxial surface (2) Palisade towards abaxial surface

(3) Undifferentiated mesophyll (4) Palisade along both the surface

In dicot root vascular cambium derived from conjuctive tissue form -

(1) Sec. xylem and sec. medullary rays

(2) Sec. phloem & sec. xylem

(3) Sec. xylem, sec. phloem, primary and sec. medullary rays

(4) Sec. xylem, sec. phloem and sec. medullary rays

Shape of guard cells in monocot plants is-

(1) Kidney shape (2) Bean seeds shape

(3) Dumb-bell shape or bone shape (4) Oval

Eustele is found in -

(1) All dicot and monocot stem (2) All dicot root and monocot stem

(3) Dicot stem (4) Stem of dicot & gymnosperm

Which of the following set of characters are found in dicot stem but not in monocot stem-

(1) Phloem parenchyma, endodermis and vessels

(2) Cortex, pith and companian cell

(3) Endodermis, pericycle and phloem parenchyma

(4) Conjoint, collateral V.B.

Distinct annual rings occurs in plants growing in-

(1) Tropical region (2) Arctic region

(3) Regions with seasonal changes (4) Regions where no seasonal changes

Which of these exhibits secondary growth-

(1) Gametophytes of pteridium (2) Gymnosperm's stem and monocot stem

(3) Root and stem of gymnosperm and dicot (4) Stem and leaf of gymnosperm and monocot

Tyloses occur in-

(1) Primary xylem only (2) Secondary xylem only

(3) Secondary and primary xylem (4) Secondary xylem and secondary phloem

Annual rings are formed due to activity of-

(1) Extra stelar cambium (2) Intrastelar cambium

(3) Sec. xylem and sec. phloem (4) Extra stelar & intrastelar cambium

Which of the following statement is correct about phellogen of stem-

(1) Phellogen is primary in origin

(2) Phellogen is secondary in origin

(3) Phellogen is example of apical meristem

(4) Phellogen is composed of parenchymatous & sclerenchymatous tissue

Answer Key

Section–A

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

Section–B

Q.1	4	Q.2	1	Q.3	1	Q.4	4	Q.5	2	Q.6	2	Q.7	4
Q.8	3	Q.9	4	Q.10	4	Q.11	3	Q.12	4	Q.13	4	Q.14	3
Q.15	2	Q.16	3	Q.17	3	Q.18	3	Q.19	3	Q.20	2	Q.21	1
Q.22	1	Q.23	3	Q.24	1	Q.25	3	Q.26	2	Q.27	3	Q.28	4
Q.29	3	Q.30	4	Q.31	3	Q.32	3	Q.33	3	Q.34	2	Q.35	2
Q.36	2												

EXERCISE – 2 Previous Years

Questions

Fibres are obtained from **[JIPMER 2002]**

(1) Xylem, phloem and sclerenchyma
(2) Xylem, phloem, sclerenchyma and epidermis
(3) Xylem, parenchyma, epidermis
(4) Xylem, parenchyma, endodermis

The quiescent centre in 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

Root cap regenerates or produced from **[MP PMT 2003]**

(1) Calyptrogen (2) Pleurome
(3) Periblem and histogen (4) Dermatogen

Vascular cambium of the root is an example of **[BHU 2000; AIIMS 2000]**

(1) Apical meristem (2) Intercalary meristem
(3) Secondary meristem (4) Root apical meristem

Grass stem elongates by the activity of **[APMEE 2002; KCET 2003]**

(1) Primary meristem (2) Secondary meristem
(3) Intercalary meristem (4) Apical meristem

Aerenchyma is found in **[CPMT 2002]**

(1) Lithophytes (2) Hydrophytes (3) Sciophytes (4) Xerophytes

Cork cambium is a **[J&K CET 2002]**

(1) Secondary meristem (2) Apical meristem
(3) Intercalary meristem (4) Primary meristem

The cell wall of xylem cells is rich in **[MPPMT 2002]**

(1) Lipid (2) Protein (3) Lignin (4) Starch

Vessels are the major conducting element mainly found in **[KCET 2003]**

(1) Xylem of angiosperms (2) Xylem of gymnosperms
(3) Both (1) and (2) (4) None of these

Passage cells are found in **[AIIMS 2002]**

(1) Dicot stem (2) Aerial root (3) Monocot root (4) Monocot stem

Vessels are found in **[CBSE PMT 2002]**

(1) All pteridophyta (2) All angiosperms
(3) Some gymnosperm (4) Both (2) and (3)

Axillary bud and terminal bud are derived from the activity of **[CBSE PMT 2002]**

(1) Parenchyma (2) Lateral meristem (3) Apical meristem (4) Intercalary meristem

Cells of quiescent centre are characterised by **[CPMT 2003]**

(1) Dense cytoplasm and prominent nuclei (2) Light cytoplasm and small nuclei

(3) Dividing regularly to add to the corpus (4) Dividing regularly to add to tunica

Apical meristem of root is present **[CPMT 2003]**

(1) Only in radicles (2) Only in tap roots
(3) Only in adventitious roots (4) In all the roots

Diffuse porous woods are characteristics of plants growing in **[CBSE PMT 2003]**

(1) Alpine regions (2) Cold winter regions
(3) Temperate regions (4) Tropical regions

Porous wood contains mainly **[AIIMS 2001]**

(1) Fibres (2) Vessels (3) Trachieds (4) Solid secretions

Bordered pits are very common in **[Wardha 2002]**

(1) Monocotyledons (2) Gymnosperms (3) Dicotyledons (4) Pteridophytes

Which of the following is known as wood **[AFMC 2003]**

(1) Primary xylem (2) Secondary xylem (3) Secondary phloem (4) Cambium

Epidermis in stem is produced from **[BHU 2002]**

(1) Protoderm (2) Procambium (3) Ground meristem (4) Calyptrogen

Which of the following is absent in the primary and secondary structure of stem of Pinus **[AIIMS 2000]**

(1) Seive tubes (2) Mucilage duct (3) Companion cells (4) Phloem parenchyma

Function of vessels is **[BHU 2000]**

(1) Conduction of water and mineral (2) Conduction of food
(3) Mechanical strength (4) All of the above

At maturity, which of the following is non-nucleated **[RPMT 2002]**

(1) Sieve cell (2) Companion cells (3) Palisade cell (4) Cortical cell

The layer of cells outside the phloem meant for giving rise to the root branches is called **[Kerala CET(Med.) 2003]**

(1) Cambium (2) Corpus (3) Endodermis (4) Pericycle

The lateral roots generally originate in **[DPMT 2003]**

(1) Endodermal cells lying against phloem (2) Cortex
(3) Pericycle cells lying against protoxylem (4) Cork cambium

Which of the following do not have stomata **[AIIMS 2000]**

(1) Xerophytes (2) Mesophytes (3) Hydrophytes (4) Submerged hydrophytes

Passage cells are present in **[KCET (Med.) 2000]**

(1) Epidermis (2) Endodermis (3) Xylem (4) Lenticels and hydathodes

Vascular bundles in the stem of Cucurbita or Lagenaria are **[BHU 2001]**

(1) Collateral (2) Bicollateral (3) Radial (4) Inverted

The bicollatoral vascular bundle is the characteristic feature of plants belonging to the family **[BHU 2001]**

(1) Cruciferae (2) Liliaceae (3) Cucurbitaceae (4) Malvaceae

Passage cells occur in
[AIIMS 2002]

(1) Monocot root (2) Dicot root (3) Monocot stem (4) Both (1) and (2)

Stomata in Water Lily and Podostemon occur respectively **[BHU 2002]**

(1) Lower leaf surface and absent (2) Upper leaf surface and absent
(3) Both leaf surface and upper part (4) Absent in both

Root hairs are found **[Kerala CET (Med.) 2003]**

(1) In the zone of maturation (2) Adventitious roots
(3) On the root cap (4) Apical meristem

Vascular bundles in which phloem is found on both sides of xylem are called (in which of the following phloem occurs on two patches) **[BVP 2003]**

(1) Collateral (2) Bicollateral (Amphiphloic)
(3) Radial (4) Amphicribral

Monocot stem has **[RPMT 2002; BHU 2002]**

(1) Bicollateral closed vascular bundles (2) Bicollateral open vascular bundles
(3) Collateral open vascular bundles (4) Collateral closed vascular bundles

In monocot roots which types of vascular bundles are found **[BHU 2003]**

(1) Collateral, conjoint and closed (2) Radial V.B. with exarch xylem
(3) Bicollateral, conjoint and closed (4) Radial V.B. with endarch xylem

Vascular bundles are scattered in **[Kerala CET (Med.) 2002]**

(1) Bryophytes (2) Dicot root (3) Dicot stem (4) Monocot stem

Dorsiventral leaf has **[Kerala CET (Med.) 2002]**

(1) Stomata on both side (2) Stomata on lower surface
(3) Stomata on upper surface (4) No stomata

In the leaf vascular bundles are found in the **[Kerala CET (Med.) 2003]**

(1) Veins (2) Palisade tissue (3) Lower epidermis (4) Upper epidermis

In a dicotyledonous stem, the sequence of tissues from the outside to the inside is **[AIIMS 2003]**

(1) Phellem - Pericycle - Endodermis - Phloem
(2) Phellem - Phloem - Endodermis - Pericycle
(3) Phellem - Endodermis - Pericycle- Phloem
(4) Pericycle - Phellem - Endodermis - Phloem

In a longitudinal section of a root, starting from the tip upward, the four zones occur in the following order **[CPMT 2004]**

(1) Cell division, cell enlargement, cell maturation, root cap
(2) Cell division, cell maturation, cell enlargement, root cap
(3) Root cap, cell division, cell enlargement, cell maturation
(4) Root cap, cell division, cell maturation, cell enlargement

Intrafascicular cambium is situated in **[BVP 2003]**

(1) Out side the vascular bundles (2) In medullary rays

(3) Inside the vascular bundles (4) In between the vascular bundles

If four radial vascular bundles are present, then the structure will be **[CPMT 2002]**

(1) Monocot stem (2) Monocot root (3) Dicot stem (4) Dicot root

The functional xylem of dicot tree is **[AFMC 2001]**

(1) Sap wood (2) Hard wood (3) Heart wood (4) Autumn wood

Main function of lenticel is **[CBSE PMT 2002]**

(1) Transpiration (2) Guttation (3) Bleeding (4) Gaseous exchange

Heart wood or duramen is **[KCET (Med.) 2001]**

(1) Outer region of secondary xylem (2) Inner region of secondary xylem
(3) Outer region of secondary phloem (4) Inner region of secondary phloem

Wood is a common name of **[J & KCET (Med.) 2002]**

(1) Phloem (2) Secondary xylem (3) Cambium (4) Vascular bundles

Cambium is most active in **[AFMC 2003]**

(1) Summer (2) Winter (3) All seasons (4) Snow areas

Leaves are situated on **[AFMC 2003]**

(1) Nodes (2) Internodes (3) Tip (4) None of these

Commercial cork is obtained from **[BHU 2003]**

(1) Mango (2) Oak (Quercus suber)
(3) Ficus religiosa (4) Pinus

Which of the following tissues is present in the leaves of Pinus to conduct water and food **[AFMC 2002]**

(1) Xylem (2) Phloem
(3) Transfussion tissue (4) Conducting tissue

Lightest wood is **[JIPMER 2002]**

(1) Cereus giganteus (2) Ochroma lagopus (3) Hardwickia binata (4) Cycas

The stems of hydrophytic plants are soft and weak because of the poor development of **[JIPMER (Med,) 2002]**

(1) Pith and supporting parenchyma (2) Phloem and companion cells
(3) Xylem and supporting tissue (4) Cortex and endodermis

Tunica corpus theory was proposed by **[Orissa 2007]**

(1) Schmidt (2) Nageli (3) Hanstein (4) Wolf

Cambium produces growth in **[RPMT 2005]**

(1) Branches (2) Girth (3) Pith (4) Cortex

Vascular bundles grow from **[WB 2009]**

(1) Protoderm (2) Periderm (3) Ground meristem (4) Procambium

Tunica coropus theory is connected with **[Orissa 2009]**

(1) Root apex (2) Root cap (3) Shoot apex (4) Secondary growth

Which meristem helps in increasing girth? **[CET Chd. 2006]**

(1) Lateral meristem / cambium (2) Intercalary meristem
(3) Primary meristem (4) Apical meristem

Quiescent centre occurs in **[CPMT 2005, WB 2010]**

(1) Shoot apex (2) Root apex (3) Both A and B (4) Meristematic tissue

Intercalary meristem produces **[Har. PMT 2007]**

(1) Secondary growth (2) Primary growth (3) Apical growth (4) Secondary thickeing

Histogen

tissues are classified on the basis of **[Manipal 2005]**

(1) Plane of division (2) Type of cells they form

(3) Position (4) Origin

Meristematic cells are characterised by **[Manipal 2005]**

(1) Thin cell walls and large intercellular spaces

(2) Thin cell walls and no intercellular spaces

(3) Thick cell walls and large intercellular spaces

(4) Thick cell walls and small intercellular spaces

Which one is not formed from procambium? **[Wardha 2005]**

(1) Xylem (2) Phloem

(3) Intrafascicular cambium (4) Interfascicular cambium

..... is an exmple of secondary meristem **[COMED- K's 2006]**

(1) Xylem (2) Phloem (3) Phloem (4) Cork cambium

Cells of quiescent centre have lower concentration of **[CET Chd. 2006]**

(1) DNA (2) Proteins (3) RNA (4) All the above

Length of petiole increases by the activity of **[CPMT 2007]**

(1) Apical meristem (2) Lateral meristem

(3) Intercalary meristem (4) All the above

Intercalary meristem is derivative of **[KCET 2008]**

(1) Promeristem (2) Primary meristem (3) Lateral meristem (4) Secondary meristem

Dividing cells not yet committed to become specific cell type are **[CPMED- K's 2008]**

(1) Epidermal cells (2) Ground cells (3) Periderm cells (4) Meristem cells

In dicot stems, vascular cambium is formed from **[Orissa 2008]**

(1) Procambium (2) Cambium (3) Promeristem (4) Protoderm

Vascular tissues of flowering plant develp from **[CBSE 2008]**

(1) Dermatogen (2) Periblem (3) Plerome (4) Phellogen

Length of different internodes in culm of sugarcane is variable due to **[CBSE 2008]**

(1) Shoot apical meristem

(2) Position of axillary buds

(3) Intercalary meristem

(4) Size of leaf lamina at the node below each internode

Lateral meristems are **[KCET 2009, 2010]**

(1) Phellogen and procambium (2) Procambium and dermatogen

(3) Fascicular cambium and procambium (4) Fascicular cambium and cork combium

Interfascicular cambium is **[COMED- K's 2009]**

(1) Intercalary meristem (2) Secondary meristem

(3) Apical meristem (4) Noncalary meristem

Histogens are components of **[COMED - K's 2010]**

(1) Secondary phellogen (2) Apical meristem

(3) Lateral meristem (4) Intercalary meristem

Which one of the following is not a lateral meristem **[CBSE 2010]**

(1) Interfascicular cambium (2) Phellogen
(3) Intercalary meristem (4) Intrafascicular cambium

The tissue which has dead cells in the functional state is **[CET Chd. 2009]**

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

The only plant cells without nucleus among the following are **[CET Chd. 2009]**

(1) Cambium (2) Xylem vessels elements
(3) Root hairs (4) Companion cells

A closed collateral bundle is one where **[Orissa 2008, AFMC 2010]**

(1) Xylem and phloem occur on different radii
(2) Collateral bundle without cambium
(3) Xylem and phloem are separated by cambium
(4) Collateral bundle with cambium

Anatomically Jute fibres are **[COMED-K's 2008]**

(1) Xylem fibers (2) Cortial fibers (3) Pith fibers (4) Phloem fibers

Jute of commerce is got from **[DPMT 2009]**

(1) Primary phloem (2) Secondary pholem (3) Secondary xylem (4) Primary xylem

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 possess cytoplasm but no nuclei
(4) The shoot apical meristem has a quiescent centre.

Vascular bundles having phloem on the periphery of both outer and inner cambium are **[DPMT 2005]**

(1) Bicollateral closed (2) Bicollateral open (3) Radial (4) Biradial

Find out the correct ones in the following table: **[EAMCET 2005]**

	Tissue	Structure Features	Function
1.	Collenchyma	Cell wall with stems water content	Photosynthesis in young
2.	Parenchyma	Suberised cell walls	Storage of food
3.	Sclerenchyma	Lignified cell walls	Mechanical strength
4.	Digestive glands	Dense cytoplasm without water	Breaking substrate

(1) 1 and 2 (2) 2 and 3 (3) 1 and 4 (4) 1 and 3

Common feature in vessel elements and sieve tube elements is **[CBSE 2006]**

(1) Enucleate condition (2) Presence of p-protein
(3) Thick secondary wall (4) Pores on lateral walls

In sieve elements, the possible functionof P-proteins is **[AIIMS 2006]**

(1) Autolytic enzymes (2) Sealing mechanism on wounding

(3) Providing energy for active translocation (4) Deposition of callose on sieve plates

Bicollateral

conjoint vascular bundle possess **[Kerala 2006]**

(1) Xylem and phloem on alternate radii

(2) Phloem surrounds xylem

(3) Xylem surrounds phloem

(4) Xylem and phloem on same radius with two groups of phloem, on the two side of xylem

(5) Xylem and phloem on same radius with one group of phloem outside xylem

Bordered pits are elongated transversely and arranged in vertical series. The pattern is known as **[CET Chd. 2006]**

(1) Scalariform pitting (2) Intervascular pitting

(3) Reticulate thickening (4) Oblique pitting

Trichomes take part in **[JKCMEE 2007]**

(1) Transpiration and exchange of gases (2) Protection and reduction of transpiration

(3) Exudation of water drops (4) Desiccation

Sclereids found in seed coat of pulses are **[COMED-K's 2007]**

(1) Marcrosclereids (2) Brachysclereids (3) Osteosclreids (4) Asterosclereids

Collenchyma is **[CPMT 2007]**

(1) Living with no reserve food (2) Living with protoplasm

(3) Dead and hollow (4) Dead with reserve food

In a vascular bundle, xylem shows centripetal develpment. It is **[KCET 2008]**

(1) Centrarch (2) Mesarch (3) Endarch (4) Exarch

Senescence is an active developmental cellular processes in the growth and functioning of a flowering plant, is indicated in **[CBSE 2008]**

(1) Annual plants (2) Floral parts (3) Leaf abscission (4) Vessels and tracheids

Tissue cells commonly found in friut walls of nuts and pulp of some fruits like guava are called **[AMU 2009]**

(1) Fibres (2) Sclereids (3) Tracheids (4) Vessels

Annular and spirally thickened conducting element generally develop in protoxylem when root or stem is **[CBSE 2009]**

(1) Widening (2) Differentiating (3) Maturing (4) Elongating

Which of the following is a complex tissue **[CPMT 2010]**

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

The activity of sieve tubes is remotely controlled by the protoplasm of **[COMED - K's 2010]**

(1) Phloem parenchyma (2) Companion cells

(3) Phloem fibres (4) Both phloem parenchyma and phloem fidres

Find the incorrect statement **[AMU 2010]**

(1) Root hairs are unicellular elongations (2) Trichomes are unicellular elongations
(3) Trichomes are mutlicellular elongations (4) Root hairs absorb water and minerals

Transport of food material in higher plants takes place through **[CBSE Main 2010]**

(1) Companion cells (2) Sieve elements (3) Tracheids (4) Transfusion tissue

Cotton fibre is basically a type of **[WB 2010]**

(1) Trichome (2) Scale (3) Dried seed coat (4) Nonglandular hair

Well developed pith is found in **[KCET 2008]**

(1) Monocot root and monocot stem (2) Monocot stem and dicot root
(3) Monocot root and dicot stem (4) Dicot root and dicot stem

Function of cork cambium is to producce **[Orissa 2010]**

(1) Secondary xylem and secondary phloem (2) Cork and secondary cortex
(3) Secondary cortex and phloem (4) Cork

Tyloses occur in **[KCET 2010]**

(1) Secondary xylem (2) Secondary phloem (3) Callus tissue (4) Cork cells

Exchange of gases between air and internal tissue of older corky stem takes place through **[HPPMT 2007]**

(1) Sieve tube (2) Pits (3) Stomata (4) Lenticels

In roots, lateral branches grow from **[DPMT 2003, KCET 2007]**

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

In monocots **[CPMT 2010]**

(1) Leaves have reticulate venation (2) Stems annual rings
(3) Seeds have two storage organs (4) Stems have scattered conducting starnds

Cork cambium is also called **[Har. PMT 2005, BV 2006]**

(1) Phelloderm (2) Phellem (3) Periderm (4) Phellogen

Endodermis of dicot stem is also called **[AMU 2009]**

(1) Bundle sheath (2) Starch sheath (3) Mesophyll (4) Water channel

Endodermis is part of **[BV 2006]**

(1) Medulla (2) Stele (3) Cortex (4) Exodermis

Growth rings are formed by the activity of **[Pb. PMT 2007]**

(1) Extrastelar cambium (2) Intrastelar cambium
(3) Interstelar cambium (4) Both B and C

Inner darker, harder portion of secondary xylem that cannot conduct water in older dicot stem is called **[KCET 2005, BHU 2006]**

(1) Alburnum (2) Bast (3) Duramen (4) Wood

Epiblema is the name of **[DPMT 2005]**

(1) Epidermis of leaf (2) Epidermis of stem
(3) Epidermis of dicot root (4) Epidermis of both dicot and monocot roots

Tyloses are baloon-like ingrowths in vessels developing from adjoining **[Pb. PMT 2005]**

(1) Parenchyma through pits in vessel wall
(2) Parenchyma through general surface of vessel wall
(3) Fibers through general surface of vessel wall
(4) Fibers through pits in vessel wall

Casparian thicknings ocur in the cells of **[KCET 2006]**

(1) Pericycle of stem (2) Endodermis of stem

(3) Pericycle of root (4) Endodermis of root

Phellogen is also known as **[BHU 2007]**

(1) Vascular cambium (2) Periderm (3) Cork cambium (4) Apical cambium

Secondary growth is best observed in **[CBSE 2007]**

(1) Teak and Pine (2) Deodar and Fren

(3) Wheat and Maiden Hair Fern (4) Sugarcane and Sunflower.

Passage cells are thin walled cells found in **[CBSE 2007]**

(1) Phloem elements to serve as entry points

(2) Testa of seeds for emergence of embryonal axis

(3) Central area of style for passage of pollen tube

(4) Endodermis of roots to facilitate rapid transport of water from cortex to pericycle

What differentiates a dicot leaf from monocot leaf **[BHU 2008]**

(1) Stomata only on upper side

(2) Differentiation of palisade and spongy parenchyma

(3) Parallel venation

(4) Stomata on upper and lower sides

Cellular layers from outside to inside in old dicot stem are **[KCET 2008]**

(1) Epidermis, phellem, phellogen, phelloderm

(2) Epidermis, hypodermis, cortex, endodermis

(3) Epidermis, phellogen, phellem, endodermis

(4) Epidermis, hypodermis, phellogen, phelloderm

Cuticle is absent in **[DPMT 2009]**

(1) Mesophytes (2) Young roots (3) Leaves (4) Mature stem

In an annual ring, the light coloured part is **[DPMT 2009]**

(1) Heart wood (2) Sapwood (3) Early wood (4) Late wood

Pith parenchyma generally lacks **[COMED-K's 2009]**

(1) Vacuole (2) Chloroplasts (3) Mitochondria (4) Nucleus

Tetrarch bundles occur in **[COMED-K's 2009]**

(1) Leaf of Cicer arietinum (2) Leaf of Pisum sativum

(3) Root of Cicer arietinum (4) Root of Zea mays

In Barley stem, vascular bundles are **[CBSE 2009]**

(1) Open and scattered (2) Closed and scattered

(3) Closed and radial (4) Open and in a ring

Palisade parenchyma is absent in leaves of **[CBSE 2009]**

(1) Gram (2) Soyabean (3) Sorghum (4) Mustard

Anatomically fairly old dicotyledonous root is distinguised from dicotyedonous stem by

(1) Position of protoxylem (2) Absence of secondary xylem

(3) Absence of secondary pholem (4) Presence of cortex

Arrange the following in the order of their location from periphery to centre in the entire dicotyledonous plant body **[EAMCET 2009]**

(a) Fusiform cells (b) Trichoblasts (c) Collocytes (d) Tylosis (1) b, c, a, d (2) a, b, c, d (3) d, a, b, c (4) c, b, a, d

Vascular bundle of monocot is **[CPMT 2010]**

(1) Scattered (2) Closed (3) Endarch (4) All the above

A structure absent in monocot is **[AFMC 2010]**

(1) Sieve tubes (2) Pith (3) Cambium (4) Vessels

Which of the following is not correct **[AMU 2010]**

(1) Early wood is characterised by a large number of xylary elements

(2) Late wood is characterised by a large number of xylary elements

(3) Early wood is characterised by vessels with narrower cavities

(4) Late wood is characterised by vessels with narrower cavities

Medullary rays are made up of **[AMU 2010]**

(1) Fibres cells (2) Tracheids (3) Sclerencyma cells (4) Parenchymatous

Heart wood differs from sapwood in **[CBSE 2010]**

(1) Absence of vessels and parenchyma (2) Having dead and non-conducting elements
(3) Being susceptible to pests and pathogens (4) Presence of rays and fibres

Ground tissue includes **[CPMT 2011]**

(1) All tissues external to endodermis

(2) All tissues except epidermis and vascular bundles

(3) Epidermis and cortex

(4) All tissues internal to endodermis

The cork cambium, cork and secondary cortex are collectivelty called **[CPMT 2011]**

(1) Phelloderm (2) Phellogen (3) Periderm (4) Phellem

The common bottle cork is a product of : **[AIPMT Pre 2012]**

(1) Phellogen (2) Xylem
(3) Vascular Cambium (4) Dermatogen

Closed vascular bundles lack : **[AIPMT Pre 2012]**

(1) Conjunctive tissue (2) Cambium (3) Pith (4) Ground tissue

Water containing cavities in vascular bundles are found in : **[AIPMT Pre 2012]**

(1) Maize (2) Cycas (3) Pinus (4) Sunflower

Companion cells are closely associated with : **[AIPMT Pre 2012]**

(1) Vessel elements (2) Trichomes (3) Guard cells (4) Sieve elements

As compared to a dicot root, a monocot root has : **[AIPMT Mains 2012]**

(1) More abundant secondary xylem (2) Many xylem bundles
(3) Inconspicuous annual rings (4) Relatively thicker periderma

Age of a tree can be estimated by : **[AIPMT 2013]**

(1) biomass (2) number of annual rings
(3) diameter of its heartwood (4) its height and girth

Inter fascicular cambium develops from the cells of : **[AIPMT 2013]**

(1) Xylem parenchyma (2) Endodermis

(3) Pericycle (4) Medullary rays

In china rose the flowers are : **[AIPMT 2013]**

(1) Actinomorphic, epigynous with valvate aestivation

(2) Zygomorphic, hypogynous with imbricate aestivation

(3) Zygomorphic, epigynous with twisted aestivation

(4) Actinomorphic, hypogynous with twisted aestivation

Among bitter gourd, mustard, birnjal, pumkin, china rose, lupin, cucumber, sunnhemp, grain, guava, bean, chilli, plum, petunia, tomato, rose, withania, potato, onion, aloe and tulip how many plants have hypogynous flower? **[AIPMT 2013]**

(1) Ten (2) Fifteen (3) Eighteen (4) Six

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

(1) Protoxylem (2) Cortical cells (3) Secondary xylem (4) Secondary phloem

Tracheids differ from other tracheary elements in : **[AIPMT 2014]**

(1) lacking nucleus (2) being lignified
(3) having casparian strips (4) being imperforate

Answer Key

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

Q.134 1 Q.135 4 Q.136 2 Q.137 2 Q.138 4 Q.139 4 Q.140 2
Q.141 1 Q.142 4

EXERCISE – 3 AIIMS Special Questions

INSTRUCTIONS

In the following questions, a statement of assertion (A) is followed by a statement of reason (R).

(1) If both Assertion & Reason are true and the reason is the correct explanation of the assertion, then mark (1).

(2) If both Assertion & Reason are true but the reason is not the correct explanation of the assertion, then mark (2).

(3) If Assertion is true statement but Reason is false, then mark (3).

(4) If both Assertion and Reason are false statements, then mark (4).

A : Endodermis is present between general cortex and pericycle in maize stem. R : Eustele is present in maize stem.

A : In *Cucurbita* stem, vascular bundles are conjoint, bicollateral and either open or close.

R : Outer and inner cambium are present and only inner cambium is functional in *Cucurbita* stem.

A : Fusiform cells are elongated and tapering cells.

R : These cells form axial system consisting of vascular rays.

A : Septaless tracheids are absent in *Trochodendron.*

R : Heteroxylous wood is present in *Trochodendron.*

A : According to Hanstein, there are three histogens in dicot root. R : In monocot roots, outermost groups of initials form root cap.

A : In woody stems, the amount of heart wood continues to increase year after year. R : The activity of the cambial ring continues uninterrupted.

A : Monocot stem bear collateral open vascular bundles.

R : If cambium is absent, such vascular bundles are called open type.

A : Water and mineral uptake by root hairs from the soil occurs through apoplast until it reaches endoderm is.

R : Casparian strips in endodermis are suberized.

A : In angiosperms, the conduction of water is more efficient because their xylem has vessels.

R : Conduction of water by vessel elements is an active process with energy supplied by xylem parenchyma rich in mitochondria.

A : Apical meristem of root is subterminal.

R : At the terminal end of root, root cap is present.

A : Annual ring do not occur in dicot trees growing on sea shore. R : There is little climate variation.

A : Tyloses are more abundant in Duramen.

R : They provide rigidity & strength to heart wood.

A : Open vascular bundles are found in dicot stem & gymnosperm. R : Cambium is absent in between xylem & phloem.

A : Histogen theory is not applicable to shoot apex.
R : The shoot apex is not clearly divided into three layers.

A : Collenchyma forms the hypodermis of dicotyledon stems. R : This the reason for flexibility of dicotyledon stems.

A : Various types of pits are formed in sclerenchyma. R : The deposition of lignin in sclerenchyma.

A : The seed coat of legume plants becomes hard.
R : The presence of macrosclerids in seed coat of legume plants.

A : Vascular supply to leaf is called leaf trace.
R : The leaf trace extends between the leaf base and point where it merges with stem.

A : Phloem transports prepared food material from leaves to all parts of the plants.
R : In phloem there are some values which stop the flow from down wards to upwards.

A : In true xerophytes major part of xylem is dead.
R : True xerophytes grows in water stress condition and dead tissues more developed in water stress condition.

Answer Key

Q.1	4	Q.2	4	Q.3	3	Q.4	3	Q.5	4	Q.6	1	Q.7	4

Q.8	1	Q.9	3	Q.10	1	Q.11	1	Q.12	1	Q.13	3	Q.14	1
Q.15	1	Q.16	1	Q.17	1	Q.18	2	Q.19	3	Q.20	1		