BIOLOGY

Chapter 6: Anatomy of Flowering Plants

ANATOMY OF FLOWERING PLANTS

Anatomy

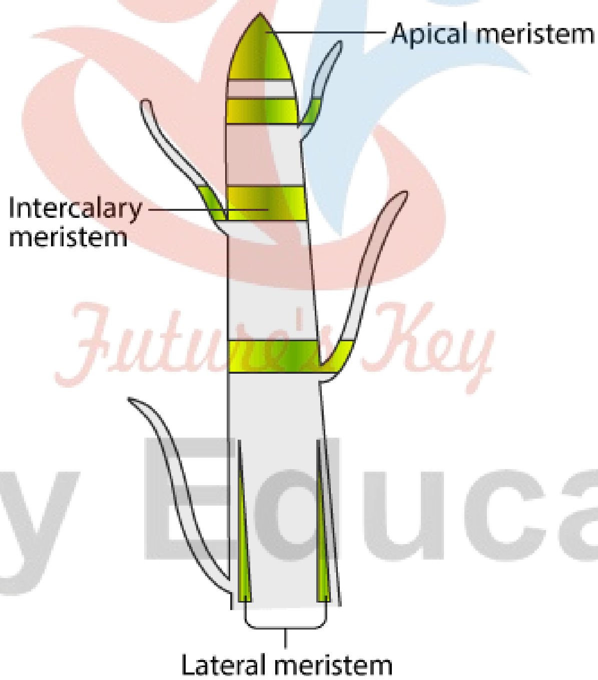
Anatomy is the study of internal structure of organisms. Plant anatomy includes organization and structure of tissues. Tissue is a group is cells having a common origin and usually performing a common function.

The Tissue

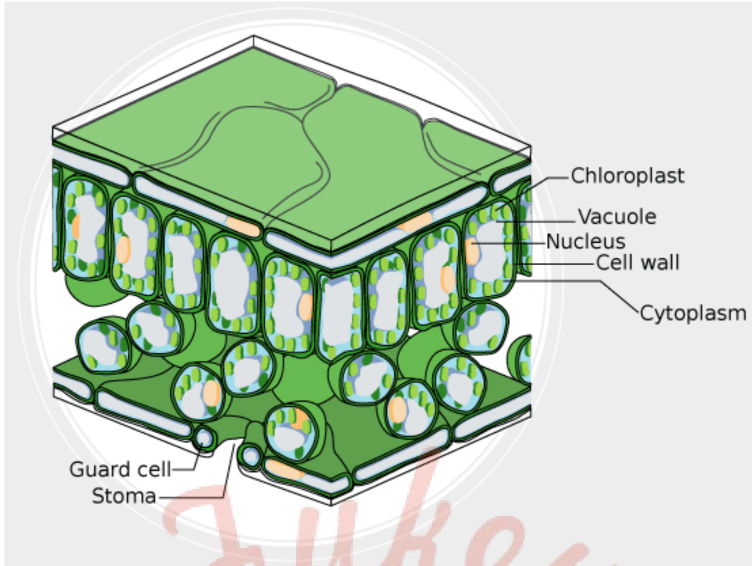
A group of cells having a common origin and usually performing common function are called tissues.

There are two types of tissues (i) Meristematic (ii) Permanent.

Meristematic Tissues: The meristematic tissue is made up of the cells which have the capability to divide. Meristems in plants are restricted to a specialized regions and responsible to the growth of plants.



Permanent Tissues: The permanent tissues are derived from meristematic tissue, are composed of cells, which have lost the ability to divide and have become structurally and functionally specialised.



Meristematic tissues:

There are three types of Meristem:

- Apical meristem
- Intercalary meristem
- Lateral meristem

Apical meristem: Meristematic tissue is a simple tissue composed of group of similar and immature cells which can divide and form new cells. The meristem which occurs at tips of roots and shoots are called apical meristem.

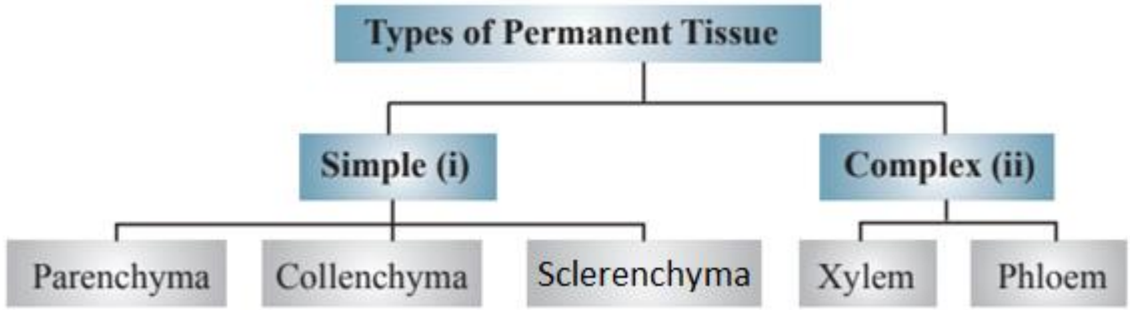
Intercalary meristem: Intercalary meristem occurs between mature tissues especially in grasses. Both apical meristems and intercalary meristems are primary meristems because they appear early in life of a plant and help to form the primary plant body.

Lateral meristem: The meristem which occurs on the sides and takes part in increasing girth of the plants are called Lateral meristem. Intrafascicular cambium in the primary lateral meristem. Vascular cambium, cork cambium are secondary meristem.

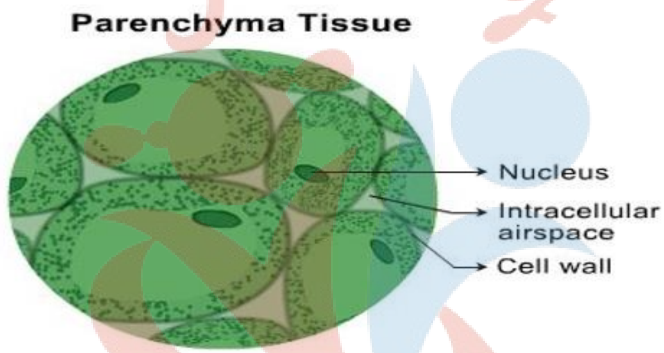
Axillary bud: The buds which are present in the axils of leaves (Consist of cells left behind from shoot apical meristem) and are responsible for forming branches of flowers.

Permanent tissues

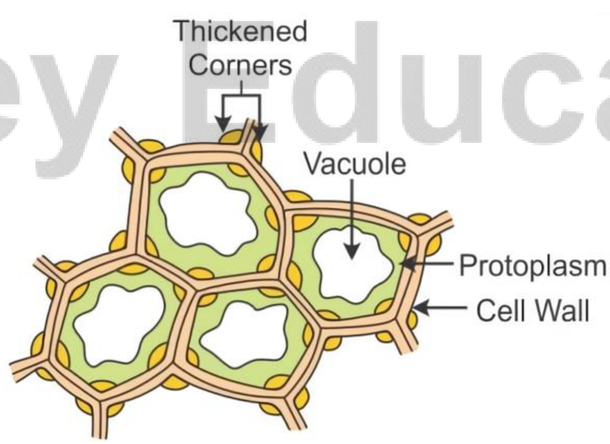
The permanent tissues are derived from meristematic tissue, are composed of cells, which have lost the ability to divide and have become structurally and functionally specialized.



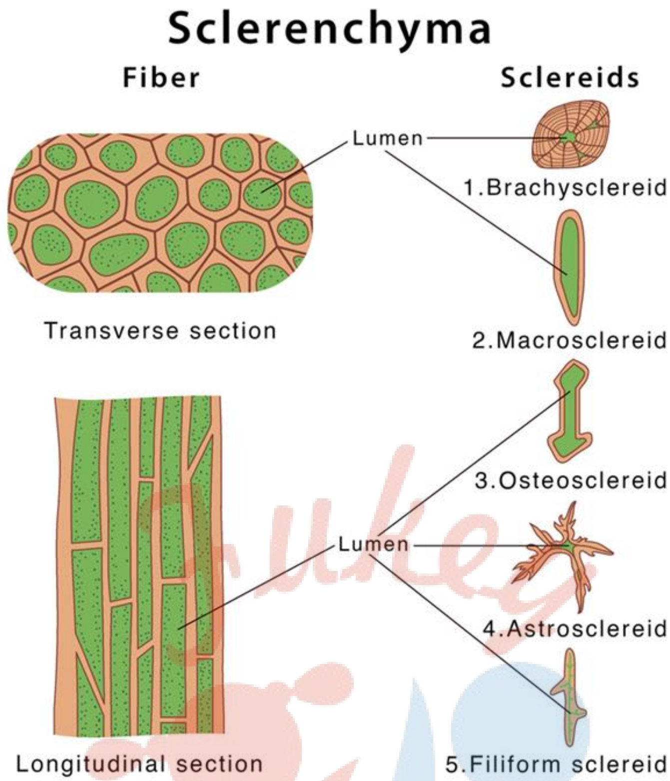
Parenchyma: Parenchyma is a simple permanent living tissue which is made up of thin-walled isodiametric cells. Each cell encloses a large central vacuole and peripheral cytoplasm containing nucleus. They are found in non-woody and soft areas of stem, root, leaves, fruits and flowers. They store the food and provide turgidity to softer parts of plant.



Collenchyma: Collenchyma consists of cells which are much thickened at corner due to cellulose, hemicellulose and pectin. Oval, spherical or polygonal often contain chlorophyll. They provide mechanical support to the growing parts of the plants like young stem.



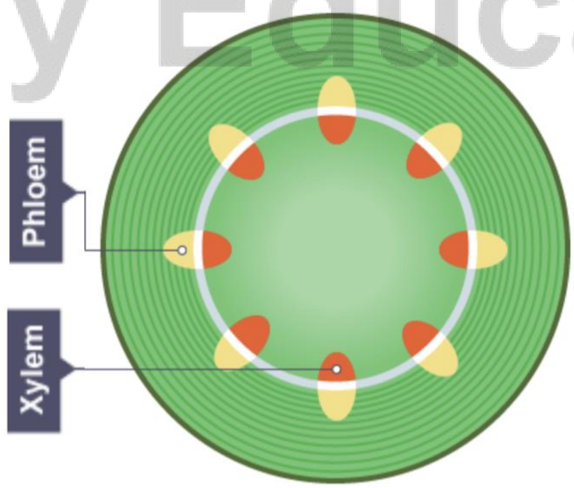
Sclerenchyma: Sclerenchyma are supportive tissue having highly thick-walled cells with little or no protoplasm due to deposition of cellulose or lignin. They are of two types: fibers and sclereids. They provide mechanical support to mature plant organs to tolerate bending, shearing, compression etc.



Complex tissue: Permanent tissues having all cells similar in structure and function are called simple permanent tissues and those having different kinds of cells are called complex tissue.

Xylem: Xylem consists of tracheid's vessels, xylem fibers and xylem parenchyma. It conducts water and minerals from roots to other parts of plant.

Phloem: Phloem consists of sieve tube elements, companion cells, phloem fibers and phloem parenchyma; Phloem transports the food material from leaves to various parts of the plant.



Endarch: Primary xylem is of two types- protoxylem and metaxylem. In stem, protoxylem lies in centre and metaxylem towards periphery. This type of primary xylem is called endarch.

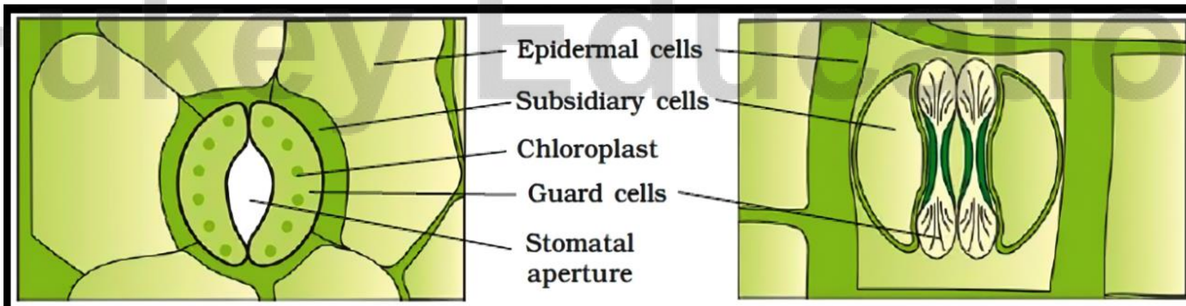
Exarch: In roots, protoxylem lies in periphery and metaxylem lies towards the center. This type of primary xylem is called exarch.

Tissue System

The tissue system is divided into three categories based on a division of labor. Each system usually consists of a combination of tissue organizations that perform specific functions.

Epidermal Tissue System

- It forms the outermost covering of whole plant body, which consists of epidermal cells, stomata, epidermal appendages (trichomes and hairs).
- Epidermis is single layered, parenchymatous with waxy thick layers of cuticle to prevent water loss.
- Stomata is present in epidermis of leaves. It regulates the transpiration and gaseous exchange. In dicots, stomata are bean-shaped having two guard cells closing the stomatal pore. In monocots, stoma is dumbbell shaped. Guard cells contain chloroplasts and help in opening and closing of stomata.
- Guard cells are surrounded by subsidiary cells. The stomatal aperture, guard cells and the surrounding subsidiary cells are together called stomatal apparatus.
- Epidermis also contains a number of hairs. Root hairs are unicellular elongation of epidermal cells. Trichomes are present on stems, which are multicellular, branched or un-branched preventing water loss due to transpiration.



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

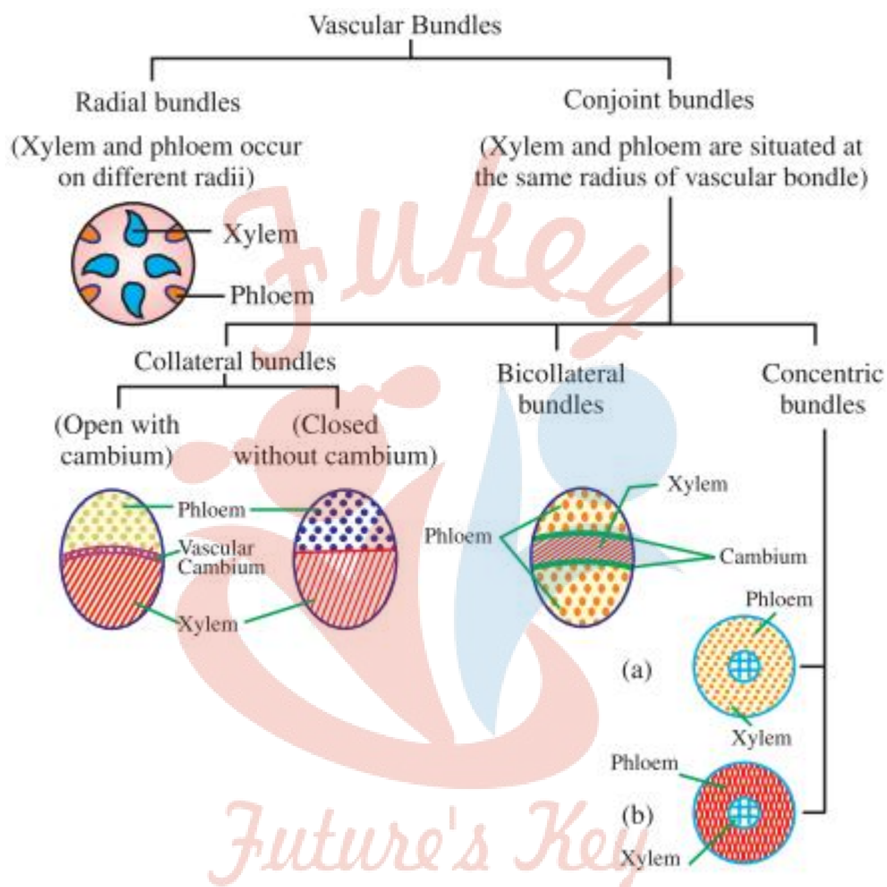
The ground Tissue System

- All the tissue between epidermis and vascular bundle forms the ground tissues. It consists of simple permanent tissues. Parenchyma is present in pericycle, cortex, pith and medullary rays in stem and roots.

- In leaves the mesophyll, chloroplast containing cell, forms the ground tissues.

The vascular tissue system

It includes vascular bundles which are made up of xylem and phloem.

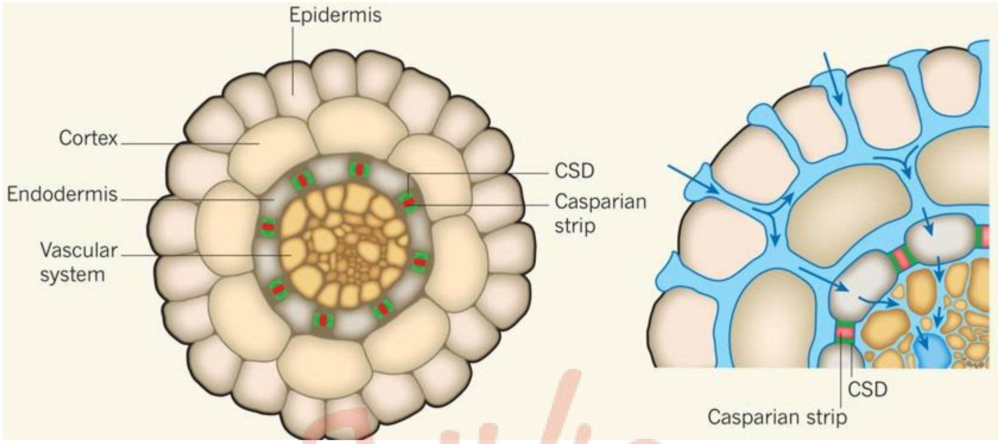


Anatomy of Root

Dicot Root	Monocot Root
Cortex is comparatively narrow.	Cortex is very wide.
Endodermis is less thicknened casparian strips are more prominent.	Endodermal cells are highly thickened Casparian strips are visible only in young roots.
The xylem and phloem bundles varies from 2 to 5.	Xylem and phloem are more than 6 (polyarch).
Pith is absent or very small.	Well-developed pith is present.
Secondary growth takes place.	Secondary growth is absent.

Casparian Strips

The tangential as well as radial walls of endodermal cells of dicot roots have deposition of water impermeable, waxy material, suberin in the form of casparian strips.



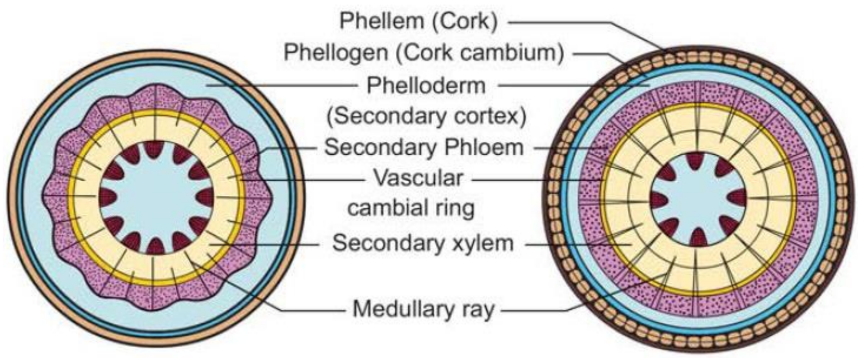
Anatomy of Stem

Dicot Stem	Monocot Stem
The ground tissue is differentiated into cortex, endodermis, pericycle and pitch.	The ground tissue is made up of similar cells
The vascular bundles are arranged in a ring.	The vascular bundles are scattered throughout the ground tissue.
Vascular bundles are open, without Surrounded bundle sheath and wedge-shaped outline.	Vascular bundles are closed, by sclerenchymatous bundle sheath, oval or rounded in shape.
The stem shows secondary growth due to presence of cambium between xylem and phloem.	Secondary growth is absent.

Secondary growth dicot stem

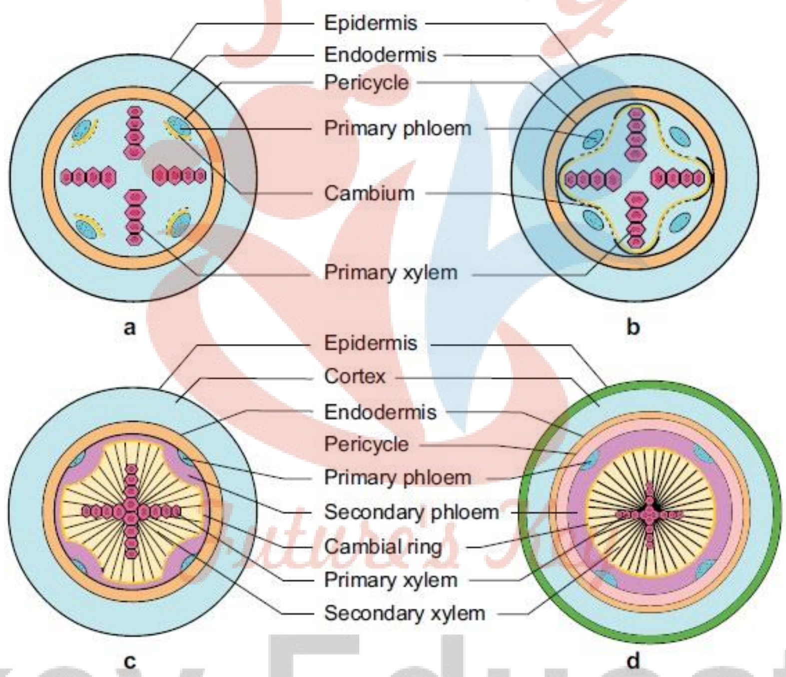
An increase in the girth (diameter) in plants. Vascular cambium and cork cambium (lateral meristems) are involved in secondary growth.

- Formation of cambial ring: Intrafascicular cambium + interfascicular cambium.
- Formation of secondary xylem and secondary phloem from cambial ring.
- Formation of spring wood and autumn wood.
- Development of cork cambium(phellogen).



Secondary growth in dicot roots

Secondary growth in dicot roots occur with the activity of secondary meristems (vascular cambium). This cambium is produced in the stele and cortex, and results in increasing the girth of dicot roots.



Spring wood

It is also called early wood in which cambium is active Vessels with wide cavities & Light in colour, low density presence of Xylary elements more.

Autumn Wood

Also called late wood in which cambium is less active presence of Xylary elements is less Vessels are narrow & Dark, high density.

Heartwood

Central or innermost region of stem which is hard, durable and resistant to attack of Microorganisms and insects & not involved in conduction of water, gives mechanical support to stem.

Sapwood

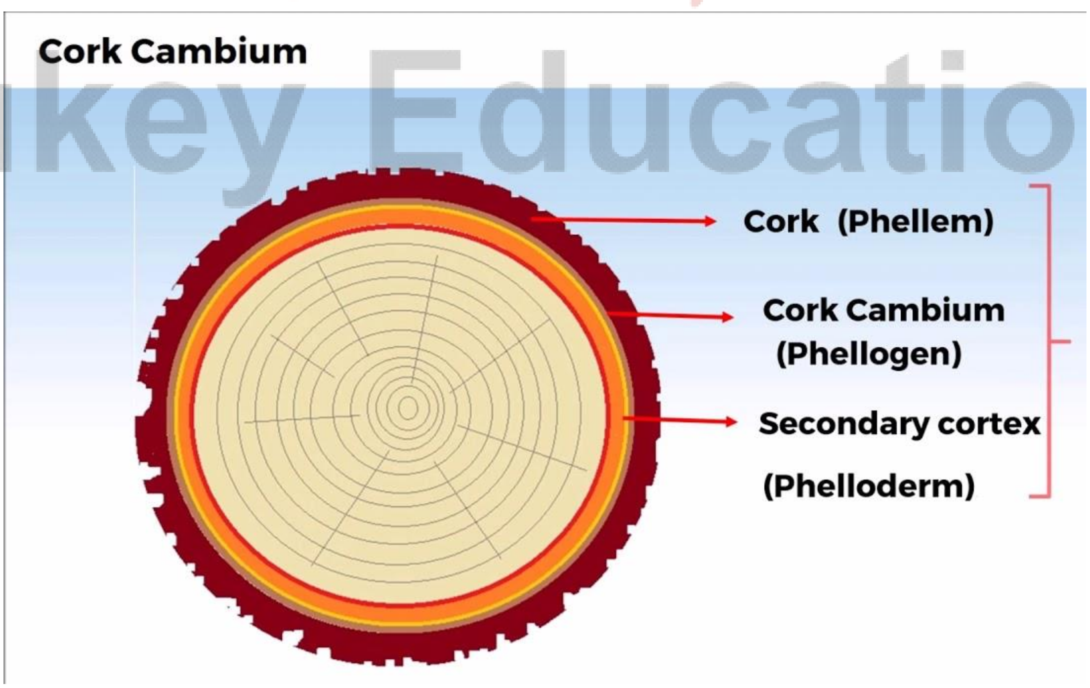
Peripheral region stem, light in colour Involved in conduction of water and mineral.

Anatomy of Leaf

Dorsiventral (Dicot) Leaf	Isobilateral (monocot) Leaf
Stomata are absent.	Stomata present on both sides.
Mesophyll is differentiated into two parts.	Mesophyll is undifferentiated.
Bundle sheath is single layered.	Bundle sheath is double layered
Hypodermis of the mid-rib region, is collenchymatous.	Hypodermis of the mid-rib region is sclerenchymatous.
Stomata have kidney shaped guard cells.	Stomata have kidney shaped dumb cells.

Cork Cambium

- Meristematic tissue which develops in the cortex region is called cork cambium or phellogen.
- The phellogen cuts off cells on both sides. The outer cells differentiate to form cork or phellem while the inner cells differentiate into secondary cortex or phelloderm.
- Phellogen, phellem and phelloderm are collectively called periderm.
- Due to activity of the cork cambium, pressure builds up on the remaining layers peripheral



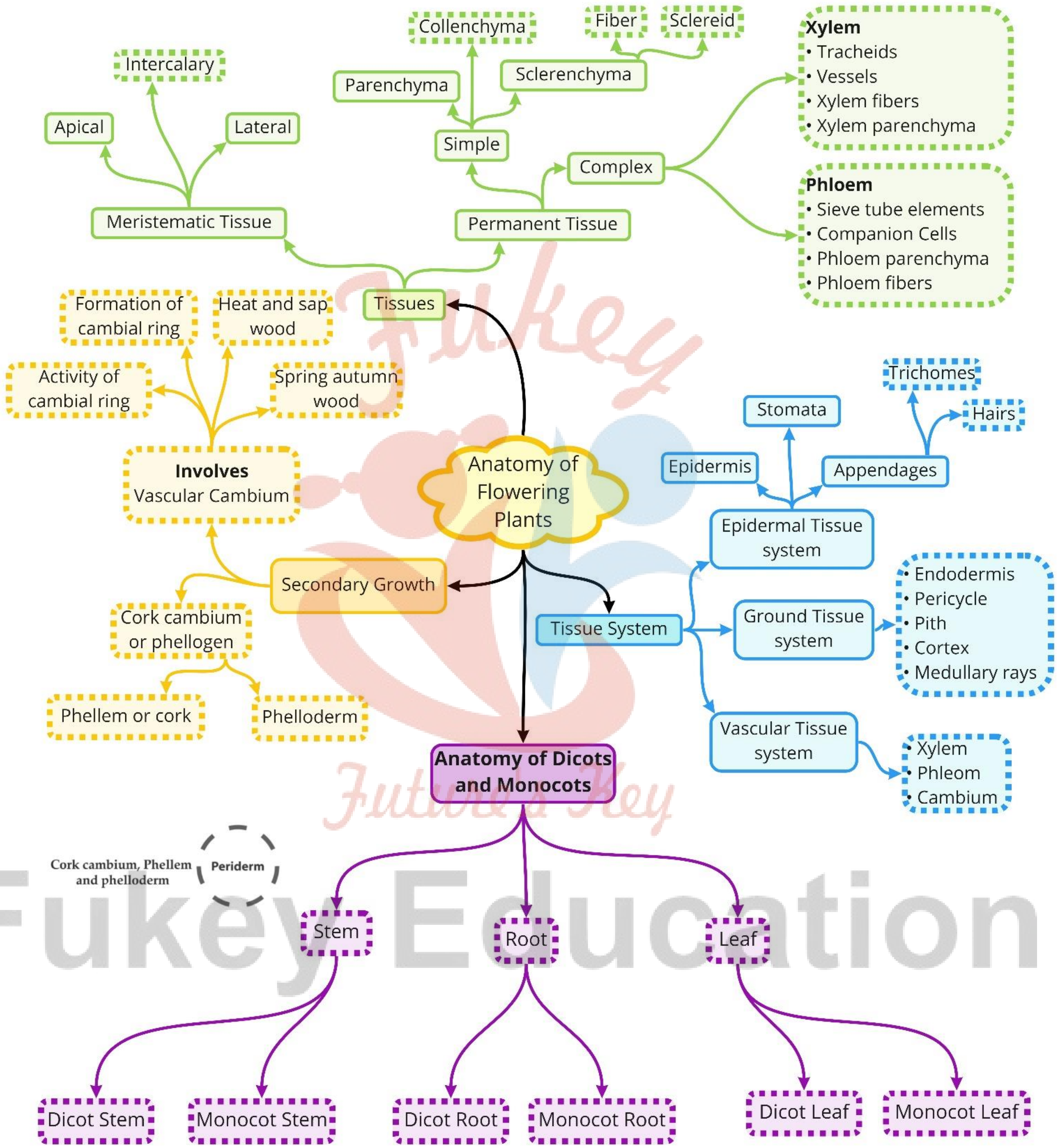
Lenticels

- At certain regions, the phellogen cuts off closely arranged parenchymatous cells on the outer side instead of cork cells. These parenchymatous cells soon rupture the epidermis, forming a lens-shaped openings called lenticels.
- Lenticels permit the exchange of gases between the outer atmosphere and the internal tissue of the stem.

Secondary Growth in Roots

- The vascular cambium of the dicot root originates from the tissue located just below the phloem bundles. A portion of pericycle tissue present above the protoxylem forms a continuous wavy ring. It gradually becomes circular. Rest of the steps are similar as in dicot stem.
- Secondary growth takes place in stems and roots of gymnosperms. No secondary growth occurs in monocots.

Class : 11th Biology
Chapter- 6 : Anatomy of Flowering Plants



Important Questions

➢ Multiple Choice Questions:

Question 1. Intercalary meristem is derived from

(a) Apical meristem
(b) Protoderm
(c) Calyptrogen
(d) Lateral meristem

Question 2. Secondary meristem develops from

(a) Apical meristem
(b) Permanent tissue
(c) Secondary tissue
(d) Vascular combium

Question 3. Cambium is considered to be a lateral meristem because it

(a) Gives rise to lateral branches
(b) Increase the girth of the plant
(c) Increase both length and girth of plant
(d) Increase the length of the plant.

Question 4. Quiscent centre is located in

(a) Shoot apex
(b) Root apex
(c) Bud apex
(d) Leaf apex

Question 5. Casparian strips occur in the cells of

(a) Exodermis
(b) Epiderms
(c) Hypodermis
(d) Endoderms

Question 6. Lignified cells with narrow and pointed end wall are

(a) Chlorenchyma
(b) Parenchyma
(c) Sclerenchyma
(d) Endoderms

Question 7. Nucleus is absent in

(a) Vessels
(b) Sieve tube elements

(c) Tracheid
(d) All of these

Question 8. Age of a tree is calculated by its

(a) Girth
(b) Height
(c) Number of annual rings
(d) Number of branches

Question 9. Youngest secondary xylem occurs

(a) Just outside the vascular cambium
(b) Just inside the vascular cambium
(c) Just outside the vascular cambium
(d) Just inside the cork cambium

Question 10. Mesophll cells in a leaf are

(a) Sclerenchymatous
(b) Collenehymatous
(c) Parenchymatous
(d) Meristem

Question 11. Healing of wounds occur due to the activity of

(a) Intercalary meristem
(b) Secondary meristem
(c) Primary meristem
(d) Apical meristem

Question 12. Lateral root arise from

(a) Cambium
(b) Pericycle
(c) Epidermis
(d) Endodermis

Question 13. Vascular bundles are absent in

(a) Dicots
(b) Monocots
(c) Cambium
(d) Pteridophytes

Question 14. Which one contain only living cells?

(a) Vessels
(b) Sclerenchyma
(c) Trachieds

(d) Parenchyma

Question 15. Vascular bundle having cambium is

(a) Closed
(b) Open
(c) Colleral
(d) Conjoint

➢ Fill In the Blanks:

1. The plant is made up of Cells which are organised into ……….. and the tissues into …………..
2. Plants have different kinds of ……….
3. Fascicular vascular cambium, interfascicular cambium and cork- cambium are examples of ……….. meristems.
4. The various simple tissues are ……….., …………. and ……………
5. Parenchymatous cells form the major components like …………….. of …………. and ……….. parts.
6. …………. forms …………… below the epidermis, in dicotyle-donous plants.

➢ True or False:

1. The spring wood is lighter in colour and has a low density whereas the autumn wood is darker and has a higher density.
2. The wood formed during spring season is called autumn wood or late wood.
3. Phellogen, phellem, and phelloderm are collectively known as lenticel.
4. The peripheral region of the secondary xylem, is lighter in colour and is known as the sapwood.
5. Secondary growth also occur in stems and roots of gymnosperms. However, secondary growth does not occur in monocotyledons.
6. All the dead cells lying outside the active cork cambium constitute the bark.

➢ Very Short Question:

1. Which structure originates the lateral roots?
2. What are Casparian strips?
3. Give an example of anomalous secondary growth.
4. Name the type of wood in which vessels are absent.
5. Give an example of thick-walled parenchyma cells.

6. Which type of vascular bundles are found in Cucurbita.
7. What are the meristematic tissues?
8. What is the function of Kasparian strips?
9. What is the function of tracheids?
10. What are tyloses?

➢ Short Questions:

1. What are tracheary elements? Of what use are these to the plants?
2. If you are provided with microscopic preparation of transverse sections of a meristematic tissue and permanent tissue, how would you distinguish them apart?
3. What are the three basic tissues systems in Howering plants? Name the tissues under each system.
4. Describe the structure and functions of the primary xylem.
5. Why do we notice distinct rings in the tree of the temperate region while the tree of the coastal area is not distinct?
6. What is heartwood? Mention its any three characteristics.
7. Point out the limitations of wood.
8. What value is the study of plant anatomy?

➢ Long Questions:

1. What are the characters of collenchyma tissues? Give its functions also.
2. Draw a well-labelled diagram showing the L.S.of phloem of an angiosperm with its components.
3. Describe briefly the various types of vascular bundles.
4. Describe briefly the internal structure of the monocot root with the help of a labelled diagram.
5. Define the following.

   (i) Radial vascular bundles
   (ii) Collateral vascular bundles
   (iii) Exarch xylem
   (iv) Endarch xylem
   (v) Stele
6. Distinguish between:

   (i) Phiilem and Pheiloderm

(ii) Open bundle and closed bundle
(iii) Fascicular cambium and inter fascicular cambium
(iv) Conjoint vascular bundles and Radial vascular bundles
(v) Periderm and Bark

Assertion Reason Question-

1. In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

   (a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
   (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
   (c) If Assertion is true but Reason is false.
   (d) If both Assertion and Reason are false.

   Assertion: Apical meristem of root is subterminal.

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

2. In these questions, a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

   (a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
   (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
   (c) If Assertion is true but Reason is false.
   (d) If both Assertion and Reason are false.

   Assertion: Histogen theory is not applicable to shoot apex.

   Reason: The shoot apex is not clearly divided into three layers.

Case Study Based Question-

1. The cells of the permanent tissues do not generally divide further. Permanent tissues having all cells similar in structure and function are called simple tissues. A simple tissue is made of only one type of cells. The various simple tissues in plants are parenchyma, collenchyma and sclerenchyma.

   Parenchyma forms the major component within organs. The cells of the parenchyma are generally isodiametric. They may be spherical, oval, round, polygonal or elongated in shape. Their walls are thin and made up of cellulose. They may either be closely packed or have small intercellular spaces. The parenchyma performs various functions like photosynthesis, storage, secretion.

   The collenchyma occurs in layers below the epidermis in most of the dicotyledonous plants. It is found either as a homogeneous layer or in patches. It consists of cells which are much thickened at the corners due to a deposition of cellulose, hemicellulose and pectin. Collenchymatous cells may be oval, spherical or polygonal and often contain chloroplasts. These cells assimilate food when they contain chloroplasts. Intercellular spaces are absent. They provide mechanical support to the growing parts of the plant such as young stem and petiole of a leaf.

Sclerenchyma consists of long, narrow cells with thick and lignified cell walls having a few or numerous pits. They are usually dead and without protoplasts. On the basis of variation in form, structure, origin and development, sclerenchyma may be either fibres or sclereids. The fibres are thick-walled, elongated and pointed cells, generally occurring in groups, in various parts of the plant. The sclereids are spherical, oval or cylindrical, highly thickened dead cells with very narrow cavities (lumen). These are commonly found in the fruit walls of nuts; pulp of fruits like guava, pear and sapota; seed coats of legumes and leaves of tea. Sclerenchyma provides mechanical support to organs.

1.) Tissue made of only one type of cell is termed as _________

a.) Simple permanent tissue
b.) Complex permanent tissue
c.) Simple Meristematic tissue
d.) Complex Meristematic tissue

2.) Identify the correct statement

Statement 1 – Cells of the parenchyma are generally isodiametric.
Statement 2 – The collenchyma occurs in layers below the epidermis.
Statement 3 – Sclerenchyma are usually dead and without protoplasts
Statement 4 – The cells of the permanent tissues do not generally divide further.

a.) Only 1
b.) Both 2 & 4
c.) Both 1 & 3
d.) All of the above

3.) Enlist the type of Simple permanent tissue?

4.) Explain Sclerenchyma.

5.) Write short note on Parenchyma?

2. The complex tissues are made of more than one type of cells and these work together as a unit. Xylem and phloem constitute the complex tissues in plants. Xylem functions as a conducting tissue for water and minerals from roots to the stem and leaves. It also provides mechanical strength to the plant parts. It is composed of four different kinds of elements, namely, tracheids, vessels, xylem fibres and xylem parenchyma. Tracheids are elongated or tube like cells with thick and lignified walls and tapering ends. These are dead and are without protoplasm. In flowering plants, tracheids and vessels are the main water transporting elements. Vessel is a long cylindrical tube-like structure made up of

many cells called vessel members. Vessel members are interconnected through perforations in their common walls. Primary xylem is of two types – protoxylem and metaxylem. The first formed primary xylem elements are called protoxylem and the later formed primary xylem is called metaxylem. In stems, the protoxylem lies towards the centre (pith) and the metaxylem lies towards the periphery of the organ. This type of primary xylem is called endarch. In roots, the protoxylem lies towards periphery and metaxylem lies towards the centre. Such arrangement of primary xylem is called exarch.

Phloem transports food materials, usually from leaves to other parts of the plant. Phloem in angiosperms is composed of sieve tube elements, companion cells, and phloem parenchyma and phloem fibres. Sieve tube elements are also long, tube-like structures, arranged longitudinally and are associated with the companion cells. The functions of sieve tubes are controlled by the nucleus of companion cells. The companion cells are specialised parenchymatous cells, which are closely associated with sieve tube elements. The companion cells help in maintaining the pressure gradient in the sieve tubes. Phloem parenchyma is made up of elongated, tapering cylindrical cells which have dense cytoplasm and nucleus. The phloem parenchyma stores food material and other substances like resins, latex and mucilage. Phloem fibres (bast fibres) are made up of sclerenchymatous cells. These are generally absent in the primary phloem but are found in the secondary phloem. At maturity, these fibres lose their protoplasm and become dead. The first formed primary phloem consists of narrow sieve tubes and is referred to as protophloem and the later formed phloem has bigger sieve tubes and is referred to as metaphloem.

1.) Xylem and phloem are examples of

a.) Meristematic tissue
b.) Simple tissue
c.) Protective tissue
d.) Complex tissue

2.) The protoxylem lies towards periphery and metaxylem lies towards the centre. Such arrangement of primary xylem is known as

a.) Exarch
b.) Endarch
c.) Inarch
d.) None of the above

3.) What are the functions of xylem and phloem?

4.) Define Protoxylem and Metaxylem?

5.) Define Protophloem and Metaphloem?

6.) Explain the composition of xylem?

✓ Answer Key-

➢ Multiple Choice Answers:

1. (a) Apical meristem.
2. (b) Permanent tissue
3. (b) Increase the girth of the plant
4. (b) Root apex
5. (d) Endoderms
6. (c) Sclerenchyma
7. (d) All of these
8. (c) Number of annual rings.
9. (b) Just inside the vascular cambium.H
10. (c) Parenchymatous
11. (b) Secondary meristem
12. (b) Pericycle
13. (d) Pteridophytes
14. (d) Parenchyma
15. (b) Open

➢ Fill In the Blanks:

1. tissues, organs
2. meristems
3. lateral
4. parenchyma, collenchyma, sclerenchyma
5. cortex., pit, mesophyll, leaves, floral
6. Collenchyma, hypodermis

➢ True or False:

1. True
2. False
3. False
4. True

5. True
6. True

➢ Very Short Answers:

1. Answer: Pericycle
2. Answer: These are thickenings of lignin and suberin formed around the artificial walls of the endodermis to prevent plasmolysis.
3. Answer: Bougainvillaea.
4. Answer: Softwood, e.g. Pinus.
5. Answer: Xylem Parenchyma in secondary tissue.
6. Answer: Bicollateral.
7. Answer: They are a perpetually juvenile group of cells with the indefinite power of division.
8. Answer: To prevent loss of water and minerals back to the cortex.
9. Answer: Tracheids transport water and give mechanical support to the tree.
10. Answer: They are the vessels of hardwood containing bladder like ingrowth in the pores of lateral walls.

➢ Short Answer:

1. Answer: These are vessels and tracheids. They are conducting cells of the xylem. The xylem vessels have perforations in their end walls while perforations are absent in tracheids, they form a continuous channel through the root, stem and leaves for the conduction of water and minerals.
2. Answer: Meristematic tissues are composed of cells that are always in a dividing stage and divide endlessly to form new cells. These cells exist in different shapes without any intercellular spaces. These cells are thin-walled, rich in protoplasm and active with large nuclei and without vacuoles.

   Permanent tissues are derived from meristematic tissue and are composed of cells, which have lost the power of division. These cells have their definite shape, size and function. These cells may be thin-walled or thick-walled.
3. Answer: In flowering plants, the three basic tissue systems are:

   (a) DermalIt comprises the epidermis which is protective in function. During secondary growth, it is replaced by periderm.

   (b) Vascular tissue system It consists of xylem and phloem and is found in the stele. In the root, the vascular bundles are renal with exarch condition whereas, in the stem, these are collateral with each condition.

(c) Ground or Fundamental Tissue It includes all the tissues except dermal and vascular as parenchyma and sclerenchyma. It is found mainly between the epidermis and vascular cylinder and is formed of thin-walled cells with intercellular spaces in between them. Collenchyma is usually found to be thickened at the comers whereas currency nations are dead tissue and provide mechanical support.

4. Answer: The primary xylem consists of tracheids vessels, xylem parenchyma and xylem fibres. The tracheids are elongated with tapering ends. They provide strength as well as help in absence of sap from roots to the leaves. The vessels are composed of a row of cells with large perforations at both ends but no bordered pits.

   They help in the conduction of water and minerals and help in the storage of food. The xylem fibres are made up of sclerenchymatous cells associated with the xylem and they provide mechanical support to the plant body.

5. Answer: The climatic conditions affect largely the activity of the cambium. It temperate region, the. cambium activity varies and it is not uniform throughout the year. But in coastal areas, it remains uniform throughout the year. Thus, due to the periodical activity of cambium in the temperate region, we notice distinct rings of spring and winter wood and not in the coastal area.

6. Answer: Heartwood: The hard central region of a tree trunk made up of xylem vessels that do not take part in the conduction of water.

   Three characteristics of heartwood:

   i. It is a non-functional and dead position.

   ii. It is dark coloured and filled with resins, tennis etc.

7. Answer: Limitations of Wood:

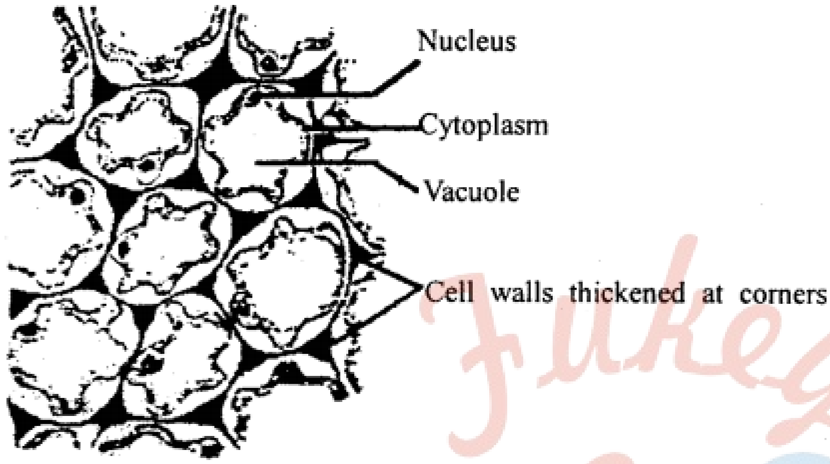
   - It does not change its physical and mechanical properties while heating.
   - It cannot be changed into new shapes and forms.
   - It is least resistant to infection caused by microorganisms and decay.
   - It is combustible

8. Answer: It helps to get the knowledge of plant structure and to solve various taxonomic problems. The determination of various adulterants in spices coffee, tea vegetable, dyes, tobacco saffron, as asafoetida is possible only when one knows about the anatomy of this substance.

   Pharmacology and Pharmacology are dependent upon anatomical studies to know about the drug plants and their actions. It also helps in forming spurious materials from the standard woods. It also helps forensic experts fro solving criminal cases.

➢ Long Answer:

1. Answer: Collenchyma tissue: Collenchyma tissue cells are living isodiametric without any intercellular spaces. The comer walls are thickened by Pectinisation. They appear cylindrical in vertical section and oval or polygonal in cross-section. The nucleus in each cell lies at a comer position.



Collenchyma

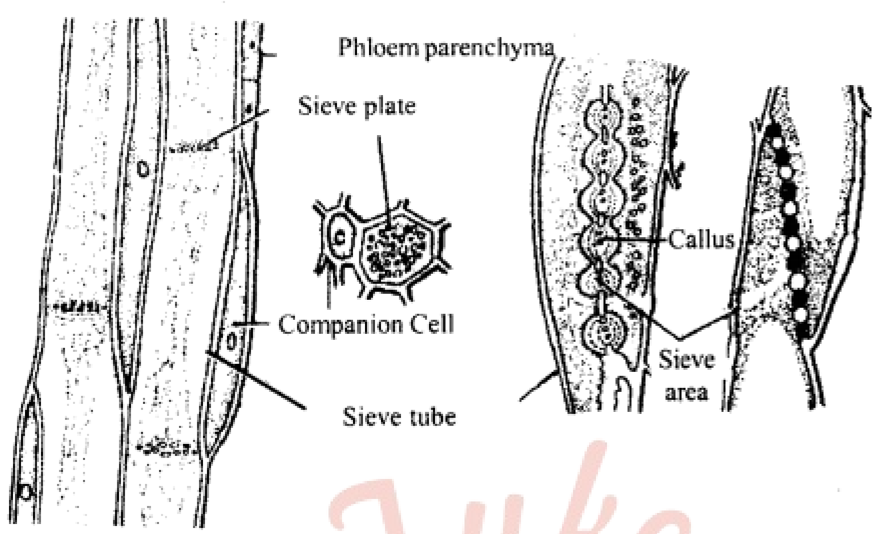
They are found in the dicot stem below the epidermis and on the outer region of the leaf, midribs and pedicels. On the basis of thickening, they are of three types:

1. Lamellar,
2. Angular,
3. Lacunate

Functions: Collenchyma tissue provides mechanical function as well v as the function of photosynthesis.

2. Answer: Phloem is a food conducting tissue and it consists of:
   - Sieve, elements
   - Companion cells
   - Phloem fibres and
   - Phloem parenchyma.
   - Sieve elements: These occur as a single cell in pteridophytes and gymnosperms and longitudinal file of cells in angiosperms. The morphological specialization of sieve plates is the development of sieve area on their walls bearing sieve plates. The sieve plate bears a large number of perforations.

     The protoplasmic strands maintain continuity through these perforations within the adjoining sieve tubes. In a mature sieve element there occurs a thin layer of parietal cytoplasm and a large central vacuole. The most important features of sieve elements are that they lack a nucleus at maturity.



Structure of phloem (L.S)

- Companion cells: These are thin-walled, living parenchyma narrow cells, which are closely associated with sieve tube elements. They appear rounded or polygonal with dense granular cytoplasm, « prominent nucleus and numerous small vacuoles. The companion cells lack starch. The nuclei of the companion cells serve as the nucleus of sieve tubes as they lack them. The companion cells mainly occur in angiosperms, ac-companying the sieve tube elements.
- Phloem fibres: They form a prominent part of both the primary and secondary phloem. They are elongated cells with lignified walls having simple pits. They provide support and help in the transport of food material. They are used for making cords and ropes etc.
- Phloem parenchyma: These are the living parenchyma cells associated with sieve tube cells. They are elongated with sieve tube cells. They are elongated, pointed in shape and store the starch, fat and other organic substances. The tannings and resins are also found in these cells, They are elongated like the sieve elements.

  The sieve element is a living component, which lacks a nucleus at maturity.

3. Answer: These are of the following types:

   1. Radial The bundles in which xylem and phloem are arranged on different adulterating with each other and form the separate bundles are called radial vascular bundles as in all roots.

   2. Conjoint The xylem and phloem are situated at the same radius and form a vascular bundle together.

   These are divided into three types:

   (a) Collateral: These are the bundles where xylem and phloem are arranged on some radius, xylem is located internally and phloem externally. These may be open when there is a patch of cambium in between the xylem and phloem e.g. Helianthus or closed when there is no cambium at all as seen in monocot stems

(b) Bicallatiral: In this vascular bundle, the phloem is found in two groups one outside the xylem elements and the other inner to them. These are always open and found in pumpkin.

(c) Concentric: The bundle in which either Phloemounds the phloem completely is known as concentric.

This exists in two forms.

i. Anphicribral: The xylem lies at the centre and is surrounded by a ring of phloem, e.g., fern.

ii. Amphivaial: The phloem lies at the centre and is surrounded by the xylem e.g. Dracaena.

4. Answer: A transverse section of the monocot root shows the following issues.

i. It is composed of a single layer of compactly arranged thin-walled cells without intercellular spaces and cuticle. It bears many unicellular root hair.

ii. Cortex: It is present beneath the epidermis. It consists of 15-20 layers of parenchymatous cells with large intercellular spaces.

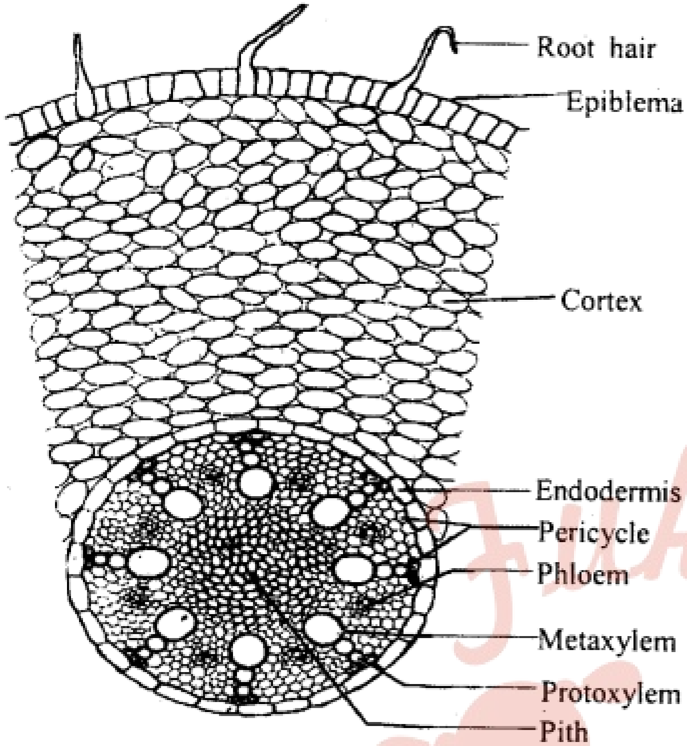
iii. Endodermis: It is the innermost layer of the cortex. Its cells are barrel-shaped with Casparian strips on their anticlinal walls. The passage cells are seen just opposite the protoxylem ends.

iv. Pericycle: It consists of a single layer of thin-walled parenchymatous cells.

v. Vascular bundle: The vascular bundles are radial and the xylem is exarch. The xylem and phloem bundles are always more than six.

vi. Pith: It occupies the central portion of the stele and is made up of parenchymatous cells.

vii. Conjunctive tissue: It consists of parenchymatous cells and is found between the xylem and phloem strands.



T.S. of a typical monocot root

5. Answer: Radial vascular bundles: The bundles in which xylem and phloem are arranged in different radii alternating with each other and form the separate bundles are called radial vascular bundles as in all roots.

   Collateral vascular bundles: These are the bundles where xylem and phloem are arranged not at the same radius. Xylem is located internally and phloem externally. These may be open when there is a patch of cambium in between the xylem and phloem e.g. Helianthus or closed when there is no cambium at all as seen in the monocot stem.

   Exarch xylem: It is the condition where protoxylem is located towards the periphery of axis and metaxylem inwards e.g. root.

   Endarch xylem: It is the condition where metaxylem is located towards the periphery of axis and protoxylem inwards e.g. stem.

   Stele: All the tissues that lie internal to Endoolerinis are collectively called stele. The outermost layer of stell is known as the pericycle.

6. Answer: Phiilem: It is a dead tissue that is formed by the activity of cork cambium in the outer region of the cortex during secondary growth. It is protective in function.

   Pheiloderm: It is a living tissue that is formed by the activity of cork cambium in the inner side of the cortex. It regains during secondary growth. If performs the function of storage.

   Open Bundle: Avascular bundle containing cambium between xylem and phloem is called an open bundle e.g. dicot stem.

   Closed Bundle: Avascular handle lacking cambium between xylem and phloem is called a closed bundle e.g. monocot stem.

Fascicular cambium: It is a strip of cambium found between the xylem and phloem of each vascular bundle of dicot stem.

Interfascicular cambium: It is a strip of cambium that is formed from the cells of medullary rays adjoining with the fascicular cambium. It occurs dining secondary growth.

Conjoint vascular bundles: Xylem and phloem lie in the same bundles. They lie on different radii alternating with each other e.g. Dicot and monocot root.

Radial vascular bundles: Xylem and phloem lie in separate bundles. They lie on different radii alternating with each other e.g. Dicot and monocot root.

Periderm: It includes three tissue consisting of phellogen, phellem and phelloderm and is formed at the peripheral region of the axis.

Bark: It includes all the tissue external to the secondary xylem formed during secondary growth. These are cambium, secondary phloem.

Assertion Reason Answer-

1. (a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

   Explanation: Root apical meristem is subterminal because of the presence of a protective terminal root cap over it.

2. (a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.

   Explanation: Histogen theory, which proposes that the three principal tissues of the root-vascular cylinder, cortex, and epidermis-originate from three groups of initial cells, or histogens, in the apical meristem-Pleroma, periblem, and dermatogen respectively. A fourth histogen, the calyptrogen, produces the root cap.

Case Study Answer-

1. **Answer:**

   1.) a

   2.) d

   3.) There are various simple tissues in plants such as,

   - Parenchyma
   - Collenchyma
   - Sclerenchyma

   4.) Sclerenchyma are one of the simple type of permanent tissue. Sclerenchyma consists of long, narrow cells with thick and lignified cell walls. They are usually dead and without protoplasts. On the basis of variation in form, structure, origin and development, sclerenchyma may be either fibres or sclereids. The fibres are thick-walled, elongated and pointed cells, generally occurring in groups, in various parts of the plant. The sclereids are spherical, oval or cylindrical, highly thickened dead cells with very narrow cavities (lumen). Sclerenchyma provides mechanical support to organs.

5.) Parenchyma are one of the simple type of permanent tissue. It forms the major component within organs. The cells of the parenchyma are generally isodiametric. They may be spherical, oval, round, polygonal or elongated in shape. Their walls are thin and made up of cellulose. They may either be closely packed or have small intercellular spaces. The parenchyma performs various functions like photosynthesis, storage, secretion.

2. **Answer:**

1.) d

2.) a

3.) Functions of xylem and Phloem are as follows;

- Xylem – Xylem functions as a conducting tissue for water and minerals from roots to the stem and leaves. It also provides mechanical strength to the plant parts.
- Phloem – Phloem transports food materials, usually from leaves to other parts of the plant. The phloem parenchyma stores food material and other substances like resins, latex and mucilage.

4.) The first formed primary xylem elements are called protoxylem and the later formed primary xylem is called metaxylem.

5.) The first formed primary phloem consists of narrow sieve tubes and is referred to as protophloem and the later formed phloem has bigger sieve tubes and is referred to as metaphloem.

6.) Xylem is composed of four different kinds of elements;

- tracheids
- vessels
- xylem fibres
- xylem parenchyma

Tracheids are elongated or tube like cells with thick and lignified walls and tapering ends. These are dead and are without protoplasm.

Vessel is a long cylindrical tube-like structure made up of many cells called vessel members. Vessel members are interconnected through perforations in their common walls.

Primary xylem is of two types – protoxylem and metaxylem. The first formed primary xylem elements are called protoxylem and the later formed primary xylem is called metaxylem.

In stems, the protoxylem lies towards the centre (pith) and the metaxylem lies towards the periphery of the organ. This type of primary xylem is called endarch.

In roots, the protoxylem lies towards periphery and metaxylem lies towards the centre. Such arrangement of primary xylem is called exarch.