

**Question 1:**

State the location and function of different types of meristem.

Answer

Meristems are specialised regions of plant growth. The meristems mark the regions where active cell division and rapid division of cells take place. Meristems are of three types depending on their location.

**Apical meristem**

It is present at the root apex and the shoot apex. The shoot apical meristem is present at the tip of the shoots and its active division results in the elongation of the stem and formation of new leaves. The root apical meristem helps in root elongation.

**Intercalary meristem**

It is present between the masses of mature tissues present at the bases of the leaves of grasses. It helps in the regeneration of grasses after they have been grazed by herbivores. Since the intercalary meristem and the apical meristem appear early in a plant's life, they constitute the primary meristem.

**Lateral meristem**

It appears in the mature tissues of roots and shoots. It is called the secondary meristem as it appears later in a plant's life. It helps in adding secondary tissues to the plant body and in increasing the girth of plants. Examples include fascicular cambium, interfascicular cambium, and cork cambium

**Question 2:**

Cork cambium forms tissues that form the cork. Do you agree with this statement? Explain.

Answer

When secondary growth occurs in the dicot stem and root, the epidermal layer gets broken. There is a need to replace the outer epidermal cells for providing protection to the stem and root from infections. Therefore, the cork cambium develops from the cortical region. It is also known as phellogen and is composed of thin-walled rectangular cells. It cuts off cells toward both sides. The cells on the outer side get



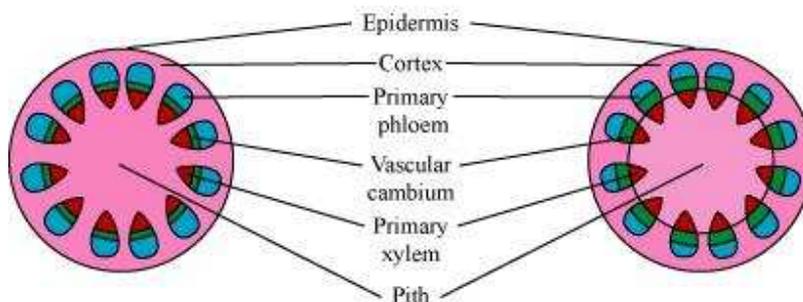
differentiated into the cork or phellem, while the cells on the inside give rise to the secondary cortex or phelloderm. The cork is impervious to water, but allows gaseous exchange through the lenticels. Phellogen, phellem, and phelloderm together constitute the periderm.

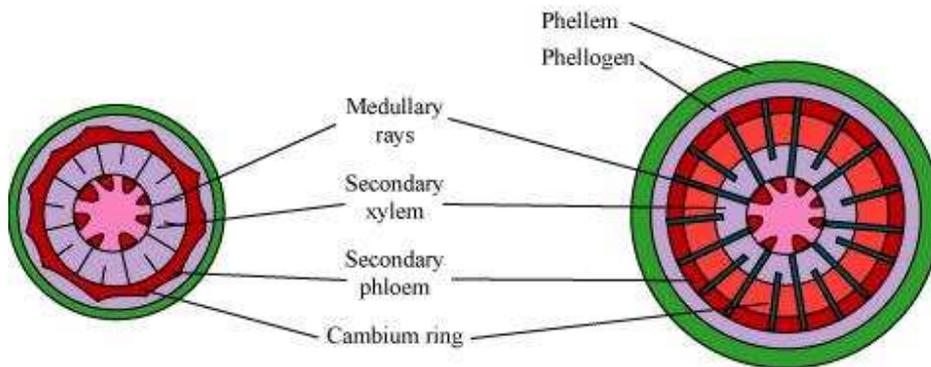
**Question 3:**

Explain the process of secondary growth in stems of woody angiosperm with help of schematic diagrams. What is the significance?

Answer

In woody dicots, the strip of cambium present between the primary xylem and phloem is called the interfascicular cambium. The interfascicular cambium is formed from the cells of the medullary rays adjoining the interfascicular cambium. This results in the formation of a continuous cambium ring. The cambium cuts off new cells toward its either sides. The cells present toward the outside differentiate into the secondary phloem, while the cells cut off toward the pith give rise to the secondary xylem. The amount of the secondary xylem produced is more than that of the secondary phloem.





Stages of secondary growth in dicot stem

The secondary growth in plants increases the girth of plants, increases the amount of water and nutrients to support the growing number of leaves, and also provides support to plants.

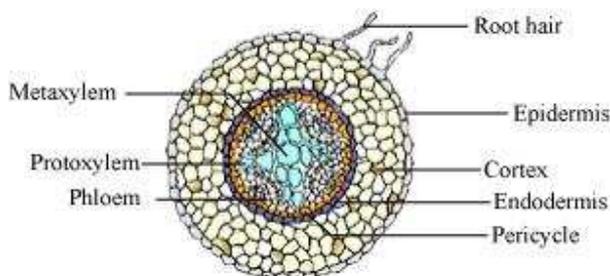
**Question 4:**

Draw illustrations to bring out anatomical difference between

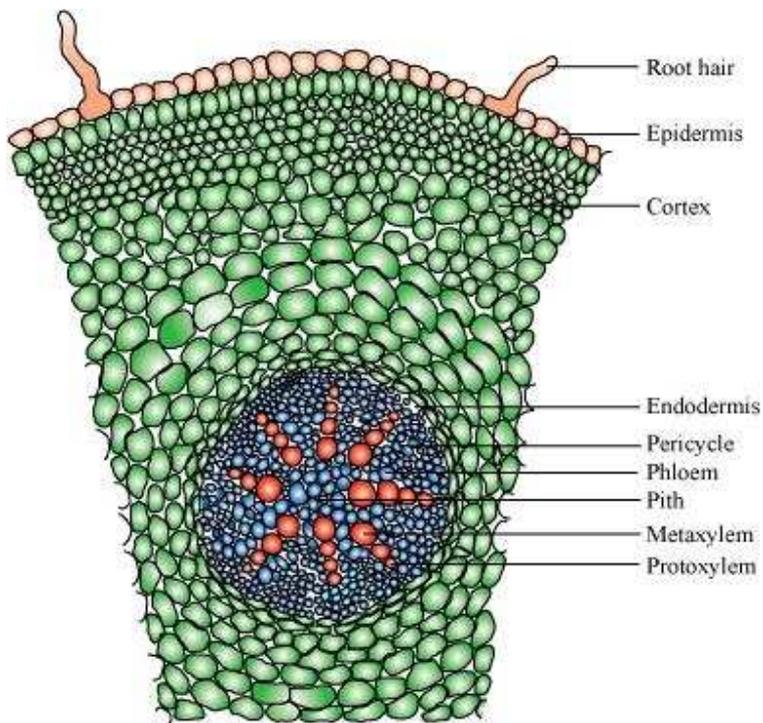
- (a) Monocot root and dicot root
- (b) Monocot stem and dicot stem

Answer

**(a) Monocot root and dicot root**

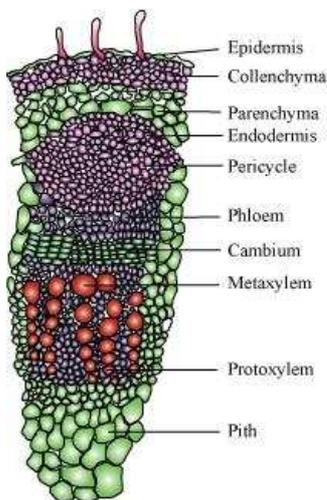


T.S. of dicot root (Primary)

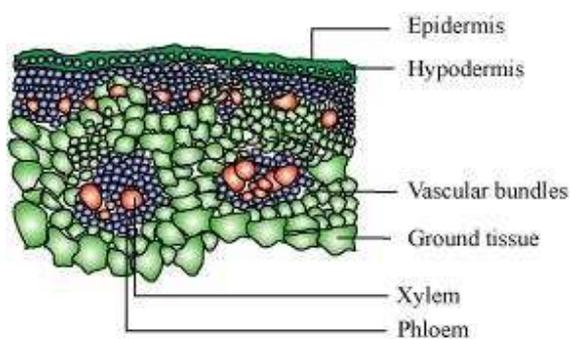


T.S. of monocot root

**(b) Monocot stem and dicot stem**



T.S. of dicot stem



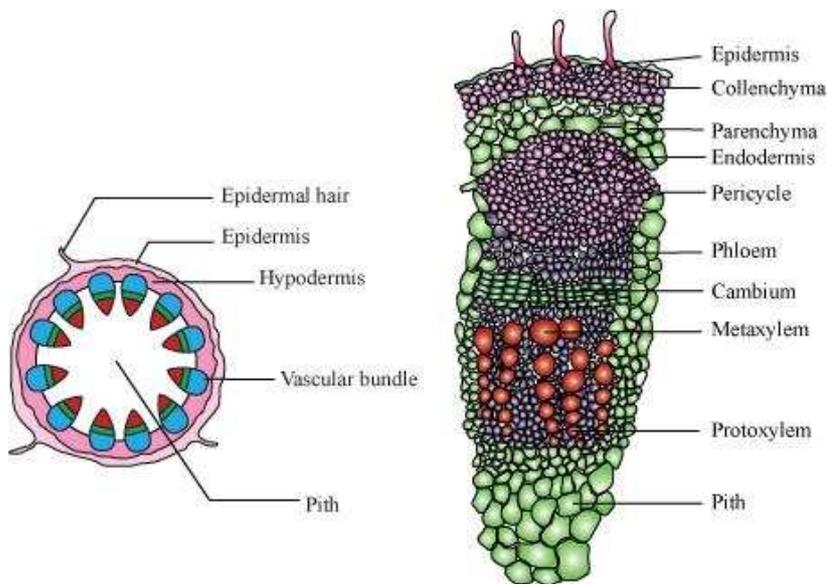
T.S. of monocot stem

**Question 5:**

Cut a transverse section of young stem of a plant from your school garden and observe it under the microscope. How would you ascertain whether it is a monocot stem or dicot stem? Give reasons.

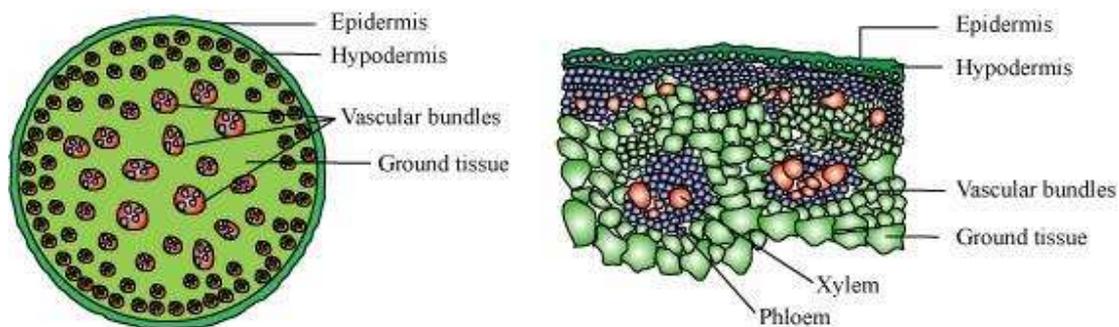
Answer

The dicot stem is characterised by the presence of conjoint, collateral, and open vascular bundles, with a strip of cambium between the xylem and phloem. The vascular bundles are arranged in the form of a ring, around the centrally-located pith. The ground tissue is differentiated into the collenchyma, parenchyma, endodermis, pericycle, and pith. Medullary rays are present between the vascular bundles.



T.S. of dicot stem

The monocot stem is characterised by conjoint, collateral, and closed vascular bundles, scattered in the ground tissue containing the parenchyma. Each vascular bundle is surrounded by sclerenchymatous bundle-sheath cells. Phloem parenchyma is absent and water-containing cavities are present.



T.S. of monocot stem

**Question 6:**

The transverse section of a plant material shows the following anatomical features, (a) the vascular bundles are conjoint, scattered and surrounded by sclerenchymatous bundle sheaths (b) phloem parenchyma is absent. What will you identify it as?

Answer

The monocot stem is characterised by conjoint, collateral, and closed vascular bundles, scattered in the ground tissue containing the parenchyma. Each vascular bundle is surrounded by sclerenchymatous bundle-sheath cells. Phloem parenchyma and medullary rays are absent in monocot stems.

**Question 7:**

Why are xylem and phloem called complex tissues?

Answer

Xylem and phloem are known as complex tissues as they are made up of more than one type of cells. These cells work in a coordinated manner, as a unit, to perform the various functions of the xylem and phloem.

Xylem helps in conducting water and minerals. It also provides mechanical support to plants. It is made up of the following components:

- Tracheids (xylem vessels and xylem tracheids)
- Xylem parenchyma
- Xylem fibres

Tracheids are elongated, thick-walled dead cells with tapering ends. Vessels are long, tubular, and cylindrical structures formed from the vessel members, with each having lignified walls and large central cavities. Both tracheids and vessels lack protoplasm. Xylem fibres consist of thick walls with an almost insignificant lumen. They help in providing mechanical support to the plant. Xylem parenchyma is made up of thin-walled parenchymatous cells that help in the storage of food materials and in the radial conduction of water.

Phloem helps in conducting food materials. It is composed of:



- Sieve tube elements
- Companion cells
- Phloem parenchyma
- Phloem fibres

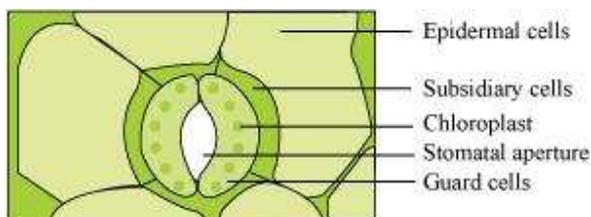
Sieve tube elements are tube-like elongated structures associated with companion cells. The end walls of sieve tube elements are perforated to form the sieve plate. Sieve tube elements are living cells containing cytoplasm and nucleus. Companion cells are parenchymatous in nature. They help in maintaining the pressure gradient in the sieve tube elements. Phloem parenchyma helps in the storage of food and is made up of long tapering cells, with a dense cytoplasm. Phloem fibres are made up of elongated sclerenchymatous cells with thick cell walls.

#### Question 8:

What is stomatal apparatus? Explain the structure of stomata with a labelled diagram.

Answer

Stomata are small pores present in the epidermis of leaves. They regulate the process of transpiration and gaseous exchange. The stomatal pore is enclosed between two bean-shaped guard cells. The inner walls of guard cells are thick, while the outer walls are thin. The guard cells are surrounded by subsidiary cells. These are the specialised epidermal cells present around the guard cells. The pores, the guard cells, and the subsidiary cells together constitute the stomatal apparatus.



**Question 9:**

Name the three basic tissue systems in the flowering plants. Give the tissue names under each system.

Answer

No.	Tissue system	Tissues present
1.	Epidermal tissue system	Epidermis, trichomes, hairs, stomata
2.	Ground tissue system	Parenchyma, collenchyma, sclerenchyma, mesophyll
3.	Vascular tissue system	Xylem, phloem, cambium

**Question 10:**

How is the study of plant anatomy useful to us?

Answer

The study of plant anatomy helps us to understand the structural adaptations of plants with respect to diverse environmental conditions. It also helps us to distinguish between monocots, dicots, and gymnosperms. Such a study is linked to plant physiology. Hence, it helps in the improvement of food crops. The study of plant-structure allows us to predict the strength of wood. This is useful in utilising it to its potential. The study of various plant fibres such as jute, flax, etc., helps in their commercial exploitation.

**Question 11:**

What is periderm? How does periderm formation take place in dicot stem?

Answer

Periderm is composed of the phellogen, phellem, and phelloderm.

During secondary growth, the outer epidermal layer and the cortical layer are broken because of the cambium. To replace them, the cells of the cortex turn meristematic,



giving rise to cork cambium or phellogen. It is composed of thin-walled, narrow and rectangular cells.

Phellogen cuts off cells on its either side. The cells cut off toward the outside give rise to the phellem or cork. The suberin deposits in its cell wall make it impervious to water. The inner cells give rise to the secondary cortex or phelloderm. The secondary cortex is parenchymatous.

**Question 12:**

Describe the internal structure of a dorsiventral leaf with the help of labelled diagrams.

Answer

Dorsiventral leaves are found in dicots. The vertical section of a dorsiventral leaf contains three distinct parts.

**[1] Epidermis:**

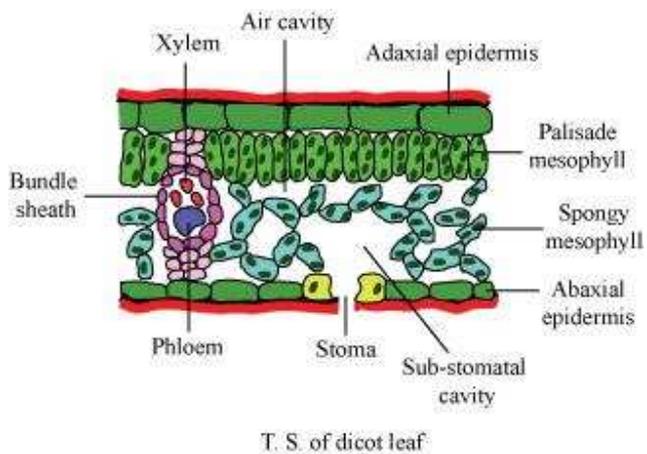
Epidermis is present on both the upper surface (adaxial epidermis) and the lower surface (abaxial epidermis). The epidermis on the outside is covered with a thick cuticle. Abaxial epidermis bears more stomata than the adaxial epidermis.

**[2] Mesophyll:**

Mesophyll is a tissue of the leaf present between the adaxial and abaxial epidermises. It is differentiated into the palisade parenchyma (composed of tall, compactly-placed cells) and the spongy parenchyma (comprising oval or round, loosely-arranged cells with inter cellular spaces). Mesophyll contains the chloroplasts which perform the function of photosynthesis.

**[3] Vascular system:**

The vascular bundles present in leaves are conjoint and closed. They are surrounded by thick layers of bundle-sheath cells.



# Chapter-6

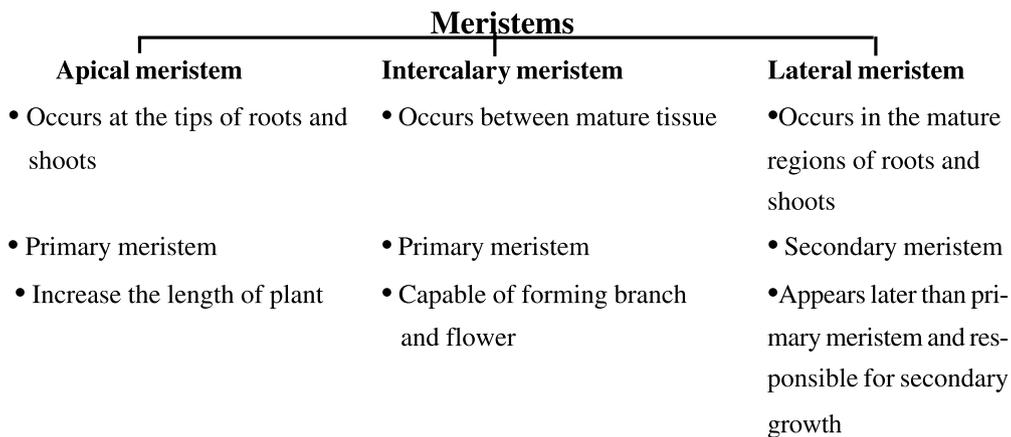
## ANATOMY OF FLOWERING PLANTS

### POINTS TO REMEMBER

**Anatomy :** Anatomy is the study of internal structure of organisms. Plant anatomy includes organisation and structure of tissues.

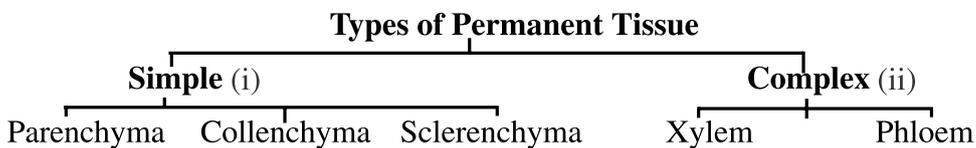
There are two types of tissues (i) Meristematic (ii) Permanent

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



**Axillary bud :** The buds which are present in the axils of leaves and are responsible for forming branches or flowers.

**Permanent tissues :** The permanent tissues are derived from meristematic tissue and are composed of cells, which have lost the ability to divide.



**Parenchyma :** Thin walled cells, with intercellular spaces, cell wall is made up of cellulose. It performs the function like photosynthesis, storage, secretion.

- (i) Formed of only one type of structurally and functionally similar mature cells having a common origin. They are homogeneous.
- (ii) They are heterogeneous, formed of two or more types of mature cells of common origin.

**Collenchyma :** It is formed of living, closely packed isodiametric cells. It's cells are thickened at the corners due to deposition of cellulose and pectin. It provides mechanical support to the growing parts of the plant.

**Sclerenchyma :** It is formed of dead cells with thick and lignified walls. They have two types of cells : fibres and sclereids.

**Xylem :** Xylem consists of tracheids, vessels, xylem fibres and xylem parenchyma. It conducts water and minerals from roots to other parts of plant.

**Protoxylem :** The first formed primary xylem elements.

**Metaxylem :** The later formed primary xylem.

**Endarch :** Protoxylem lies towards the centre and metaxylem towards the periphery of the organ.

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

**Protophloem :** First formed phloem with narrow sieve tubes.

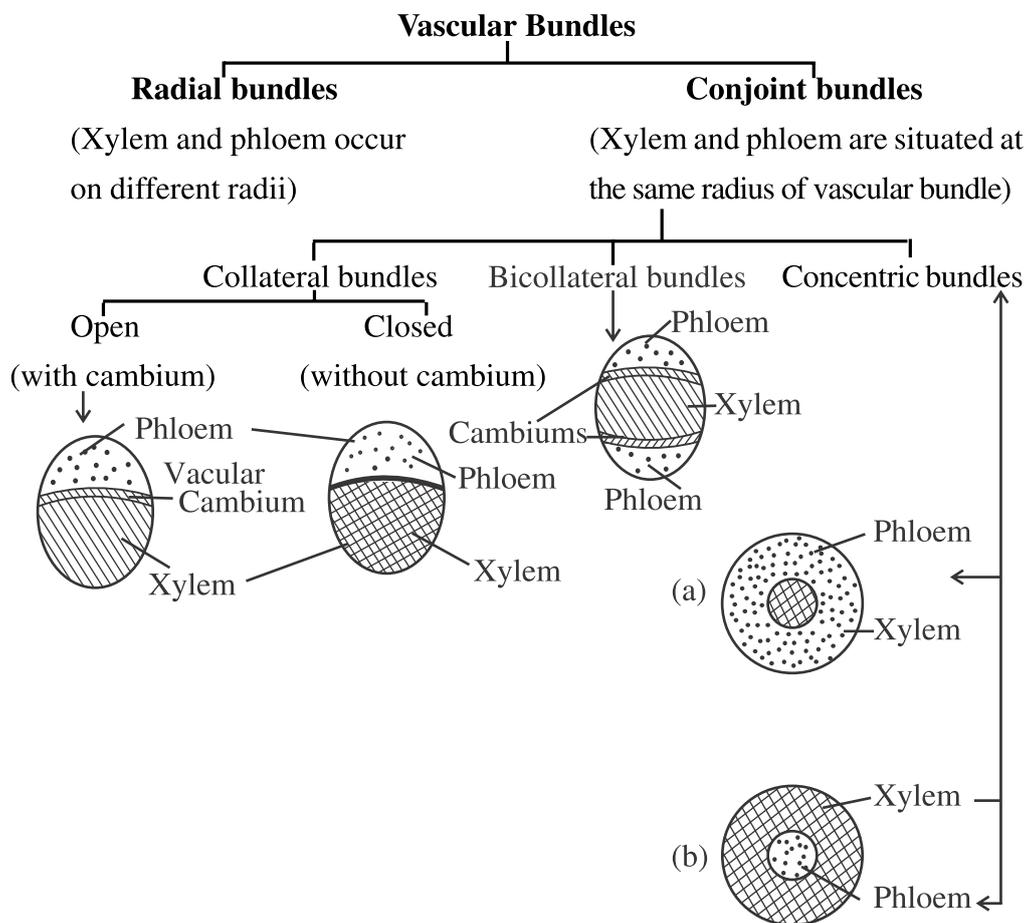
Metaphloem : Later formed phloem with bigger sieve tubes.

### **The Tissue System :**

**1. Epidermal tissue system :** It includes cuticle, epidermis, epidermal hairs, root hairs, trichomes and stomata.

**2. The ground tissue system :** It is made up of parenchyma, collenchyma, sclerenchyma. In dicot stems and roots (both monocots and dicots) the ground tissue is divided into hypodermis cortex, endodermis, pericycle, medullary rays and pith.

**3. The vascular tissue system :** It includes vascular bundles which are made up of xylem and phloem.



### Anatomy of Root

<b>Dicot Root</b>	<b>Monocot Root</b>
1. Cortex is comparatively narrow.	1. Cortex is very wide.
2. Endodermis is less thickened casparian strips are more prominent.	2. Endodermal cells are highly thickened Casparian strips are visible only in young roots.
3. The xylem and phloem bundles varies from 2 to 5.	3. Xylem and phloem are more than 6 (polyarch).
4. Pith is absent or very small.	4. Well developed pith is present.
5. Secondary growth takes place with the help of vascular cambium and cork cambium	5. Secondary growth is absent.

## Anatomy of Stem

Dicot Stem	Monocot Stem
<ol style="list-style-type: none"> <li>1. The ground tissue is differentiated into cortex, endodermis, pericycle and pith.</li> <li>2. The vascular bundles are arranged in a ring.</li> <li>3. Vascular bundles are open, without bundle sheath and wedge-shaped outline.</li> <li>4. The stem shows secondary growth due to presence of cambium between xylem and phloem.</li> <li>5. Stomata have kidney-shaped guard cells.</li> </ol>	<ol style="list-style-type: none"> <li>1. The ground tissue is made up of similar cells.</li> <li>2. The vascular bundles are scattered throughout the ground tissue.</li> <li>3. Vascular bundles are closed, surrounded by sclerenchymatous bundle sheath, oval or rounded in shape.</li> <li>4. Secondary growth is absent.</li> <li>5. Stomata have dumb bell-shaped guard cells.</li> </ol>

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

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

Cork Cambium ————┐  
                                  └─ Cork (phellem) - From outer cells  
   └─ Sec. cortex (phellogen) - From inner cells

(Phellogen + Phellem + Phellogen) = Periderm

**Secondary growth in dicot roots :** Secondary growth in dicot root occurs 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.

### Anatomy of Leaf

<b>Dorsiventral (Dicot) Leaf</b>	<b>Isobilateral (monocot) Leaf</b>
1. Stomata are absent or less abundant on the upper side. 2. Mesophyll is differentiated into two parts upper palisade parenchyma and lower spongy parenchyma. 3. Bundle sheath is single layered and formed of colourless cells. 4. Hypodermis of the mid-rib region is collenchymatous.	1. The stomata are equally distributed on both sides. 2. Mesophyll is undifferentiated. 3. Bundle sheath may be single or double layered. 4. Hypodermis of the mid-rib region is sclerenchymatous.

#### Spring Wood

- 1) Also called early wood.
- 2) Cambium is active
- 3) Xylary elements more
- 4) Vessels with wide cavities
- 5) Light in colour, low density.

#### Autumn Wood

- 1) Also called late wood
- 2) Cambium less active
- 3) Xylary elements less
- 4) Vessels narrow
- 5) Dark, high density.

#### Heartwood

- 1) Central or innermost region of stem which is hard, durable and resistant to attack of Microorganisms and insects.
- 2) Not involved in conduction of water.

#### Sapwood

- 1) Peripheral region of stem, light in colour
- 2) Involved in conduction of water and mineral

**Lenticels** - Produced when phellogen cuts off parenchymatous cells on outer side. These cells rupture the epidermis forming lens shaped openings called lenticels.

**Function** - Permit exchange of gases

### QUESTIONS

#### Very Short Answer Questions (1 mark each)

1. Name the tissue represented by the jute fibres used for making the ropes.
2. Which kind of roots have polyarch vascular bundles ?
3. What is heart wood ?

4. State the role of pith in stem.
5. Where are bulliform cells found in leaves ?
6. Which meristem does produce growth in length ?
7. What forms the cambial ring in a dicot stem during the secondary growth ?
8. Name the anatomical layer in the root from which the lateral branches of root originate.
9. Which tissue of the leaf contains chloroplast ?
10. A plant tissue when stained, showed the presence of hemicellulose and pectin in cell wall of its cells. Name the tissue.
11. Write the function of phloem parenchyma.
12. What constitutes the cambial ring?
13. Name the cells which make the leaves curl in plants during water stress.
14. Give the function of lenticels.
15. The vascular bundles are surrounded by a thick layer of cells. What is the name of the cells?
16. Where are casparian strips found?
17. Give the function of companion cells.

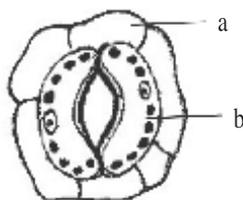
**Short answer type Questions:-**

**(2 marks each)**

18. Why is cambium considered to be lateral meristem ?
19. Give any four differences between tracheids and vessels.
20. How are open vascular bundles differ from closed vascular bundles ?
21. What are trichomes ? State their functions.
22. Given below are the various types of tissue and their functions. Which out of these is not a matching pair and why :
  - (a) Collenchyma : provides mechanical support to the growing parts of plant.
  - (b) Sclerenchyma : photosynthesis, storage and secretion.
  - (c) Chlorenchyma : perform the function of photosynthesis.
  - (d) Xylem : conduction of water and minerals.
23. In which part of the plant you would see the following:
  - (a) Radial vascular bundle
  - (b) Well developed pith

**Short Answer Question-I (3 marks each)**

24. Give the points of difference between lenticels and stomata.
25. Even being a monocotyledonous plant the Palm increases in girth. Why and how does it take place?
26. Differentiate between enderch and exarch conditions
27. If you are provided with microscopic preparation of transverse section of a meristemic tissue and permanent tissue, how would you distinguish them ?
28. Differentiate between arenchyma and collenchyma on the basis of their structure and function.
29. Are there any tissue elements of phloem which are comparable to those of xylem ? Explain.
30. Palm is a monocotyledonous plant, yet it increases in girth. How is it possible?
31. Observe the figure and answer the following questions :
  - (i) Name parts (a) and (b).
  - (ii) Are these types of stomata observed in monocot or in dicot plants ?
  - (iii) Which parts of stomata constitute the stomatal apparatus ?



**Long Answer Questions (5 marks each)**

32. (i) What are meristems ?
  - (ii) Name the various kinds of meristems in plants.
  - (iii) State the location and functions of meristems.
33. (i) Suppose you are examining a cross section of a stem under compound microscope, how would you determine whether it is monocot stem or dicot stem ?
  - (ii) Write the characteristics of collenchyma.
34. What is secondary growth in plants ? Describe various steps of secondary growth in dicot stem with the help of diagrams.

## ANSWERS

### Very Short Answers (1 mark each)

1. Sclerenchyma.
2. Monocotyledonous roots.
3. The hard central region of tree trunk made up of xylem vessels.
4. Pith stores the food material.
5. Bulliform cells are found in the upper epidermis of monocot leaves.
6. Primary meristem.
7. Fascicular and intrafascicular strips of meristem.
8. Pericycle of mature zone.
9. Mesophyll tissue.
10. Chollenchyma.
11. Lateral conduction of food and supply of water from xylem.
12. Cambial ring is formed by fusion of interfascicular and intrafascicular cambium strips.
13. Bulli form or motor cells.
14. Permit exchange of gases
15. Bundle sheath cells
16. Endodermis
17. Maintain pressure gradient in Sieve tubes

### Short Answers-II (2 marks each)

18. The cambium is considered as a lateral meristem because it occurs along the lateral sides of the stem and roots and appears later than primary meristem. Cells of this meristem divide periclinally and increase the thickness of the plant body.

19.	<b>Tracheid</b>	<b>Vessel</b>
	1. A tracheid is formed from a single cell.	1. A vessel is made of a number of cells.
	2. The ends are rounded or transverse.	2. The ends are generally oblique and tapering.
	3. They are comparatively narrower.	3. They are comparatively wider.
	4. The lumen is narrower.	4. The lumen is wide.

**20. Open Vascular bundles :** These vascular bundles contain a strip of cambium in between phloem and xylem. Open vascular bundles are collateral and bicollateral.

**Closed Vascular bundles :** Intrafascicular cambium is absent. Closed vascular bundles can be collateral or concentric.

**21.** Trichomes are multicellular epidermal hairs on the stem, seeds or fruits. Trichomes help in protection, dispersal of fruits and seeds and reduction in water loss.

**22.** (b) Sclerenchyma : photosynthesis, storage and secretion is not a matching pair. The function of sclerenchyma is to provide mechanical support to organs.

**23.** (a) Root (b) monocot root

#### Short Answers-I (3 marks each)

**24 Lenticels :** Found in old stems & roots in the cork tissues containing a number of complimentary cells and they are permanently opened pores.

**Stomata :** Found in leaves and young stems in the epidermis and have two guard cells. They open and close in response to turgidity of their guard cells.

**25.** Palms possess residual meristem below their leaf primordial, which adds ground parenchyma and vascular bundles. The ground parenchyma can also undergo further divisions even after the completion of elongation.

**26. Endarch condition**

1. Protoxylem towards pith and metaxylem towards periphery
2. Found in Stem

**Exarch condition**

1. Protoxylem towards periphery and metaxylem towards pith
2. Found in root.

**27. Meristematic tissues** are composed of cells that have the capability to divide. These cells exist in different shapes without intercellular space. Cells are thin walled, rich in protoplasm, without vacuoles.

**Permanent tissues** are derived from meristematic tissue and are composed of cells have their definite shape, size and function. These cells may be thin walled (living) or thick walled (dead).

28.	<b>Arenchyma</b>	<b>Collenchyma</b>
	(a) Parenchymatous tissue containing large air space.	(a) Tissue contains deposits of cellulose and large pectin at the corner of cells.
	(b) Thin walled cells, isodiametric in shape with intercellular space.	(b) Consists of oval and polygonal cells without intercellular space.
	(c) Provides buoyancy to the plant.	(c) Provides elasticity and mechanical strength.

29. (a) The sieve elements of phloem is comparable to the vessel of the xylem because both lack nucleus.  
 (b) Phloem fibre is similar to the xylem fibre because both provide tensile strength to the tissue.  
 (c) Phloem parenchyma and xylem parenchyma is the living components of phloem and xylem respectively.
30. A palm tree is monocotyledonous plant, hence do not have primary cambium in the vascular bundles of stem. However, with age the tree grows in diameter. A secondary cambium may be formed in the hypodermal region of the stem. The later forms the conjunctive tissue and patches of meristematic cells. The activity of meristematic cells results in the formation of secondary vascular bundles.
31. (i) a : epidermal cell  
 b : guard cell  
 (ii) In dicot plants.  
 (iii) The stomatal apparatus includes the stomatal aperture, guard cells and the surrounding subsidiary cells.

Long Answers (5 marks each)

32. (i), (ii) and (iii) : Refer 'Points to remember'  
 33. (i) and (ii) : Refer. 'Points to remember'

34. • **Secondary growth** : Refer 'Points to remember).
- **Steps of secondary growth** : Refer page 94-97, NCERT, Text Book of Biology for Class XI.
  - Figure 6.9, page 95 NCERT, Text Book of Biology for Class XI.