6 Anatomy of Flowering Plants

Anatomy of every plant changes as per the habitat and so does the morphology. Anatomy of plants is all about studying internal structures of plants. Plants in desert areas have succulent leaves while aquatic plants have floating leaves with stomata on the upper side similarly trees in forest have strong, wooden bark and crops in fields have much delicate .

Topic Notes

- *Tissue System*
- *Anatomy of Plants*

TISSUE SYSTEM 1

TOPIC 1

TYPES OF TISSUE SYSTEM

Tissue system is a tissue or a group of tissues derived from a portion of meristem which performs a similar function in the plant body irrespective of its position. On the basis of their location and structure, Sach (1875) recognised three systems in plants:

(1) Epidermal tissue system

(2) Ground tissue system

(3) Vascular tissue system

Epidermal Tissue System

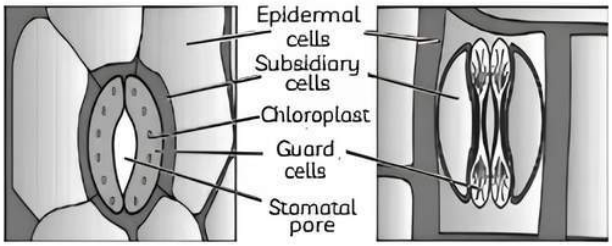
The word epiderm itself suggests the meaning, *i.e.* 'epi' means outer and 'derm' means skin/covering/ layer. The epidermal tissue system acts as the outer covering of the whole plant body. It is made up of epidermal cells, stomata and epidermal outgrowths such as trichomes.

Epidermal cells are made up of parenchymatous tissue and have large vacuoles. These cells are covered by a thick waxy layer known as cuticle. Thickness of cuticle is inversely proportional to transpiration, *i.e.* more is the thickness of the cuticle, less is the transpiration rate and *vice versa*.

Important

➥ *Cuticle is absent in submerged hydrophytes and roots of plants.*

Stomata are structures found mostly on the surface of leaves and young stems. It is made up of stomatal pore and is guarded by guard cells which are surrounded by subsidiary cells. The outside walls of guard cells that are away from the stomatal pore are thin and the inner walls are thicker that is towards the stomatal pore. The guard cells have chloroplasts and control the opening and closing of stomata. Guard cells found in dicots are bean-shaped and those found in monocots like grass are dumb-bell shaped. Occasionally, a few epidermal cells near the guard cells become specialised in shape and size and are referred to as subsidiary cells. About 85 to 90% of transpiration in plants occurs through stomata. These also help in exchange of gases. The stomatal aperture, guard cells and the surrounding subsidiary cells together are called as stomatal apparatus.



Diagrammatic Representation of Stomata:
(a) Stomata with Bean-Shaped Guard Cell
(b) Stomata with Dumb-bell Shaped Guard Cell

Important

➥ *The stomata that open during day are photoactive stomata and stomata that open at night are scotoactive stomata.*

Epidermal outgrowth consists of small finger-like hairs present on the surface of roots and stems. The hairs present on the surface of roots are unicellular and help in absorption of water and minerals from soil. The hairs present on the surface of stems are multicellular, and secretory in nature, they are known as trichomes which prevent loss of water during transpiration.

Ground Tissue System

Ground tissue system makes up the majority of the plant's body and extends from below the epidermis to the centre. All excluding epidermis and vascular tissue, comes under ground tissue system. It consists of hypodermis, cortex, pericycle, medullary rays and pith. There is no differentiation in the ground tissue system of monocotyledonous stems, where vascular bundles are scattered.

Important

➥ *Ground tissue system is dominated by parenchyma tissue.*

➥ *Ground tissue system of leaves is called mesophyll. Mesophyll is made up of two types of photosynthetic cells, palisade and spongy.*

Vascular Tissue System

The complex permanent tissues such as xylem and phloem form the vascular tissue system. Vascular tissue consists of two types of vascular bundles which are as follows:

(1) Radial vascular bundles

(2) Conjoint vascular bundles

Radial vascular bundles are found in roots of plants in which xylem and phloem are arranged alternately at different radii.

Conjoint vascular bundles are mainly found in the stem and leaves of plants in which xylem and phloem are arranged at the same radius joining each other. There are two types of conjoint vascular bundles, namely:

(1) Collateral vascular bundles

(2) Concentric vascular bundles

In collateral vascular bundles, xylem and phloem are arranged laterally, where phloem is located at the outer side of bundles.

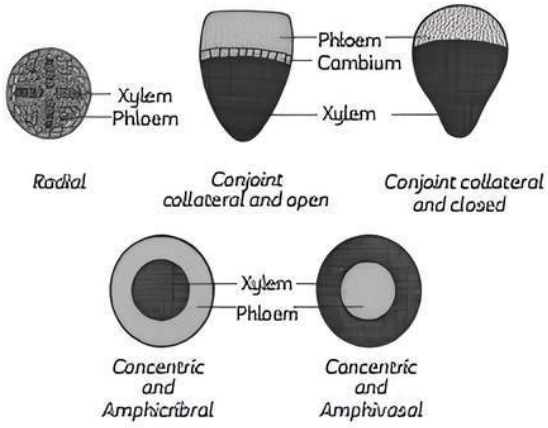
In dicots and gymnosperms, vascular bundles contain cambium in between phloem and xylem which is responsible for secondary growth of tissues in plants; such types of vascular bundles are called conjoint open vascular bundles.

In monocots, cambium is absent in between phloem and xylem; such types of vascular bundles are called conjoint closed vascular bundles.

In concentric vascular bundles, xylem and phloem are arranged in circles or concentric rings. There are two types of concentric vascular bundles as follows:

(1) **Amphicribral or Hadrocentric vascular bundles:** This type of vascular bundle is found in pteridophytes like fern, in which xylem is placed at the centre and surrounded by phloem in circles.

(2) **Amphivasal or Leptocentric vascular bundles:** Vascular bundles, in which phloem is present at the centre surrounded by xylem in concentric circles, are known as Amphivasal vascular bundles.



Types of Vascular Bundles

Example 1.1: **Name the three basic tissue systems in the flowering plants. Give the tissue names under each system.**

Ans. The three basic tissue systems in the flowering plants are as follows:

(1) Epidermal tissue system consisting of epidermis, trichomes, hairs and stomata.

(2) Ground tissue system is made up of tissues such as parenchyma, collenchyma, sclerenchyma and mesophyll. It consists of cortex, pericycle, medullary rays and pith.

(3) Vascular tissue system includes xylem, phloem and cambium.

Example 1.2: **Case Based:**

We all keep cucumbers to calm our eyes, as it gives a hydrating effect. As soon as we cut the cucumber, we see water coming out from it. This water is nothing but leakage of vascular bundles consisting of xylem at the centre surrounded by phloem from both sides. This type of vascular bundle is called bicollateral vascular bundle in which phloem is present on both the sides of xylem.

(A) Vascular bundles with the presence of cambium are found in:

(a) Dicots

(b) Monocots

(c) Gymnosperms

(d) Both (a) and (c)

(B) Amphicribral type of vascular bundle is shown by:

(a) fern **(b) groundnuts**

(c) maize **(d) cucumber**

(C) Which type of vascular bundles are found in the roots of plants?

(D) Write down the difference between conjoint collateral open-type and conjoint collateral closed-type vascular bundles.

(E) Assertion (A): **Amphivasal type of vascular bundles are also known as leptocentric vascular bundles.**

Reason (R): **In amphivasal vascular bundles, phloem is surrounded by xylem in concentric circles.**

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

Ans. (A) *(d) Both (a) and (c)*

Explanation: In dicots and gymnosperms, vascular bundles contain cambium in between phloem and xylem which is responsible for secondary growth of tissues. In plants; such types of vascular bundles are called conjoint open vascular bundles.

(B) *(a) Fern*

Explanation: Amphicribral type of vascular bundles are found in pteridophytes like fern, in which xylem is placed at the centre and surrounded by phloem in circles.

Groundnut is a dicot and vascular bundles found in dicots are collateral open containing cambium in between xylem and phloem. Maize is a monocot and vascular bundles found in monocots are closed collateral that lacks cambium in between xylem and phloem. Family Cucurbitaceae show bicollateral vascular bundles.

(C) Radial vascular bundles are found in roots of plants in which xylem and phloem are arranged alternately at different radii.

(D)

S. No.	Conjoint collateral open-type vascular bundle	Conjoint collateral closed-type vascular bundle
(1)	The vascular bundles in which cambium is present between xylem and phloem are known as Conjoint collateral open-type vascular bundles.	The vascular bundles in which cambium is absent between xylem and phloem are known as Conjoint collateral closed-type vascular bundles.
(2)	This type of vascular bundle is found in dicots and gymnosperms.	This type of vascular bundle is found in monocots.

(E) *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: Amphivasal vascular bundles are also known as leptocentric vascular bundles because in amphivasal vascular bundles, phloem (food conducting tissue) is surrounded by water conducting tissue, xylem in concentric circles.

Related Theory

➥ *Amphivasal type of vascular bundles is found in Dracaena.*

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. Identify the simple tissue among the following.

(a) Parenchyma (b) Xylem

(c) Epidermis (d) Phloem

[NCERT Exemplar]

Ans. *(a) Parenchyma*

Explanation: Simple permanent tissues are made up of only one type of cell performing similar functions. They may be found dead or living in plants. Parenchyma, Collenchyma and Sclerenchyma are the three types of simple tissues found in the body of plants. Xylem and Phloem are types of complex permanent tissue. Epidermis consists of long elongated, tightly arranged cells which make up the outer layer of the initial plant body.

2. Which type of xylem is present in the stem of plants?

(a) Endarch and exarch (b) Endarch

(c) Exarch (d) Hydrarch

Ans. *(b) Endarch*

Explanation: Endarch is an arrangement of primary xylem in which the protoxylem is placed at the centre and is surrounded by a metaxylem from periphery. Such types of arrangements of primary xylem are seen in stems of plant. Exarch is an arrangement of primary xylem in which the metaxylem placed at the centre is surrounded by protoxylem from the periphery. Such types of arrangements of primary xylem are seen in roots of plants.

3. Which is the outermost layer of the primary plant body?

(a) Trichomes (b) Epidermis
(c) Cuticle (d) Parenchyma

Ans. *(b) Epidermis*

Explanation: Epidermis consists of long elongated, tightly arranged cells which make up the outer layer of the initial plant body.

Trichomes are finger-like multicellular, secretory hairs which are present on the epidermal surface of the stem. They prevent water loss caused by transpiration.

Epidermal cells are covered by a thick waxy layer known as cuticle. Thickness of cuticle is inversely proportional to transpiration, *i.e.* thick the cuticle, less is the transpiration and *vice versa*.

Parenchyma is the most abundantly found simple permanent tissue in plants with thin cellulose cell walls and tightly packed cells or cells with little intercellular spaces.

4. **Statement A: Vascular strands show a radial arrangement in stems.**

Statement B: It is helpful in maintaining the inward movement of water from epidermis to enter the xylem without crossing phloem strand.

(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(d) Only B is correct.*

Explanation: Vascular strands show a radial arrangement in roots. No phloem lies outside of xylem strands due to the arrangement of the vascular tissues (xylem and phloem strands) in roots. This configuration aids in preventing water from the epidermis from crossing the phloem strand, where a different type of conduction is occurring, in order to enter the xylem.

5. **Statement A: In roots, vascular bundles show radial arrangement of xylem and phloem.**

Statement B: In roots, arrangement of xylem and phloem on different radii facilitates absorption process.

(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(b) Both A and B are incorrect.*

Explanation: The xylem and phloem of the radial vascular bundle are arranged simply and are separated by non-conductive tissues. The roots of dicot and monocot plants both contain these kinds of vascular bundles. Radial vascular bundles are formed when xylem and phloem coexist in patches and occupy distinct radii. The xylem and phloem in this type of vascular bundle alternate (separated by non-conductive tissues).

Assertion-Reason (A-R)

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

6. **Assertion (A): Phloem is also known as food tissue, as it transports food from root to stem and leaves.**

Reason (R): Xylem is also known as water tissue, as it transports water from root to stem and leaves.

Ans. *(d) A is false but R is true.*

Explanation: Phloem is food tissue; it transports plant food which is synthesised by leaves to other parts of the plant.

Xylem is a water tissue because it conducts water and provides water to stem and leaves which is collected from roots.

7. **Assertion (A): Gymnosperms lack vessels in their xylem.**

Reason (R): Tracheids are living cells with protoplasm.

Ans. *(c) A is true but R is false.*

Explanation: Seed-producing plants, gymnosperms do not contain vessels in their xylem. Their xylem consists of xylem fibres, xylem parenchyma and tracheids but not vessels which are present in angiosperms. Tracheids are long and elongated and appear as tubes having thick walls which taper at the end. Their walls are lignified and non-living. The walls of tracheids lack protoplasm.

Related Theory

In pteridophytes and gymnosperms, tracheids are chief conducting tissues but Selaginella, Marsilea (Pteridophytes) and Gnetum (Gymnosperm) are the exceptions. They show the presence of vessels in their xylem that conducts water and minerals. On the other hand, main conducting tissues in Angiosperms are vessels; though most species also have tracheids.

8. **Assertion (A):** **The companion cells help in maintaining the pressure gradient in the sieve tubes.**

Reason (R): **The companion cells are specialised collenchymatous cells.**

Ans. *(c) A is true but R is false.*

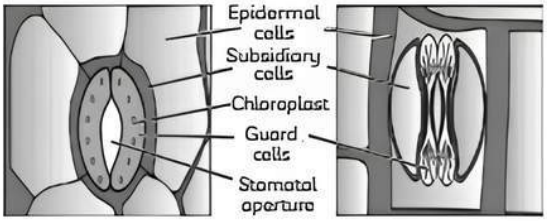
Explanation: Companion cells are essential parenchymatous cells that are closely connected to sieve tube elements. Pit fields exist between the shared longitudinal walls of the sieve tube elements and companion cells, which connect them. The partner cells aid in maintaining the sieve tubes' pressure gradient.

CASE BASED Questions (CBQs)

[**4** & **5** marks]

Read the following passages and answer the questions that follow:

9. *Observe the following diagram and answer the questions.*



Diagrammatic Representation of Stomata:
(a) Stomata with Bean-Shaped Guard Cells
(b) Stomata with Bumb-bell Shaped Guard Cells

(A) Where do you find Stomata with bean-shaped guard cells?

(B) Specify the shape of stomata present in monocots.

(C) What do you mean by stomatal apparatus? Write down the functions of guard cells.

Ans. (A) Dicots show stomata with bean-shaped guard cells.

(B) Stomata present in monocots like grasses are dumb-bell shaped.

Related Theory

➥ *On the basis of the location of stomata on leaf surface, leaves are divided into various types as follows:*

(1) Dorsiventral or Hypostomatous leaves. In which stomata are present on lower surface of leaves.

(2) Isobilateral or Amphistomatic leaves. here stomata are present on both upper and lower surface.

(3) Epistomatal leaves. In which stomata are present only on upper surface.

(4) Astomatal leaves. In which stomata are absent e.g., Submerged hydrophytes.

(C) The stomatal aperture, guard cells and the surrounding subsidiary cells together are called stomatal apparatus.

Guard cells control opening and closing of stomata and chloroplast present in guard cells helps in the process of photosynthesis.

10. *Once Shruti was doing some practical work with all her classmates. She was given a section to study the anatomy of roots and stems. While doing practicals, the lab teacher instructed all the students about the procedure of studying the anatomy of roots or stems. While doing this, when Shruti observed the thin section under the microscope, she had so many queries related to this.*

(A) What makes the apical meristem of the root sub-terminal?

(a) Meristems **(b) Trichomes**

(c) Root hairs **(d) Root cap**

(B) The meristem that occurs early in the life of a plant is known as:

(a) Lateral meristem

(b) Embryonic meristem

(c) Apical meristem

(d) Both (b) and (c)

(C) Which of the following is the example of secondary meristem?

(a) Intercalary meristem

(b) Lateral meristem

(c) Both (a) and (b)

(d) Promeristem

(D) Meristem present in grasses is:

(a) Intercalary meristem

(b) Embryonic meristem

(c) Primordial meristem

(d) Promeristem

(E) Assertion (A): **Apical meristem is responsible for the increase in length of root and stem.**

Reason (R): **Apical meristem is found in the growing tips of the plant such as root tip and shoot tip.**

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

Ans. (A) *(d) Root cap*

Explanation: The apical meristem of the root is sub-terminal because of the root cap. As this root cap covers the tip of the root for protection. Thus, the apical meristem present in the region of meristematic activity lies at the sub-terminal position. It lies just above the root cap.

(B) *(d) Both (b) and (c)*

Explanation: Meristems that occur at an early stage in plants at the tip of root and shoot are apical meristems. Embryonic meristem occupies a minor area of the tip of the root and shoot. This type of meristem occurs from the beginning of plant growth. Lateral meristem is a secondary meristem usually found in matured parts of root and shoot sections of plants.

(C) *(b) Lateral meristem*

Explanation: Lateral meristem, also known as the secondary meristem, is found in matured root and shoot sections of plants. They have a spherical form and create secondary tissue. Secondary meristem is always lateral in position. Intercalary meristem is a primary meristem that occurs in between mature tissue. This type of meristem occurs in the early life of plants and helps in forming primary plant bodies. Promeristem is also known as embryonic meristem or primordial meristem, it develops at an early stage in plants.

(D) *(a) Intercalary meristem*

Explanation: Meristem present in grasses is intercalary meristem, since grass is a monocot, meristem found in monocots is intercalary meristem. Intercalary meristem is a primary meristem that occurs in between mature tissue. This type of meristem occurs in the early life of plants and helps in forming primary plant bodies.

(E) *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: Both Assertion and reasoning are correct and reason is the correct explanation of assertion.

11. *Observe carefully the given picture and answer the questions*

Aeren-chyma	*Collen-chyma*	*Scleren-chyma*	*Chloren-chyma*

[Diksha]

(A) Among the above mentioned tissues, which one is a characteristic feature of aquatic plants? Explain.

(B) Which type of tissue provides buoyancy in aquatic plants?

(C) Give the common names of any two aquatic angiosperms known to you.

Ans. (A) Large air gaps exist in the parenchyma of aquatic plants to let them float on water. Such a parenchyma type is called aerenchyma.

It is a type of tissue with air gaps. It allows them to float to the water's upper surface.

(B) The buoyancy of floating plants is helped by aerenchyma.

(C) Water lily and water hyacinth.

VERY SHORT ANSWER Type Questions (VSA)

[1 mark]

12. Dermal tissue, ground tissue and vascular tissue are produced by which meristem?

Ans. Dermal tissue, ground tissue and vascular tissue are produced by apical meristem.

13. What type of depositions are found in collenchyma tissue?

Ans. Deposition of cellulose, hemicellulose and pectin is found in collenchyma tissue.

14. Where are sclereids found?

Ans. Sclereids are the cells found in fruit walls of nuts, pulp of fruits like guava, pear and sapota, seed coats of legumes and leaves of tea.

15. A plant tissue, when stained, showed the presence of hemicellulose and pectin in the cell wall of its cells. Name the tissue.

[Delhi Gov. QB 2022]

Ans. Collenchyma is the tissue. Cells of collenchyma contain protoplasm and are living. Cell walls show localised thickenings due to deposition of cellulose, hemicellulose and pectin substances.

16. The vascular bundles are surrounded by a thick layer of cells in leaves. What is the name of cells? [Delhi Gov. QB 2022]

Ans. Bundle sheath is a cell layer in plant leaves and stems that forms a sheath surrounding the vascular bundles.

17. Hair-like structures are found on the epidermis of stem of many plants. What are they?

Ans. Trichomes are branched / unbranched and may be soft or stiff multicellular hairs. Trichomes are present on the epidermal surface of the stem.

Caution

Students often get confused between the terms, trichomes and tracheids. Thus, it is necessary for them to know about the meaning and functions of the terms.

Tracheids: *Tube-like, long elongated, having tapering or rounded or oval ends, xylem cells which help in transporting water from roots to leaves and branches. These tracheids develop a thick lignified cell wall and at maturity, the protoplast has broken down and disappeared. Their presence is the defining characteristic of vascular plants to differentiate them from non-vascular plants.*

Trichomes: *Finger-like multicellular, secretory hairs which are present on the epidermal surface of the stem. They prevent water loss caused by transpiration.*

SHORT ANSWER Type-I Questions (SA-I)

[**2** marks]

18. Two different types of primary xylem are found in plants. Identify and define them.

Ans. Protoxylem and metaxylem are two types of primary xylem. The protoxylem is the firstly formed primary xylem which developed from the procambium. Whereas, the xylem formed after protoxylem or secondarily formed primary xylem is metaxylem.

Related Theory

Procambium is a dividing meristematic tissue that gives rise to cells that form primary xylem and primary phloem. The cells of procambium are cylindrical in shape and are located near the protoderm (upper layer of stem or root).

19. How many types of tissue systems are present in plants? Mention their names.

Ans. Broadly three types of tissue systems are present in plants as follows:

(1) Epidermal tissue system

(2) Ground tissue system

(3) Vascular tissue system

20. List any two characteristics of meristematic tissue which can be used as their distinguishing features.

Ans. Characteristics of meristematic tissue are as follows:

(1) These are the tissues having living cells with ability to divide into the regions where they are present.

(2) Cells of meristematic tissue show a high rate of metabolism.

SHORT ANSWER Type-II Questions (SA-II)

[**3** marks]

21. How will you differentiate between Parenchyma and Sclerenchyma tissues in plants?

Ans.

Parenchyma	Sclerenchyma
Parenchyma is a living tissue.	Sclerenchyma is a dead tissue.
Cell wall is made up of cellulose.	Cell wall is made up of lignin.
Contains chloroplasts and hence helps in photosynthesis and storage of food.	Gives mechanical support to the plant body and also provides strength to the plant.
Cells are loosely packed with intercellular spaces.	Cells are closely packed without intercellular spaces.

(Any three)

22. **Sneha studied various types of meristems in a book. Now she wants to make notes. She noted down all but forgot intercalary and lateral meristem. Help her by defining these two.**

Ans. **Intercalary meristem:** It is the primary meristem that occurs in between mature tissue of plants. These meristems occur in grasses and regenerate the parts removed by the grazing herbivores.

Lateral meristem: It is a type of meristem which occurs in matured parts of roots and stem after primary meristem. It is also known as secondary meristem. Examples of lateral meristem are cork cambium, fascicular vascular cambium, interfascicular cambium, etc. Their function is to produce secondary tissue.

23. **A teacher has drawn the structure of phloem on the blackboard and asked a student to tell about it. How will he describe it?**

Ans. The student can use the following points to describe the structure of phloem:

(1) Phloem is a living tissue. It is also called as bast and is responsible for conduction of organic food material from source (generally leaf) to a sink (other plant parts).

(2) On the basis of origin, it can be protophloem (first formed) and metaphloem (later formed).

(3) It is composed of sieve elements (sieve cells and sieve tubes), companion cells, phloem parenchyma and phloem fibres.

24. **Differentiate between Epidermal tissue system and Ground tissue system on the basis of their formation, components and functions.**

Ans.

Characteristics	Epidermal Tssue System	Ground Tissue System
Formation	Forms the outermost covering of plant, *i.e.* protoderm.	Forms the ground meristem in plants.
Components	Epidermal cells, stomata and epidermal outgrowths.	Excluding epidermis and vascular bundles, all other tissues come under the ground tissue system. It consists of parenchyma, collenchyma and sclerenchyma.
Functions	Stomata present on the epidermis of plant leaves modulate the process of transpiration and also help in gaseous exchange, absorption of water in roots protects plant body and helps in respiration.	Provides mechanical strength to plants and consists of parenchyma, collenchyma and sclerenchyma.

LONG ANSWER Type Questions (LA)

[**4** & **5** marks]

25. **Differentiate between Simple tissue and Complex tissue.**

Ans.

Characteristics	Simple Tissue	Complex Tissue
Cells	They consist of only one type of cell and all cells perform the same function.	They consist of more than one type of cell and different cells perform different functions but act as a single unit.
Location	Found in every part of the plant.	Found in only vascular regions of plants.
Functions	Act as supporting tissues gives strength to plants, help in food synthesis, *i.e.* photosynthesis, provides protection, store food and repairs damaged tissues. Jute and hemp are of great economical use	Conduction of water, transport of sap and transport of food material and nutrients.
Types	Parenchyma, collenchyma, sclerenchyma.	•They are classified into two types: Xylem and Phloem. Xylem consists of tracheids, xylem vessels, xylem fibres and xylem parenchyma. Phloem consists of sieve tubes, companion cells, phloem parenchyma and phloem fibres.

ANATOMY OF PLANTS 2

TOPIC 1

DICOTYLEDONOUS AND MONOCOTYLEDONOUS PLANTS

Dicotyledonous Root

The different types of cells and tissues of root arise from root apical meristem which is present at the sub-terminal position and remains protected by root cap. Roots are much simpler than stems in their internal structure. They possess the following tissues:

(1) **Epiblema or Piliferous layer:** It is the outermost layer of the root. It is made up of thin-walled, living and flattened parenchymatous cells. Some cells give rise to tubular outgrowth called Root hairs. These hairs are generally smaller than other epiblema cells and unicellular in nature. Due to root hairs, the epiblema is also called piliferous layer. These are responsible for absorption of water and minerals from the soil.

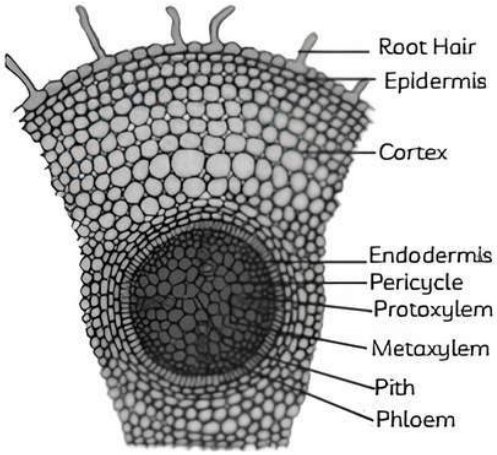
(2) **Cortex:** It is located just below the epiblema. It is made up of many layers of thin-walled parenchymatous cells. These cells enclose intercellular space for the diffusion of gasses. The cells of cortex store food and they also conduct water from the epiblema to inner parts.

(3) **Endodermis:** It is the innermost layer of the cortex. It is made up of a single layer of barrel –shaped cells which do not possess intercellular space. These cells possess a band of thickening that runs along their radial and tangential walls. This band of thickening is called **Casparian strip** which is made up of suberin and lignin and is impermeable for substance. All the tissues on the inner side of endodermis constitute a stele. It consists of pericycle, vascular bundles and pith.

(4) **Pericycle:** Endodermis is followed by one or a few layers of pericycle. The cells of pericycle are thin walled parenchymatous. It plays an important role as it forms a part of vascular cambium and cork cambium also develops from it during secondary growth. All lateral roots arise from the pericycle. Pericycle is absent in the roots of some aquatic plants.

(5) **Vascular bundles:** Inner to pericycle there are few (2-6) alternately arranged bundles of xylem and phloem. The xylem and phloem strands are arranged on different radii. Between the xylem and phloem thin-walled parenchymatous conjunctive tissues are present. Protoxylem is located in contact with the pericycle while metaxylem is present towards the centre of the root. The metaxylem elements of different xylem bundles are separate from each other so a pith is present in the centre of the root. In between two adjacent xylem bundles, there is one phloem bundle. They are separated from each other by one or more layers of small thin-walled cells called conjunctive tissue. Later on, these become meristematic to form vascular cambium.

(6) **Pith:** It is mostly absent and if present, made up of parenchyma cells which lack intercellular spaces. The main function of these cells is to store food and waste materials.



T.S. of Dicot Root

Important

➥ *Stele is the central part of the root or stem containing the tissues derived from the procambium. It is present on the inner side of the endodermis of a dicotyledonous root such as the pericycle, vascular bundles and pith.*

Monocotyledonous Root

There is no difference between the young and old roots of monocotyledonous plants as they lack secondary growth. The monocot roots consist of the following tissues:

(1) **Epiblema or Piliferous layer:** It is single-layered and made up of thin-walled cells. Some of them give rise to root hairs which are tubular and take part in absorption of water and minerals. Cuticle is absent in both epiblema and root hairs. Because they absorb water and mineral salts.

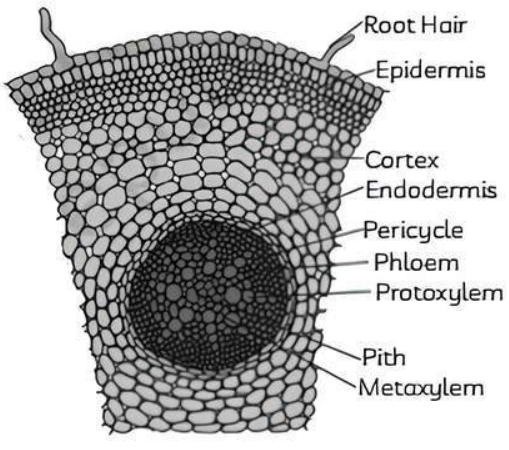
(2) **Cortex:** It is a wide region and made up of thin-walled parenchyma cells that enclose intercellular spaces for exchange of gases. It stores food. In older roots, the cortex becomes thick-walled and suberised. This is called exodermis which acts as a protective layer and to some extent absorbtive in function.

(3) **Endodermis:** It is the inner layer of cortex which is made up of a single layer and consists of barrel-shaped thick-walled cells which do not possess intercellular spaces. The young endodermal cells possess an internal strip of suberin and lignin which are generally known as Casparian strips. The cells of endodermis, lying opposite to protoxylem, are thin-walled and are called passage cells which help in conduction of fluids.

(4) **Pericycle:** It is found below the endodermis. It is single-layered and has thin-walled cells. In monocots, the pericycle does not form cambium. It only produces lateral roots. The pericycle is composed of thin-walled parenchymatous cells in the young root. But later on, it becomes thick-walled in many monocots.

(5) **Vascular bundle:** It is in the form of alternate and radial xylem and phloem bundle. The vascular bundles are arranged in the form of a ring around a central pith. The xylem bundles are exarch, *i.e.* protoxylem lies outward while metaxylem faces inward. The number of xylem bundles is more than six. Hence, it is called polyarch condition. Phloem bundles alternate with xylem bundles and is separated from each other by conjunctive tissue.

(6) **Pith:** It is large in monocots and made up of parenchymatous cells having intercellular spaces and food is stored in pith cells.



T.S. of Monocot Root

Differences between Dicot and Monocot Roots:

S. No.	Dicot Root	Monocot Root
(1)	The epiblema, the cortex and even the endodermis are peeled off and replaced by cork.	Cork is not formed. The cortex and the endodermis persist. Only the epiblema is peeled off.
(2)	Endodermis is less thickened and Casparian strips are more prominent.	Casparian strips are visible only in the younger root. The endodermal cells later become highly thickened.
(3)	Pericycle produces lateral roots, cork cambium and part of the vascular cambium.	Pericycle produces lateral roots only.
(4)	The number of xylem and phloem bundles varies from 2-5 or sometimes 80.	Xylem and phloem bundles are numerous and are 8 or more in number.
(5)	Xylem vessels are generally angular.	Xylem vessels are oval and round in shape.
(6)	Conjunctive tissue is parenchymatous.	Conjunctive tissue may be parenchymatous or sclerenchymatous.
(7)	Conjunctive parenchyma forms the cambium.	Conjunctive parenchyma does not produce cambium.
(8)	Pith is either absent or very small.	A well-developed pith is present in the centre of the root.

Example 2.1: Cut a transverse section of the 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 a dicot stem? Give reasons. [NCERT]

Ans. During observation of a cross-section of young stem, if it shows the following details it belongs to dicot stem:

(1) Internally, the stem is differentiated into epidermis, cortex, pericycle, vascular bundles and pith.

(2) Hypodermis, if present, is made up of collenchymatous cells.

(3) Below hypodermis, the cortical layer is made up of parenchymatous cells.

(4) The innermost layer of cortex *i.e.* endodermis is rich in starch grains called starch sheath.

(5) Vascular bundles are arranged in a ring and are conjoint, open due to the presence of cambium in between the xylem and phloem.

If the following details are seen, then it belongs to monocots:

(1) The stem is not differentiated into cortex and pith.

(2) Hypodermis if present is Sclerenchymatous.

(3) Vascular bundles are scattered, closed and have a bundle sheath.

(4) Peripheral vascular bundles are generally smaller than central ones.

(5) Water-containing cavities present within the vascular bundles.

Dicotyledonous Stem

Dicotyledonous stem shows the following structure from outside to inside:

(1) Epidermis: It is the outermost layer of the stem, made up of compactly arranged parenchymatous cells. The outer walls of cells possess cuticles whereas the inner walls of the epidermal cells are thin. The epidermis contains minute pores called stomata in the young stem which help in exchange of gases. Epidermal cells have no chloroplast. The tissue between the epidermis and pericycle is called Cortex.

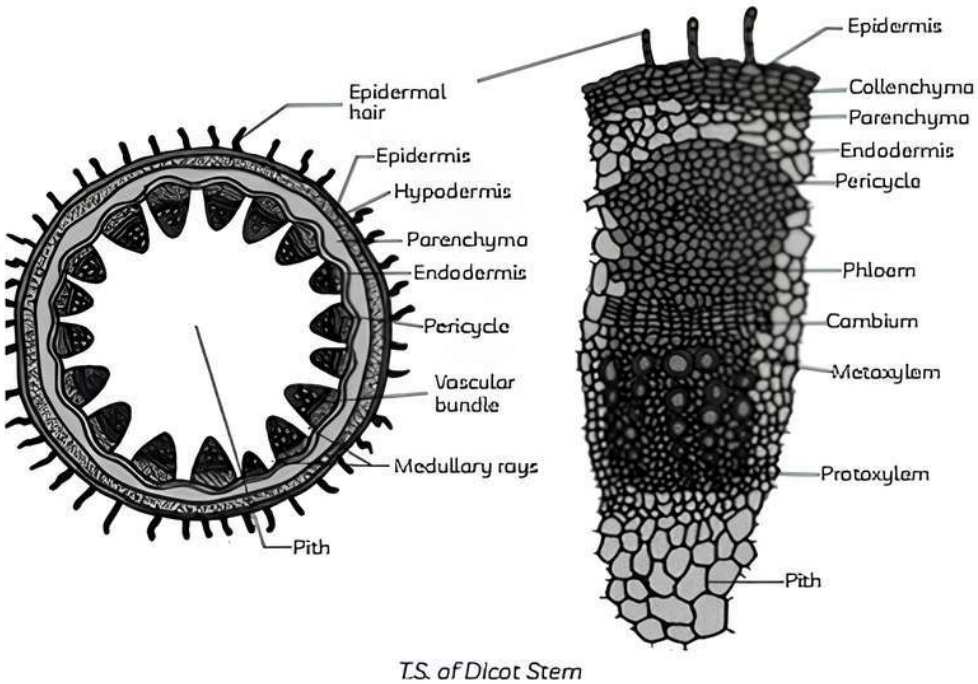
(2) Cortex: The epidermis is followed by a few to several layered thick cells made up of thin-walled parenchymatous cells and having intercellular spaces. Cortex below the hypodermis is made up of thin-walled parenchymatous cells with conspicuous intercellular spaces. Its main function is the storage of food.

(3) Endodermis: It is the innermost layer of the cortex made up of barrel-shaped cells which do not enclose intercellular spaces. It is a wavy layer of one cell in thickness. It contains starch grains as a food reserve and lacks Casparian strips. Due to the presence of starch grains in these cells, this is called Starch sheath.

(4) Pericycle: It is a layer which is found between the endodermis and vascular bundle. It is made up of sclerenchymatous cells as well as parenchymatous cells. It has alternating patches of thick-walled and thin-walled cells. It lies outside of the vascular bundle and thick-walled patches associated with the phloem part of the vascular bundle and thin-walled patches usually occur above the medullary rays. The sclerenchymatous cells of the pericycle provide mechanical strength while the parenchymatous stores food. As the bundle caps are associated with phloem part of vascular bundles, the sclerenchymatous pericycle is also called hard blast.

(5) Vascular bundles: The vascular strand is in the form of a eustele or a ring of vascular bundle present around the central pith and inner to the pericycle. Each vascular bundle is conjoint *i.e.*, xylem and phloem both are present in the same radius. The phloem to the outside, xylem towards the inner side and strip of cambium in between the two so it is open. The xylem is endarch *i.e.*, the protoxylem lies towards the pith and metaxylem towards periphery.

(6) Pith: It forms the centre of the stem and is made up of rounded parenchymatous cells which enclose intercellular spaces. These cells store food.



T.S. of Dicot Stem

Monocotyledonous Stem

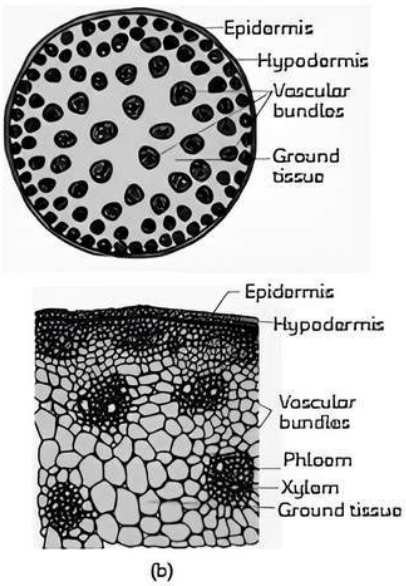
A monocot stem lacks secondary growth. Therefore, possesses only the primary permanent tissues. The various tissues, unlike a dicot stem, are not arranged in concentric rings. The solid stem can be seen in plants like *Zea mays*, *Asparagus* or fistular stem can be seen in grass (they have a central cavity). Monocotyledonous stems possess the following tissues from periphery to centre:

(1) **Epidermis:** It is the outermost single-layered protective coverings made up of living parenchymatous cells. The outer walls of epidermal cells possess deposition of silica and cutin. It is highly cutinized to prevent water loss through evaporation. Silica provides stiffness. Hairs are generally absent. At places, the epidermis possesses stomata for gaseous exchange.

(2) **Hypodermis:** It is 2-3 layered thick and generally lies below the epidermis. It is made up of sclerenchymatous cells which have lignified cell walls. It provides mechanical strength to stem.

(3) **Ground tissue:** This layer does not show distinction into cortex, endodermis, pericycle, pith and pith rays. It is made up of parenchymatous cells. The ground tissue stores food. Some of the outer cells may also synthesise food due to the presence of chloroplast (chlorenchymatous cells).

(4) **Vascular bundles:** The vascular bundles are numerous lies scattered throughout the ground tissue. The vascular bundles are rounded in which phloem lies towards the outside and xylem on the inner side. Cambium is absent so the vascular bundles are conjoint and closed. Xylem is the endarch, *i.e.* protoxylem towards the centre and metaxylem towards the periphery. Phloem consists of sieve tubes and companion cells. The phloem parenchyma is absent.



(b)

T.S. of Monocot Stem

Differences between Dicot and Monocot Stems:

S. No.	Dicot Stem	Monocot Stem
(1)	Stomata have kidney-shaped guard cells.	Stomata usually possess dumb-bell shaped guard cells.
(2)	The hypodermis is made up of collenchyma which may be green.	The hypodermis is formed of non-green sclerenchyma fibres.
(3)	The ground tissue is differentiated into cortex, endodermis, pericycle, pith, etc.	The ground tissue is a mass of similar cells.
(4)	The stem is always solid.	The stem is generally hollow in centre.
(5)	The vascular bundles are arranged in ring around the pitch.	The vascular bundles are scattered throughout the ground tissue.
(6)	Medullary rays occur in between vascular bundles for radial conduction.	Medullary rays are absent.
(7)	The vascular bundles are wedge-shaped in outline.	They are oval or round in outline.
(8)	The vascular bundles are open due to the presence of cambium in between phloem and xylem.	The vascular bundles are closed.
(9)	The stem shows secondary growth due to the formation of secondary vascular tissue and periderm.	Secondary growth is usually absent.

Dorsiventral (Dicotyledonous) Leaf

Most of the dicotyledonous leaves are dorsiventral.

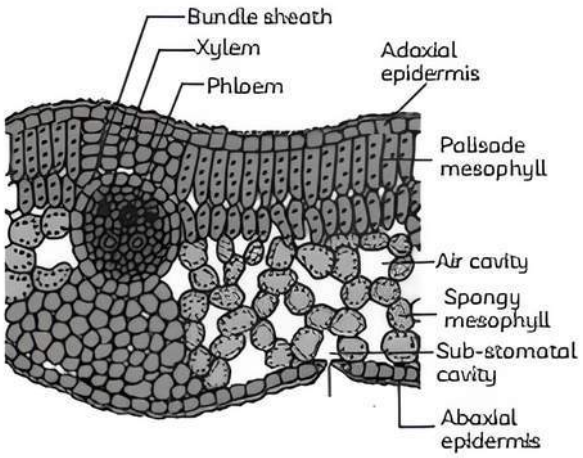
Dorsiventral (Bifacial): The leaves are commonly horizontal in orientation with distinct upper and lower surfaces. The upper surface is also called inner, adaxial or ventral surface. The lower surface is correspondingly called outer, adaxial or dorsal surface. Mesophyll is distinct as a palisade or spongy tissue with a palisade usually restricted to the upper side.

They show three distinct parts:

(1) **Epidermis:** The leaf contains an upper surface called adaxial and a lower surface called abaxial. They are made up of a single layer of parenchymatous cells which generally lack chloroplast. The outer walls are cutinised which prevents excessive transpiration. The abaxial epidermis contains more stomata as compared to adaxial epidermis. The main function of epidermis is to provide protection of internal tissue and exchange of gases.

(2) **Mesophyll:** The tissue lying between the adaxial and abaxial epidermis which contains vein, chlorenchymatous. It is made up of parenchymatous cells containing a large number of chloroplasts and having intercellular spaces. Mesophyll differentiated into two parts—Palisade parenchyma and Spongy parenchyma. The palisade lies below the upper epidermis and consists of elongated columnar cells which are arranged vertically and parallel to each other and have narrow intercellular spaces for exchange of gases. These are the main sites of photosynthesis because they are rich in discoid chloroplast. The Spongy parenchyma lies between the lower epidermis and palisade parenchyma and are oval and rounded. They are loosely arranged and have large intercellular spaces; they contain less chloroplast than in palisades.

(3) **Vascular system:** It contains a large number of vascular bundles. It lies at the boundary between the palisade and the spongy region and is seen in veins and midrib. Vascular bundles of varying sizes depending upon the venation. The vascular bundle is surrounded by sheaths of compactly arranged parenchyma cells called bundle sheaths. The vascular bundles are conjoint and collateral. Xylem lies towards the upper side and phloem towards the lower side. The main function of vascular bundle is conduction.



T.S. of Dicot Leaf

Important

➥ *Dorsiventral leaves orient themselves at an angle to the main axis and perpendicular to the direction of sunlight. Most dicots have dorsiventral leaves that are net-veined, including bushes and most trees.*

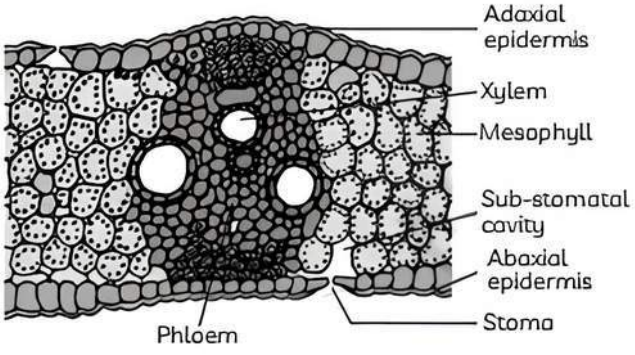
Isobilateral (Monocotyledonous) Leaf

The isobilateral monocot leaves usually do not show a distinction between petiole and lamina. The leaf base is commonly sheathing, that is, covering the stem partially or completely. The venation is parallel. Both surfaces are equally green. Most of the monocotyledonous leaves are isobilateral. The internal structure also does not show much differentiation between the upper and lower side. They also possess three main parts:

(1) **Epidermis:** The epidermis consists of compactly arranged parenchymatous cells that are cutinised. The stomata are present on both the upper side and lower sides of the epidermis. The upper epidermis contains groups of larger thin-walled cells over the region of vein called bulliform or motor cells. These are highly vacuolated and colourless. In water deficiency conditions, the bulliform cells lose water and become flaccid as a result the leaf gets rolled up to reduce the surface for exposure. These cells play an important role in the unrolling of leaves. The main functions of epidermis are protection and gaseous exchange.

(2) **Mesophyll:** It is present in between the two layers of epidermis. They are isobilateral, enclose intercellular space and contain a large number of chloroplasts which help in photosynthesis. Mesophylls of monocot leaves are not differentiated into palisade and spongy tissues.

(3) **Vascular system:** The monocot leaves possess parallel venation. Vascular bundle is surrounded by a single sheath of compactly arranged parenchymatous cells called bundle sheath. The vascular bundles are conjoint. Xylem lies towards the upper side and phloem lies towards the lower side. Its main function is transporting materials.



T.S. of Monocot Leaf

Differences between Dicot (Dorsiventral) and Monocot (Isobilateral) Leaves:

S. No.	Dicot (Dorsiventral) Leaf	Monocot (Isobilateral) Leaf
(1)	The upper surface is dark green while the lower surface is light green.	The two surfaces are equally green.
(2)	Silica is not normally deposited on the epidermal cells.	Silica deposition occurs on the walls of epidermal cells.
(3)	Stomata are absent or less abundant on the upper side.	The stomata are equally distributed on the two sides.
(4)	The stomata have kidney-shaped guard cells.	The stomata have dumb-bell shaped guard cells.
(5)	The veins do not run parallel. Instead, they form reticulation.	The veins run parallel to one another.
(6)	Mesophyll is differentiated into two parts, upper palisade and lower spongy.	Mesophyll is undifferentiated.
(7)	Protoxylem is indistinguishable.	Larger vascular bundles may show distinction into protoxylem and metaxylem.
(8)	Bundle sheath is generally a single layer and is formed of colourless cells.	Bundle sheath may be single or double-layered. The cell generally possess chloroplast.
(9)	Hypodermis of the midrib region is collenchymatous.	Hypodermis of the midrib region is sclerenchymatous.

Example 2.2: Case Based:

Ground tissue system includes all the tissues of the plant body except epidermal tissue system and vascular tissue system. It consists of simple permanent tissues like Parenchyma, collenchyma and sclerenchyma. The ground tissue system of leaves is called mesophyll. Mesophyll is made up of two types of photosynthetic cells, palisade and spongy. Palisade parenchyma occurs towards the upper surface. It is formed of columnar cells. Abundant chloroplast occurs in these cells. Intercellular spaces are quite narrow. Spongy parenchyma occurs towards the lower epidermis and encloses large intercellular spaces. Its cells are rounded, isodiametric, angular or lobed. They contain a good number of chloroplasts.

(A) Largest number of chloroplast found in:
- **(a) Palisade tissue**
- **(b) Spongy tissue**
- **(c) Transfusion tissue**
- **(d) Bundle sheath cells.**

(B) Casparian thickenings are found in the cells of
- **(a) Pericycle of the root**
- **(b) Endodermis of the roots**
- **(c) Pericycle of the stem**
- **(d) Endodermis of the stem**

(C) Collenchyma plays a major role in plant body. Explain.

(D) Give one basic difference between endodermis and epidermis.

(E) Assertion (A): **The innermost distinct layer of the cortex is called endodermis.**

Reason (R): **The cells of endodermis are non-living and bear Casparian strips.**
- **(a) Both A and R are true and R is the correct explanation of A.**
- **(b) Both A and R are true and R is not the correct explanation of A.**
- **(c) A is true but R is false.**
- **(d) A is false but R is true.**

Ans. (A) *(a) Palisade tissue*

Explanation: Mesophyll is differentiated into upper palisade and lower spongy parenchyma. This palisade found below the upper epidermis and rich in chloroplasts are arranged in 2 to 3 layered, with compactly arranged tubular cells while in other tissues the chloroplasts are few.

(B) *(b) Endodermis of the roots*

Explanation: The cells of endodermis of roots are characterised to possess Casparian strips or bands in their radial and transverse walls. These strips are made up of waxy substances like suberin and lignin whereas pericycle is made up of sclerenchymatous cells and thin-walled parenchymatous cells.

(C) Collenchyma is the chief supporting tissue in young stems. This tissue has capacity to expand and gives tensile strength to the plant body.

(D) Cells of endodermis possess Casparian strips or bands in their radial and transverse walls whereas epidermal cells do not possess Casparian strips.

(E) *(c) A is true but R is false.*

Explanation: The innermost layer of the cortexes called endodermis but endodermis is a single layer of compactly arranged parenchymatous cells present between the cortex and pericycle without intercellular spaces and possess Casparian strips made up of waxy substance like suberin.

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. What is the main function of lenticels?

(a) Guttation **(b) Transpiration**

(c) Excretion **(d) Gaseous exchange**

[NCERT Exemplar]

Ans. *(d) Gaseous exchange*

Explanation: Lenticels are the pores present in the bark of the tree. They are oval and rounded facilitating gaseous exchange while guttation is the loss of water in the form of liquid droplets (Water + minerals) from the leaf margin and tips through a special opening called hydathodes. Transpiration is the loss of water from leaves through stomata in the form of water vapour.

2. In dicot stem, vascular bundles are:

(a) scattered

(b) arranged in a ring

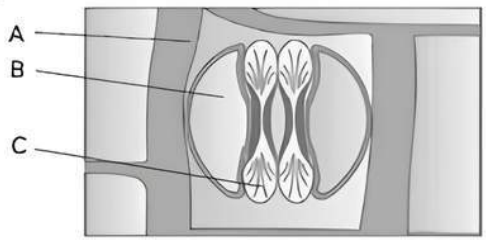
(c) surrounded by bundle sheath

(d) without cambium

Ans. *(b) arranged in a ring*

Explanation: In dicot stem, the vascular bundles are arranged in a ring around the central pith while the vascular bundle in monocot stem are scattered throughout the ground tissue, without cambium and are surrounded by a bundle sheath.

3. The given diagram shows the stomatal apparatus in dicots and monocots.



Which one is the correct option for A, B and C?

(a) A - Epidermal cells; B - Subsidiary cells; C - chloroplast

(b) A - Guard cells; B - Subsidiary cells; C - Stomatal pore

(c) A - Guard cells; B - Epidermal cells; C - Guard cells

(d) A - Epidermal cells; B - Subsidiary cells; C - Guard cells

Ans. *(d) A - Epidermal cells; B - Subsidiary cells; C - Guard cells*

Explanation: Stomata are tiny pores, and composed of two bean-shaped epidermal cells called guard cells which enclose stomatal pore. Stomata are mostly present in epidermal layers of leaves and in other aerial parts like young stems, floral parts, etc. Guard cells in dicots are kidney-shaped and in monocots are dumb-bell shaped. The guard cells may be surrounded by a varying number of specialised epidermal cells called subsidiary cells or accessory cells.

4. When the vascular bundle is open:

(a) Cambium is present on the terminal side of xylem.

(b) Cambium is present between xylem and phloem.

(c) No cambium is present between xylem and phloem.

(d) Cambium is present on the terminal side of phloem. **[Diksha]**

Ans. *(b) Cambium is present between xylem and phloem.*

Explanation: When a vascular bundle is open, the cambium is present between the xylem and phloem and when vascular bundles are closed, the cambium is absent between the xylem and phloem. In this, phloem lies towards the outside and xylem on the inner side.

Caution

➥ *Students usually get confused with the positions of xylem and phloem as the positions vary in different conditions.*

5. Phellogen and phellem respectively denote:

(a) Cork and cork cambium

(b) Cork cambium and cork

(c) Secondary cortex and cork

(d) Cork and secondary cortex

[NCERT Exemplar]

Ans. *(b) Cork cambium and cork*

Explanation: In dicot stem, cork cambium is produced by the outer cortical cells called phellogen. Phellogen produces cork called phellem on the outer side.

Related Theory

➥ *Phellogen cells divide on both the outer side as well as the inner side to form secondary tissue. The tissue produced on the inner side of phellogen is called phelloderm which shows radial arrangement and the tissue produced on the outer side is called Phellem or cork which are dead and possess suberised cell walls.*

6. **Vascular bundle in which the protoxylem is situated towards periphery is called:**

(a) Radial (b) Closed

(c) Endarch (d) Exarch

Ans. *(d) Exarch*

Explanation: The vascular bundles are arranged in the form of a ring around the pith. In monocot root the xylem is Exarch *i.e.* protoxylem lies towards the outer side while the metaxylem faces inward. In endarch, protoxylem occurs towards the centre while metaxylem towards the periphery.

7. **A conjoint and open- vascular bundle will be observed in the transverse section of:**

(a) Monocot root (b) Monocot stem

(c) Dicot root (d) Dicot stem

Ans. *(d) Dicot stem*

Explanation: In dicot stem, vascular bundles are conjoint, collateral, open, and endarch while in monocot stem vascular bundles are conjoint, collateral but closed.

8. **Which cells of leaf are highly vacuolated and can store water, if available, but in case of water deficiency it becomes flaccid?**

(a) Bulliform cells

(b) Chlorenchymatous cells

(c) Guard cells

(d) None of the above

Ans. *(a) Bulliform cells*

Explanation: Bulliform are the thin-walled cells found in adaxial epidermis of monocot leaf and can store water. While chlorenchymatous cells contain chloroplast and help in photosynthesis and guard cells regulate the opening and closing of stomata.

Related Theory

Bulliform cells are also called motor cells. During stress conditions, these cells can roll leaves and reduce the exposed surface to avoid water loss through transpiration. They are also useful in unrolling leaves during their development.

Assertion-Reason (A-R)

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

9. **Assertion (A):** **Casparian strips runs along the endodermis radial and tangential walls.**

Reason (R): **Casparian strips prevent plasmolysis of endodermal cells.**

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: The endodermal cells possess a band of thickening which runs along their radial and tangential walls. It is made up of lignin and suberin. It prevents plasmolysis of endodermal cells.

Caution

Students should know that due to the Casparian strips, the endodermal cells do not allow wall to wall movement of substance between cortex and pericycle.

10. **Assertion (A):** **Xylem is exarch in stem and endarch in roots.**

Reason (R): **Exarch of xylem facilitates inflow of water from cortex and endarch favours ascent of sap.**

Ans. *(d) A is false but R is true.*

Explanation: In stem, the xylem is endarch, *i.e.* protoxylem lies at the tip of the metaxylem. It helps in lateral conduction of the sap whereas in roots, the xylem is exarch, *i.e.* protoxylem lies in contact with the pericycle and metaxylem is present towards the pith (centre). It helps in conduction of water and minerals to the shoot from the cortex.

11. **Assertion (A):** **Palm is a monocotyledonous plant but shows secondary growth.**

Reason (R): **Presence of parenchymatous cells in the ground tissues.**

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: Palm is a monocotyledonous plant. It shows enlargement of parenchymatous cells that are present in the ground tissues causing an increase in the girth of the stem.

12. **The cambium is most active in the spring and early summer when most tree growth is taking place. During this time of the year, the bark of a tree is very loose and can be easily knocked off the tree. Inside the vascular, cambium is the largest portion of the trunk known as the xylem.**

Assertion (A): **Cambium is present in monocot stem.**

Reason (R): **The vascular bundles are in the form of atactostele.**

Ans. *(d) A is false but R is true.*

Explanation: Cambium is absent in most of the monocots and the whole procambium is consumed in the formation of vascular tissues. The vascular strands are in the form of atactostele where a large number of vascular bundles lie scattered throughout the ground tissue.

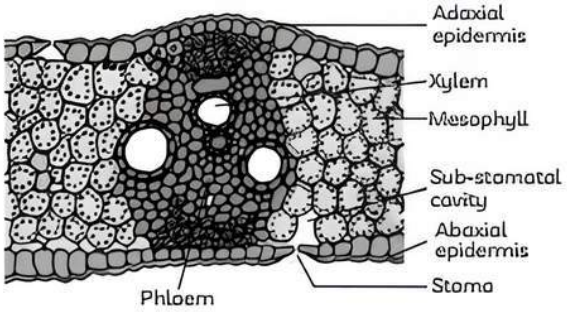
CASE BASED Questions (CBQs)

[**4** & **5** marks]

Read the following passages and answer the questions that follow:

13. *There are a lot of different types of cells inside a plant that are specialised for carrying out different vital life functions, one of the types is parenchyma. Parenchyma refers to a bulk or a cluster of cells. In plants, it is defined as a tissue that is composed of living cells with very thin cell walls. Parenchyma cells make up the non-woody interior structure of many plants. They can be found in stems, roots and leaves as they form the cortex of these structures.*

Observe the diagram carefully and answer the following questions.



(A) A distinct layer lies on the upper epidermis prevents excessive transpiration is:

(a) Guard cells **(b) Cuticle**

(c) Mesophyll **(d) Bundle sheath**

(B) The spongy parenchyma lies:

(a) between the upper epidermis and lower epidermis

(b) below the vascular bundles

(c) between the lower epidermis and palisade parenchyma

(d) below the upper epidermis

(C) The leaf which is distinct into upper and lower surfaces and mesophyll are distinguishable is:

(a) Dorsiventral **(b) Isobilateral**

(c) Unifacial **(d) All of these**

(D) Identify the simple tissue system from the following.

(a) Parenchyma **(b) Xylem**

(c) Epidermis **(d) Phloem**

(E) Bulliform or motor cells are present in:

(a) In both adaxial and abaxial epidermal cells of a dicot.

(b) In some adaxial epidermal cells of grasses.

(c) In adaxial epidermal of dicot leaves.

(d) None of the above

Ans. (A) *(b) Cuticle*

Explanation: A distinct layer of cuticle lies outside of the epidermis which prevents excessive transpiration. While guard cells are present in abaxial epidermis, mesophyll is between the upper and lower epidermis and vascular bundle is surrounded by bundle sheath.

(B) *(c) between the lower epidermis and palisade parenchyma*

Explanation: The spongy parenchyma lies between the lower epidermis and the palisade parenchyma while palisade parenchyma lies below the upper epidermis.

(C) *(a) Dorsiventral*

Explanation: Dorsiventral leaf is distinct into upper and lower surfaces and mesophyll is distinguishable into palisade and spongy tissues while Isobilateral and unifacial leaves are not distinct into upper and lower surfaces.

(D) *(a) Parenchyma*

Explanation: Parenchyma is a simple tissue. It is made up of only one type of cells whereas xylem, epidermis and phloem are

complex tissues. They are made up of more than one type of cell.

(E) *(b) In some adaxial epidermal cells of grasses.*

Explanation: Bulliform cells are present in some adaxial epidermal cells of grasses. They are highly vacuolated and can store water in case of stress.

14. *Epiblema is the outermost layer of the root and are compactly arranged thin-walled parenchymatous cells. Epiblema gives rise to thin-walled tubular outgrowth called root hairs. Root hairs possess a gummy pectic layer on the outside for cementing with soil particles and retaining water on the surface due to the presence of root hairs, it is a porous layer. Root hairs commonly do not live for more than one week. With their death, the epiblema cells become suberised and cutinized. Cortex lies below the epidermis made up of thin-walled parenchyma cells. Innermost layer of cortex, endodermis is made up of a single layer of barrel-shaped cells and does not enclose intercellular spaces.*

(A) From where do the lateral roots originate?

(B) Write one function of root hairs present in epiblema cells.

(C) Why endodermis function as a biological check post?

Ans. (A) Pericycle of mature zone.

(B) Root hairs take part in absorption of water and mineral salts from the soil.

(C) Endodermis act as a biological check post because of the Casparian strip, the endodermal cells do not allow wall to wall movement of substances between the cortex and pericycle. Substances must enter the cytoplasm of endodermal cells.

VERY SHORT ANSWER Type Questions (VSA)

[**1** mark]

15. What is the function of medullary rays?

Ans. Medullary rays help in the conduction of food and water radially and also transport gasses from pith to cortex and vice versa

16. When do you refer to a vascular bundle as an open bundle?

Ans. A vascular bundle having cambium is termed as open vascular bundle.

17. Which one out of the root or stem shows endarch arrangement of xylem?

Ans. Endarch arrangement of xylem is found in the stem.

18. What is present on the surface of the leaves which helps the plant prevent loss of water but is absent in roots? [NCERT Exemplar]

Ans. Cuticle is present on the surface of the leaves which helps the plant in prevention of loss of water but is absent in roots.

Related Theory

Plant which does not contain cuticle would require a far larger water supply to compensate for evaporation which is necessary to complete photosynthesis.

19. Where is the Casparian strip present? [Diksha]

Ans. Casparian strip present on the tangential and radial wall of endodermal cells.

SHORT ANSWER Type-I Questions (SA-I)

[**2** marks]

20. Why are a large number of stomata present at the lower surface of dicot leaves in the terrestrial plants?

Ans. Dicotyledonous leaves are dorsiventral. Stomata are small openings present on leaf surfaces to facilitate gaseous exchange. During the gaseous exchange, a large quantity of water in the form of water vapour will be lost by the transpiration process. Stomata open during daytime in the presence of sunlight. If the stomata are located on the upper surface of the leaf, there is a big loss of water. So, to reduce water loss, stomata are located on the lower surface of the leaf in a dicotyledonous plant.

21. A student took a young stem of a plant from his school garden and cut a transverse portion for the experiment. How would he determine if the stem is a monocot stem or a dicot stem after looking at it under the microscope?

Ans. By observing the arrangements of vascular bundles, the student can discover the nature of stem. If the vascular bundles are arranged in a ring then it is a dicot stem and if the vascular bundles are scattered, then it is a monocot stem.

22. A tissue was provided to a student to examine in the school laboratory. He examines the tissue and comes to the conclusion that it is a form of simple plant tissue that supports young stems and leaf petioles mechanically. Identify the tissue.

Ans. Dicotyledonous plants have collenchyma, a form of simple tissue, in the layers under the epidermis. It serves as support, particularly in areas of primary growth, and is made up of live, typically elongated cells with unevenly thickened walls (caused by the deposition of cellulose, hemicellulose, and pectin). The juvenile stem and leaf petiole, two growing plant components, are supported mechanically by this tissue.

23. Why do vascular strands have xylem and phloem show radial arrangement in roots?

Ans. The vascular strand is so arranged in roots that no phloem lies exterior to xylem strands. This arrangement is helpful in maintaining the inward movement of water from the epidermis to enter the xylem without crossing the phloem strand, where a separate kind of conduction is taking place.

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

24. What is the difference between lenticels and stomata? [NCERT Exemplar]

Ans. Instead of cork cells, the phellogen breaks off tightly packed parenchymatous cells on the outer surface in some areas. These parenchymatous cells quickly break the epidermis, generating lenticels, which are lens-shaped holes.

Lenticels allow gaseous exchange between the outside atmosphere and the stem's internal tissue. Most woody trees have these. Lenticles are open all the time.

The epidermis of leaves has structures called stomata. The process of transpiration and gaseous exchange is regulated by stomata. Each stoma is made up of two bean-shaped cells called guard cells that surround the stomata pore. The guard cells in grasses are dumb-bell shaped. Guard cells have thin outer walls (away from the stomatal pore) and thicker inner walls (towards the stomatal pore). The guard cells possess chloroplasts and regulate opening and closing of stomata.

25. There are two types of vascular bundles, *i.e.* open and closed. How will you differentiate between them?

Ans.

S. No.	Open vascular bundle	Closed vascular bundle
(1)	Open vascular bundle possess a strip of cambium in between xylem and phloem.	Cambium is absent in the closed vascular bundle.
(2)	It shows secondary growth due to which primary xylem and phloem separate apart.	Closed vascular bundles do not exhibit the secondary growth.
(3)	They are generally collateral and bicollateral.	Closed vascular bundles are generally collateral or concentric.
(4)	It is the feature of gymnosperm and dicot.	It is the feature of leaves and monocot stems.

26. Differentiate between the monocot and dicot roots.

Ans.

S. No.	Dicot root	Monocot root
(1)	Cortex is simple and narrow and is made up of parenchymatous cells.	Cortex is well-developed, wide and made up of one or more type of cells.

(2)	Endodermis is less thickened and Casparian are more prominent.	Casparian strips are visible in young root and later cell become highly thickened.
(3)	2-4 xylem and phloem patches are present (diarch or tetarch).	More than six xylem bundles (polyarch) are present.
(4)	Conjunctive parenchyma forms the cambium and secondary growth takes place.	Conjunctive parenchyma does not produce cambium and there is no secondary growth.
(5)	Pith is either absent or very small.	A well-developed pith is present in the centre of root.

LONG ANSWER Type Questions (LA)

[**4** & **5** marks]

27. Give the function of each of the following:
(A) Epidermal tissue system
(B) Lenticels
(C) Companion cells
(D) Hypodermis
(E) Pith

Ans. (A) Epidermal tissue system contains Epidermis and Epidermal appendages. Epidermis is protective in nature. Epidermis of stem and leaf is cutinised to prevent water loss. Root epidermis bears root hairs for water absorption while trichomes present in stem epidermis help in preventing water loss.

(B) Lenticels are the chief aerating structure in the periderm of the stem and are responsible for performing gaseous exchange between the internal tissues and atmosphere.

⚠ Caution

Students often get confused between the functions of stomata and lenticels. They must understand that the major difference between stomata and lenticels is that stomata mainly occurs in the lower epidermis of leaves whereas lenticels occur in the periderm of the woody trunk or stems.

(C) The companion cells are the component of phloem and occur along with the sieve tubes. They assist the sieve tubes in the process of translocation of food synthesized by leaves. They help in maintaining a proper pressure gradient in the sieve tube elements.

(D) Epidermis is followed by a few layers of sclerenchymatous hypodermis having lignified cell walls and provide mechanical strength to stem.

(E) Pith is the central portion of the stem occupied by large thin-walled parenchymatous cells. Its main function is transportation of nutrients throughout the plant and storage of nutrients within its cells.

28. Shyam wants to grow some monocot crops in his field. But as he is a farmer he does not know much about such crops and he might mix up monocots with dicot crops. Give some points of distinction between the monocot and dicot stem for his knowledge.

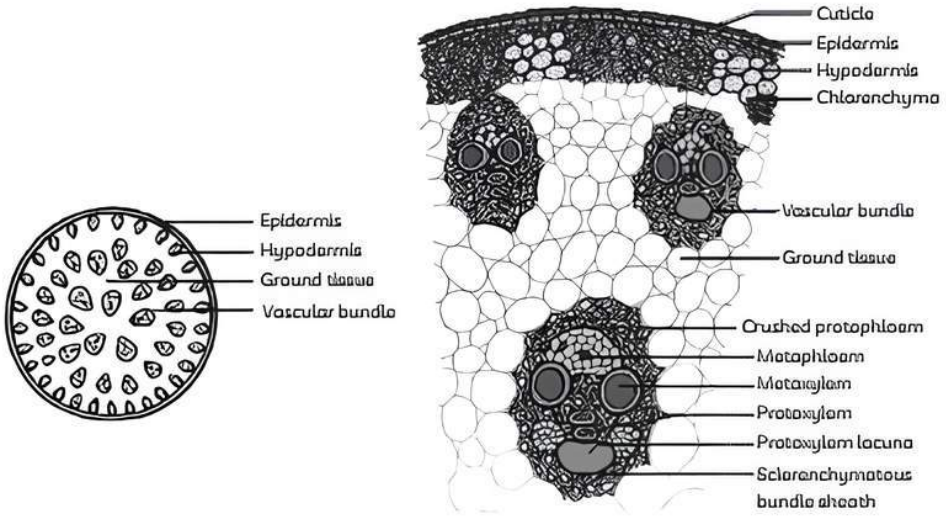
Ans.

Characteristics	Monocot Stem	Dicot Stem
Definition	Monocot stems are circular-shaped stems with lateral branches and are bounded with a layer of the dermis.	Dicot stems have a well-defined epidermis with a cuticle, a layer of dermis along with multicellular stem hair.
Vascular bundles arrangement	The vascular bundles are scattered irregularly around the ground tissue.	The vascular bundles are formed as broken rings.
Epidermal hair	Epidermal hairs are present.	Epidermal hairs may or may not be present on the surface of epidermis.
Hypodermis	The hypodermis is made of sclerenchyma fibres, and they are not green.	The hypodermis is formed of collenchyma fibres which are often green in colour.

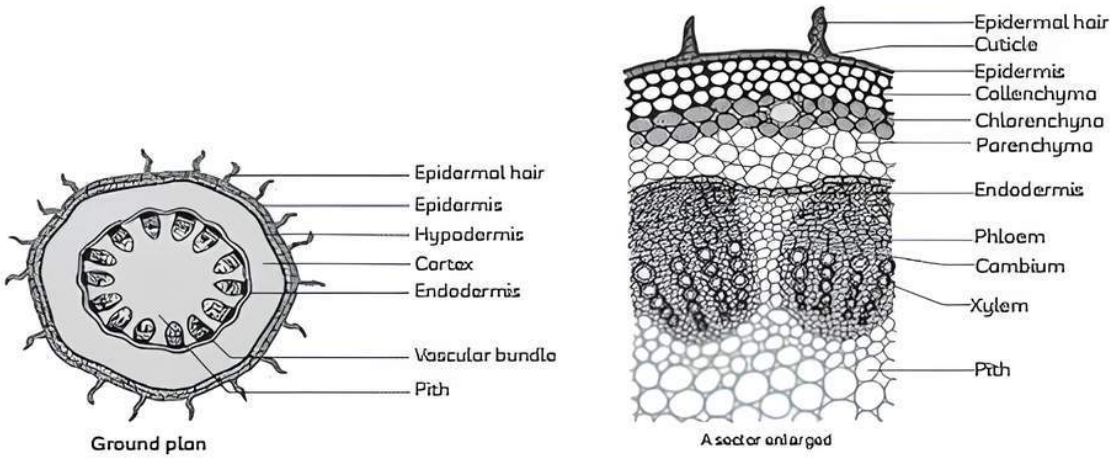
Internodes	The internodes of the monocot stem are hollow.	The internodes of the dicot stem are solid.
Trichomes	Trichomes are not present.	It may bear trichomes on the surface.
Internal tissues arrangement	There is no concentric arrangement of tissues.	The internal tissues are arranged in concentric layers.
Vessels	Vessels are rounded or oval and are arranged in a Y-shaped formation.	Vessels are of a polygonal shape and are arranged in rows or chains.
Cortex	The cortex of the monocot stem is less developed and is represented by the hypodermis.	The cortex of the dicot stem is well developed and differentiated into hypodermis, endodermis, and general cortex.
Pericycle	Pericycle in monocot stem is reduced or completely absent.	Pericycle in dicot stem is present in either completely or partially sclerenchymatous.

29. **Represent monocot and dicot stem diagrammatically.**

Ans.



Transverse Section of Monocot Stem



Transverse Section of Dicot Stem