ANATOMY OF FLOWERING PLANTS

ANATOMY OF DICOTYLEDONOUS AND MONOCOTYLEDONOUS PLANTS

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Internal structure of dicotyledon root:

Internal structure of a dicotyledon root shows following features

- 1. Epiblema (Rhizodermis or Piliferous layer):
- It is outermost layer having tubular living components.
- Cuticle and stomata are absent.
- Unicellular root hairs are formed by the elongation of some cells of it in maturation zone of root.
- These hairs perform absorption of water from the soil.

2. Cortex:

• It is composed of thin walled parenchymatous cells. Its cell are circular or polygonal with intercellular spaces.

3. Endodermis:

- It is innermost single layer of cortex, without inter cellular spaces that lies between pericycle and cortex radial and tangential wall of endodermis bear **Casparian strips** (discovered by Caspari).
- These strips contain suberin. Casparian strips are absent in those cells of endodermis that lie at the front of protoxylem.
- These are called **passage cells** or transfusion cells that help in the passage of water from cortex to pericycle.

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- Passage cells provide path to absorbed water from cortex to pericycle.
- Intercellular spaces are absent between the cells of endodermis of root.
- Endodermis acts as a water tight jacket (Dam) which prevents leakage of water from stele.



- **4. Pericycle** :- It is a single or few layers of thick walled parenchymatous cells (It is composed of prosenchyma).
- Lateral roots usually originate from the part of pericycle which is lying opposite to protoxylem. Thus lateral roots are endogenous in origin.
 Note:
- (i) The branches of stems (vegetative branches) are exogenous in origin because they originate from extrastelar region.
- (ii) Adventitious roots are endogenous in origin because they originate from stelar region.

- 5. Vascular Burtdles :- Vascular bundles are radial and exarch. xylem and phloem are separate and equal in number. The number of xylem patches and phloem patches are usually two to four but they may be two to six (diarch to hexarch). Tetrarch condition is found in gram & sunflower.
- Parenchyma which is found between the xylem and phloem is called conjunctive tissue.
- In dicot root xylem vessels appear angular (polygonal/hexagonal) in T.S.
- 6. Pith :- In dicot root pith is small (less developed) or inconspicuous or absent.

INTERNAL STRUCTURE OF MONOCOTYLEDONOUS ROOT

- The internal structure of a typical monocotyledon root is similar to dicotyledon root except some differences which are as follows:-
- 1. Number of xylem bundles are usually more than six (polyarch) in monocotyledon root.
- 2. Pith is large and well developed in monocotyledon root
- 3. Xylem vessels appear circular or oval in T.S.
- 4. Monocotyledonous roots do not undergo any secondary growth.



Note : As the epiblema dies off (in old roots), a few outer layers of the cortex become suberized (mainly) or cutinized and form the exodermis. Exodermis is usually found in monocot roots.

Note : **Velamen** :-This spongy tissue is found in aerial roots or hanging roots of epiphytes (eg. Orchids-Vanda)

- It is an example of multilayered epidermis
- It absorbs atmospheric moisture by imbibition.

Differences between dicot root and monocot root			
S. No.	Dicot Root	Monocot Root	
1	Xylem is diarch to hexarch	Xylem is polyarch	
2	Pith is less developed or absent	Pith is well developed	
3	Cambium is formed and proceeds	Cambium absent (AIPMT-2015) and	
	secondary growth	secondary growth is absent	

Internal structure of dicot stem:

Internal structure of a dicot stem involves following features-

1. Epidermis:

- Epidermis is the outermost layer of the stem.
- It is single layered.
- Outer side of epidermis is surrounded by a layer called **cuticle** that is composed of cutin.
- Multicellular hairs and stomata are found on epidermis.
- 2. Cortex In dicotyledon stem cortex divided into three parts:
- (i) Hypodermis
- (ii) General cortex
- (iii) Endodermis

(i) Hypodermis:

- It lies just below the epidermis.
- It consists of collenchyma and Its cells possess extra cellulosic thickening in various regions.
- (a) On the tangential walls (lamellate collenchyma, e.g. Sunflower).
- (b) At the angles (angular collenchyma, e.g. Castor).
- (c) Near the small intercellular spaces. (lacunate collenchyma, e.g. Cucurbita). Collenchyma cells are green and enclose small intercellular spaces.

Its **functions** are - It **provides mechanical strength** as well as **flexibility**, **storage of food**, manufacture of food with the help of chloroplasts.

(ii) General Cortex :

- It consists of parenchyma. Resin canal/mucilage canal are present in it.
- These are schizogenous in origin.
- The main function of the cortex is storage of food.

(iii) Endodermis:

- It is single layered.
- Its cells are barrel shaped.
- Endodermal cells contain conspicuous starch grains as food reserve.
- Therefore, It is called **starch sheath**.
- **3. Pericycle** : Pericycle is situated below the endodermis. The pericycle of stem is multilayered. In sunflower stem, pericycle is made of alternate bands of parenchymatous and sclerenchymatous cells. The part of pericycle which is present infront of the vascular bundle is made up of sclerenchyma and remaining part is composed of parenchyma. Part of pericycle which is situated in front of vascular bundle is known as Bundle cap. In sunflower stem, pericycle is heterogenous in nature. Sclerenchymatous part of pericyle is also known as Hard bast.



Note :- Pericycle is present above the phloem in the form of semilunar patches of sclerechynia.

4. Vascular Bundles :- The wedge shaped vascular bundles are arranged in a ring. The ring arrangement of vascular bundles is a characteristic of dicot stem. Each vascular bundle is conjoint, collateral and open and xylem is endarch.



- **5. Pith :-** This is well developed region, present in the centre. The cells of this region are made up of parenchyma.
- **6. Medullary rays :** Radially arranged parenchymatous cells in between the vascular bundles, called pith rays or medullary rays. The main function of pith rays is radial conduction of food and water.



Internal structure of monocotyledon stem:

INTERNAL STRUCTURE OF CUCURBITA STEM :

- It contains five ridges and five furrows. The vascular bundles are arranged in two rings. Each ring has five vascular bundles. In this way the totallo vascular bundles are present.
- The vascular bundles of outer ring are small in size and situated below the ridges while the vascular bundles of inner ring are large in size and located below the furrows.
- Vascular bundles are conjoint, bicollateral and open and xylem is end arch. Outer cambium is functional.
- Hypodermis is mainly present in ridge region.
- General cortex is Chlorenchymatous.
- Pericycle is sclerenchymatous.

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1. Epidermis:

- It is outer most single celled thick layer covered by thick cuticle.
- Multicellular hairs are absent & stomata are also less.

2. Hypodermis:

- It consists of **sclerenchyma**.
- It is 2–3 layered.
- It provides mechanical support to plant.

3. Ground tissue:

- The entire mass of parenchyma cells next to hypodermis and extending to the centre is called ground tissue.
- Ground tissue is not differentiated into endodermis, cortex, pericycle etc.
- **4. Vascular Bundle** :- Many vascular bundles are found scattered in the ground tissue and V.B. are generally oval (egg shaped). Peripheral vascular bundles are generally smaller then the centrally located ones.
- Vascular bundles which are situated towards the centre are large in size and less in number.
- Vascular bundles which are situated towards the periphery are small in size but more in number.
- Each vascular bundle is conjoint, collateral and closed and xylem is endarch. Each vascular bundle is surrounded by sclerenchymatous bundle sheath, So vascular bundles are called fibro vascular bundles.
- Water containing cavities are present within the vascular bundles.
- (a) Xylem :- In xylem number of vessels is less. In metaxylem there occurs two large vessels while in protoxylem there occurs one or two small vessels. Vessels are arranged in the form of V or Y. Just beneath protoxylem vessels, there occurs a water cavity which is schizolysigenous in origin. In which major part of water cavity is lysigenous in origin (formed due to lysis of protoxylem elements) and few part of water cavity is schizogenous (formed by separation of cells).
- (b) Phloem :- It consists of sieve tube elements and companion cells. Phloem parenchyma is absent.

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- 5. Pith:
- Pith is undifferentiated in monocotyledon stems.
- Sometimes in some grasses, wheat etc. the central portion of ground tissue becomes hollow and is called pith cavity.



Fig : T.S. of stem Monocot

Differences between anatomy of monocot stem and dicot stem				
S.No.	Monocot stem	Dicot stem		
1	Hairs are generally absent.	Multicellular hairs are present.		
2	Epidermis consists of larger cells.	Epidermis is composed of comparatively smaller cells.		
3	Hypodermis is sclerenchymatous.	Hypodermis is collenchymatous.		

4	Cortex is generally absent, but from	Cortex consists of many layered	
	hypodermis to centre of stem ground	parenchymatous cells.	
	tissue is present.		
5	Endodermis is absent.	Endodermis is present but usually	
		poorly developed.	
6	Pericycle is absent.	Pericycle is made of one or many layers.	
7	Medullary rays are absent.	Medullary rays are present between	
		Vascular Bundles.	
8	Pith is absent.	Pith is present.	
9	Vascular Bundles :		
i	Scattered V.B.	V.B. are arranged in a ring.	
ii	V.B. are conjoint, collateral and closed.	V.B. are conjoint, collateral and open	
iii	V.B. in centre are larger in size and	V.B. are of same size.	
	towards periphery are smaller.		
iv	Bundle sheath is present around	Bundle sheath is absent.	
	vascular bundle in monocot stem.		
v	Oval vascular bundles.	Wedge shaped vascular bundles.	
vi	Phloem parenchyma is absent.	Phloem parenchyma is present.	
vii	Xylem vessels are 'Y' or 'V' shaped.	Xylem vessels are radial.	

INTERNAL STRUCTURE OF LEAF

Generally leaves are divided into categories - Dorsiventral leaves and isobilateral leaves.

The differences in between them are as follows :

Dorsiventral of Bi - facial		Iso - bilateral of Equifacial	
1.	Present at right angle to stem	1.	Arranged parallel to stem.
2.	Upper surface of leaf receives more	2.	Both surfaces of leaf receive equal
	sun light as compared to the lower		amount of sun light so no
	surface, so there occur difference		difference occurs between internal

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between internal structure of	structure of upper & lower
upper and lower surfaces	surfaces.
Example :- Dicots	Example :- Monocots
Exceptions - Eucalyptus and	Exception - Lilium longiflorum
Nerium (leaves are	(leaves are
isobilateral)	dorsiventral)

Internal structure of a dorsiventral leaf (Dicot leaf):

Mango leaf shows following features in vertical transverse section

1. Epidermis:

- Each leaf bears upper and lower epidermis.
- Each of them consists of single layer of compactly arranged parenchymatous cells.
- **Exception-multi layered upper epidermis** is found in Ficus elastica, Piper.
- Cuticle is present on both surfaces but cuticle of upper epidermis is more thick.
- Dorsiventral leaves are mostly **hypostomatic** in which stomata present on lower surface.
- In **amphistomatic dorsiventral leaves** stomata are more on lower epidermis as compared to upper epidermis. **e.g. Potato**

2. Mesophyll:

- Mesophyll is divided into two regions **Palisade** tissue and **spongy** parenchyma.
- Palisade tissue is found towards **upper surface**.
- These cells have **more chloroplasts** and spongy parenchyma is found towards lower surface intercellular spaces are well developed between cells of spongy parenchyma.

3. Vascular bundles:

- Vascular bundles are **conjoint**, **collateral and closed type**.
- Xylem is **endarch**.

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- Xylem is towards adaxial or upper surface and phloem towards abaxial surface.
- Each vascular bundle is surrounded by a **sheath of parenchymatous cells** called **bundle sheath**. Vascular bundle of midrib is the largest and parenchyma is spread from bundle sheath on both sides upto epidermis.

INTERNAL STRUCTURE OF ISOBILATERNAL LEAF

- 1. Epidermis:
- Each leaf bears upper & lower epidermis.
- Each of them composed of single layer of compactly arranged cells.
- The thickness of cuticle on the both epidermis is equal.
- In grasses, certain adaxial epidermal cells along the veins modify themselves into large, empty, colourless cells. These are called bulliform cells. When the bulliform cells in the leaves have absorbed water and are turgid, the leaf surface is exposed. When they are flaccid due to water stress, they make the leaves curl inwards to minimise water loss.
- Distribution of stomata on both epidermis are almost **equal** thus Isobilateral leaves are **Amphistomatic.**
- 2. Mesophyll:
- Mesophyll is not differentiated into palisade tissue and spongy parenchyma.
- It is completely composed of spongy parenchyma.

• In isobilateral leaf, two distinct patches of **sclerenchyma** are present above and below each of the large vascular bundles and extend up to the upper and lower epidermal layers respectively.

3. VASCULAR BUNDLES OF LEAVES :

- Similar types of vascular bundles are found in both dorsiventral and isobilateralleaves. Vascular bundles of leaves are conjoint, collateral and closed.
- Protoxylem is situated towards the adaxial (upper) surface and protophloem towards the abaxial (lower) surface in the vascular bundle. Leaves are devoid of endodermis and pericycle.
- Vascular bundles are surrounded by a bundle sheath. It is made up of thick walled parenchyma.



- Druses \rightarrow Crystal of calcium oxalate, star shaped e.g. Nerium.
- Cystolith → Crystal of calcium carbonate, like bunch of grapes e.g. Ficus (Banyan, Rubber plant)
- Raphides \rightarrow Crystal of calcium oxalate, Needle shaped e.g. Eichhornia

Note:

- **1.** In the leaves of C₄-plants (eg. sugarcane, maize etc.) bundle sheath is chlorenchymatous.
- **2.** In grasses, certain adaxial epidermal cells along the veins modify themselves into large, empty colourless cells. These are called buDiform cells or motor cells . When the bulliform

cells in the leaves have absorbed water and are turgid, the leaf surface exposed. When they are flaccid due to water stress, they make the leaves curl inwards to minimise water loss.

- **3.** The stomata aperture guard cells and the surrounding subsidiary cells are together called stomata apparatus.
- **4.** The size of vascular bundles are dependent on the size of the veins. The veins vary in thickness in the reticulate venation of the dicot leaves.
- **5.** The parallel venation in monocot leaves is reflected in the near similar sizes of vascular bundles (except in main veins) as seen in vertical sections of the leaves.
- Both upper & lower epidermis of Nerium leaves are multilayered This is an adaptation to reduce transpiration.
- Xerophytes with isobilateral leaves contain palisade tissue on both sides and few amount of spongy tissue is present in between palisade tissue.

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Leaf	Stomata position	Examples
Epistomatic leaf	Stomata are present only on	Floating leaves
	upper surface	Example-Lotus (Nelumbium
		Victoria regia, Nymphaea)
Hypostomatic leaf	Stomata are present on	Mostly dicot leaves
	lower surface	
Amphistomatic leaf	Stomata are present on both	Submerged leaves
	surface	Examples - Vallisneria, Hydrilla