# Root anatomy of monocotyledons (Maize)
## or
## Primary structure of maize root
## or
## T.S. of monocot/maize root

In maize, roots are adventitious. T.S. of monocot root shows circular outline. It shows following primary internal structures :→

1) Epidermis
2) Cortex
3) Endodermis
4) Stele

**1]. Epidermis :→**

It is also called as epiblema or rhizodermis or piliferous layer. It is made up of compactly arrenged, barrel shaped thin walled parenchymatous cells. It is outermost and protective layer of root. It bears no. of hairs on outer surface which are called as root hairs.

**2] Cortex :→**

It is present just below the epidermis. It is made up of thin walled, rounded parenchymatous cells having intercellular spaces inbetween them.

**3] Endodermis :→**

It is innermost layer of the cortex. It is about single layered. It is made up from compactly arrenged barrel shaped cells. Inner walls of endodermal cells are very thick due to deposition

of suberian like substances. These thick radial walls appear in the form of strips called casparian strips. Some cells which are present opposite to protoxylem are thin without casparian strips those cells are called as passage cells.

4] Stele :→

It is present below the endodermis. Pericycle, vascular bundles, ~~conjuct~~ conjunctive tissues and pith are the component of stele.

a) Pericycle :→

It is outermost layer of the stele, which is present just below the endodermis. It is made up of thin walled parenchymatous cells. It is about 2-3 layered.

b) Vascular bundles :→

Below the pericycle vascular bundles are present. Each vascular bundle consists of xylem and phloem. Vascular bundles are radial, exarch & polyarch.

c) Conjuctive tissue :→

Those parenchymatous tissues which are present inbetween xylem & phloem of vascular bundles are called as conjuctive tissue.

d) Pith :→

Pith is the innermost part of the stele. It is made up of thin walled, very few parenchymatous cells. It occupies very small area in the centre of stele.

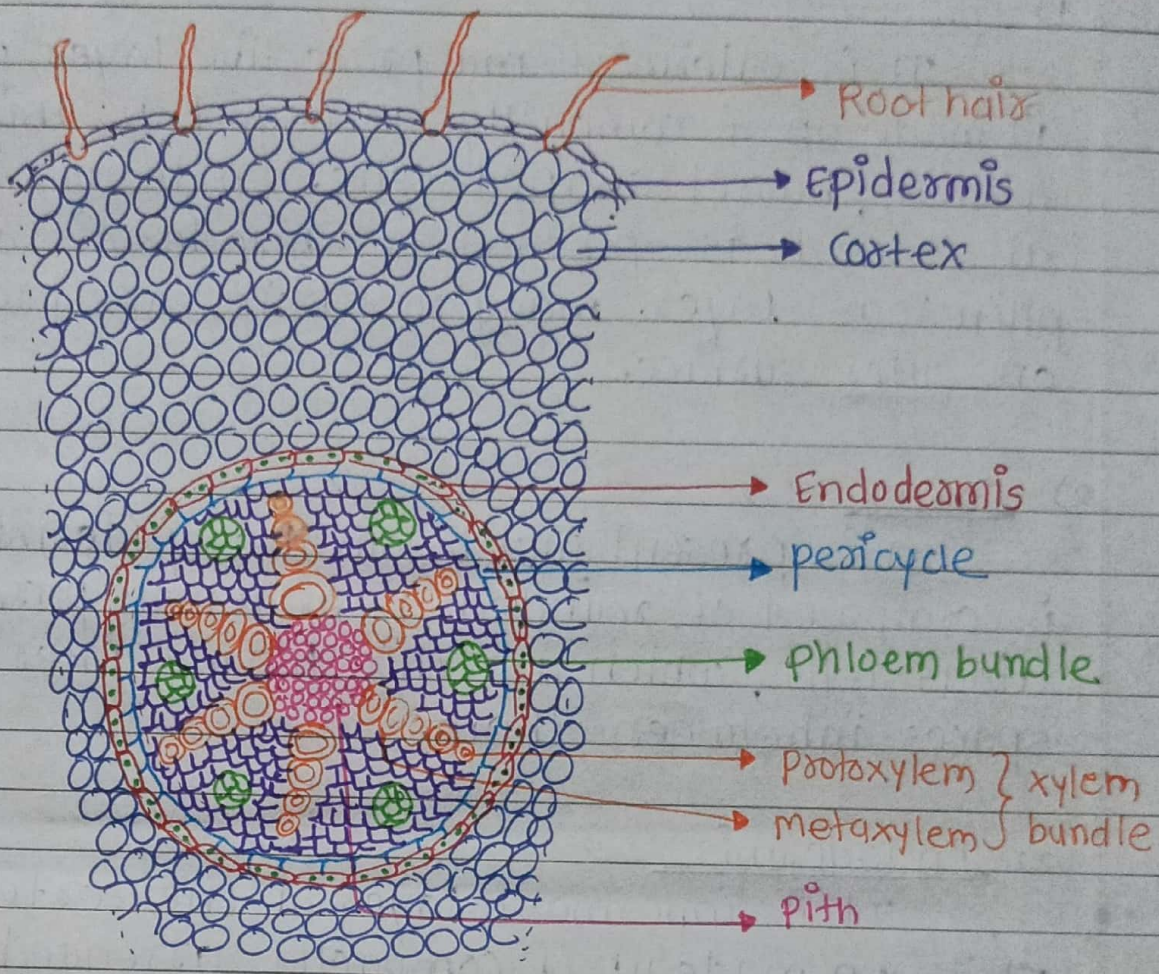


Fig. T.S. of Monocot root.

## Root anatomy of dicotyledons (sunflower)

or

## Primary structure of sunflower root

or

## T.S. of dicot/sunflower root

Roots of sunflower are tap roots. T.S. of dicot root is circular in outline. Internal structures of dicot root are as follows :→

1) Epidermis
2) Cortex
3) Endodermis
4) Stele

1) Epidermis :→

It is outermost and protective layer which is made up of compactly arrenged thin walled, barrel shaped cells. Epidermis is also called as epiblema or rhizodermis or pilifetous layer. many root hairs are present on outer surface.

2) Cortex :→

It is present just below the epidermis. It is composed of rounded homogenous parenchymatous cells, which are thin having intercellular spaces inbetween them.

3) Endodermis :→

It is innermost layer of the cortex. It is made up of compactly arrenged barrel shaped cells. Inner endodermal cells are thick due to deposition of suberian like substances. Endodermis consists of casparian strips. Thin walled cells are also present in endodermis those are called as passage cells.

4) Stele :→

Below the endodermis stele is present. It is composed of pericycle, vascular bundles, conjuctive tissues and pith.

a) Pericycle :→ It is outermost layer of stele It is made up of thin walled parenchyma. It is present below the endodermis.

b) vascular bundles :→ Each vascular bundle is radial tetrach and exarch. vascular bundles

are present just below the pericycle. Each vascular bundle consists of xylem & phloem.

c) Conjuctive tissue :→ A parenchymatous tissue which is present inbetween xylem and phloem of radial vascular bundles is called as conjuctive tissue.

d) Pith :→ It is made up of very few thin walled cells. It is innermost part of the stele. It is completely parenchymatous.

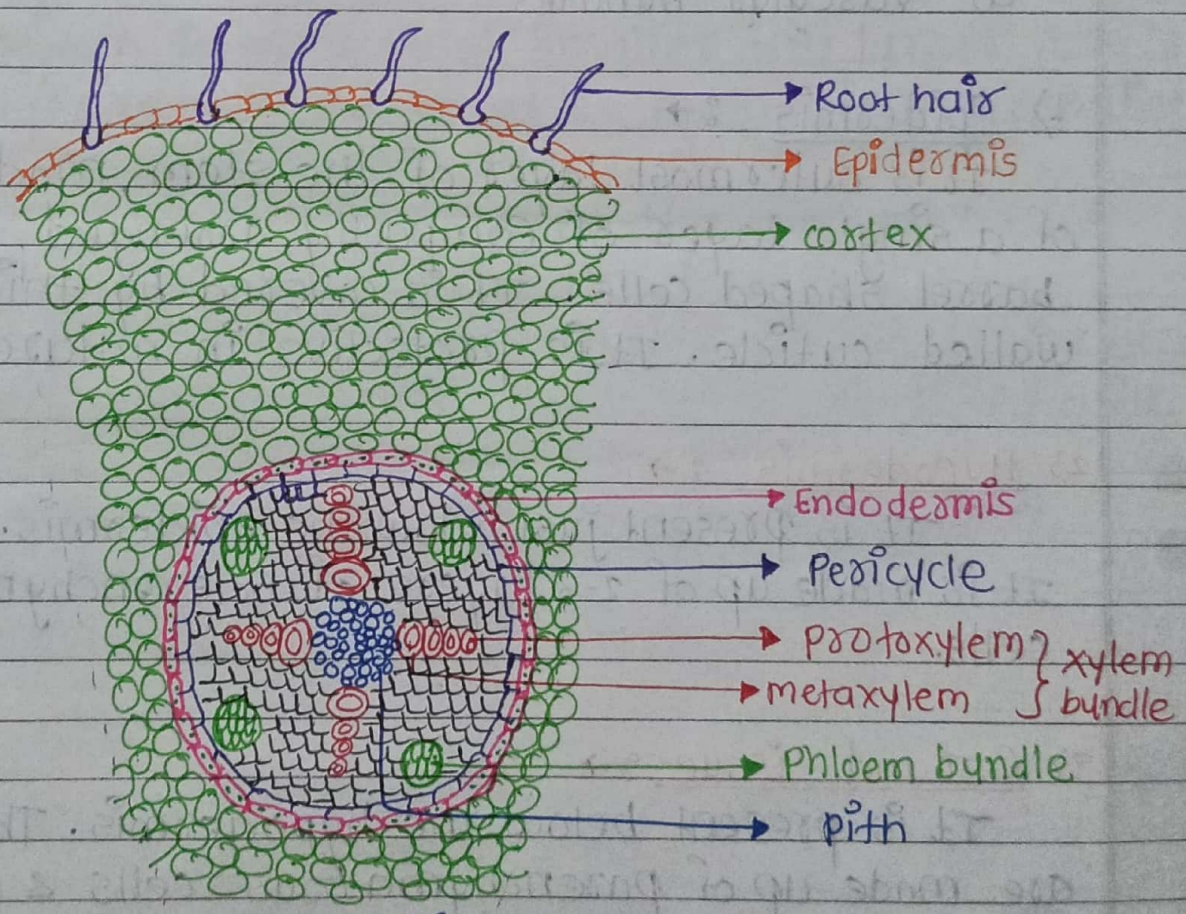


Fig: T.S. of Dicot root

# ✳ Stem anatomy of monocotyledons (maize)
## or
## Primary structure of maize stem
## or
## T.S. of monocot stem →✳←

T.S. of monocot stem shows following structures, in circular outline.

1) Epidermis
2) Hypodermis
3) Ground tissue
4) vascular bundles

### 1) Epidermis :→

It is outermost layer of the stem, made up of a single layer of compactly arrenged barrel shaped cells. It is covered by thick walled cuticle. It is protective in nature.

### 2) Hypodermis :→

It is present just below the epidermis. It is made up of 2-3 layers of sclerenchymatous cells.

### 3) Ground tissue :→

It is present below the hypodermis. These are made up of parenchymatous cells & many layers. The cells which are present towards centre are larger and loosely arrenged while the cells present towards periphery are smaller and compactly arrenged. These tissues store food material in large amount.

4] Vascular bundles :→

Number of vascular bundles are present or embeded in ground tissue. In monocot stem all the vascular bundles are scattered in ground tissue. Each vascular bundle is conjoint, collateral, endarch and closed. Vascular bundles towards centre are large & less in number while vascular bundles towards periphery are small & maximum in number. Each vascular bundle is surrounded by a sclerenchymatous patch called bundle sheath. Vascular bundle is composed of xylem & phloem.

Xylem is made up of smaller and larger vessels. Larger vessels are called as metaxylem & smaller are called protoxylem. Xylem is "Y" shaped. Two metaxylem present on the arm of "Y" & protoxylem present at the base of "Y". In mature vascular bundles lowest protoxylem disintigrate & forms cavity which is filled with water hence also called as water cavity.

Phloem is made up of sieve tubes and companion cells.

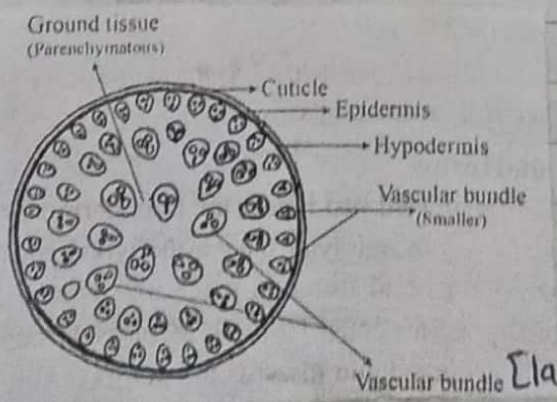


Fig. T.S. of Maize stem

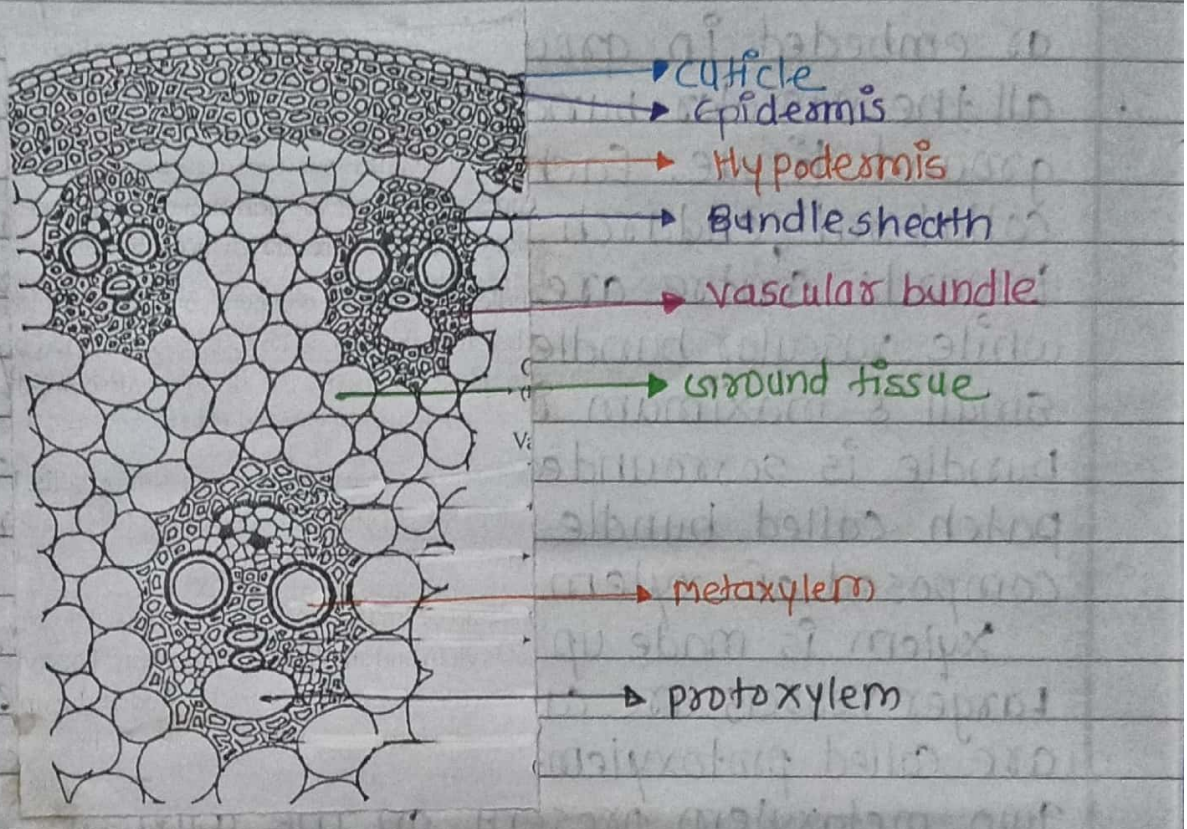


Fig. T.S. of Maize stem shows cellular details

## Stem anatomy of dicotyledon [sunflower] :→

or

## Primary structure of sunflower stem

or

## T.S. of dicot stem

T.S. of sunflower stem shows circular outline; which shows following parts :

1) Epidermis
2) Cortex
3) Endodermis
4) Stele.

### 1) Epidermis :→

It is outermost layer of stem, which is made up of compactly arrenged barrel shaped cells. It is covered by thick walled cuticle. It is protective in nature and has many hair on outer surface called epidermal hair.

### 2) Cortex :→

It is present just below the epidermis. Cortex is broad and differentiated into hypodermis, general cortex and endodermis.

#### (a) Hypodermis :→

It is present below the epidermis & made up of 2-3 layers of collenchymatous cells.

#### (b) General cortex :→

It is present below the hypodermis. It is made up of 2-3 layers of parenchymatous cells having intercellular spaces. These cells store food material in abundant quantity. Resin ducts are present in general cortex.

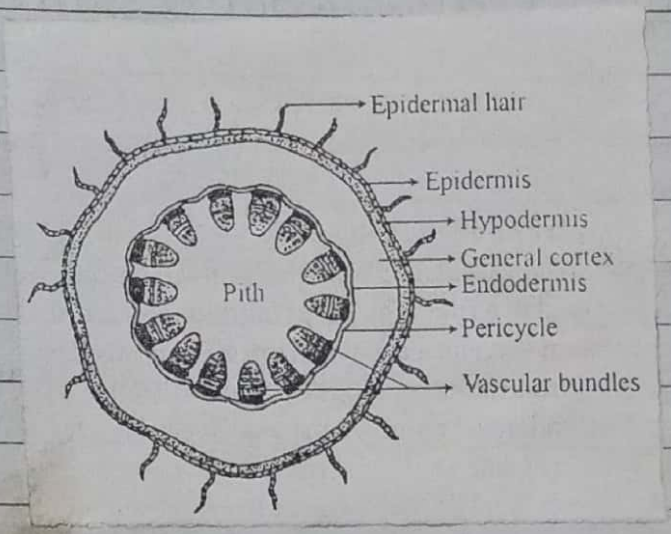


Fig. T.S. of sunflower stem

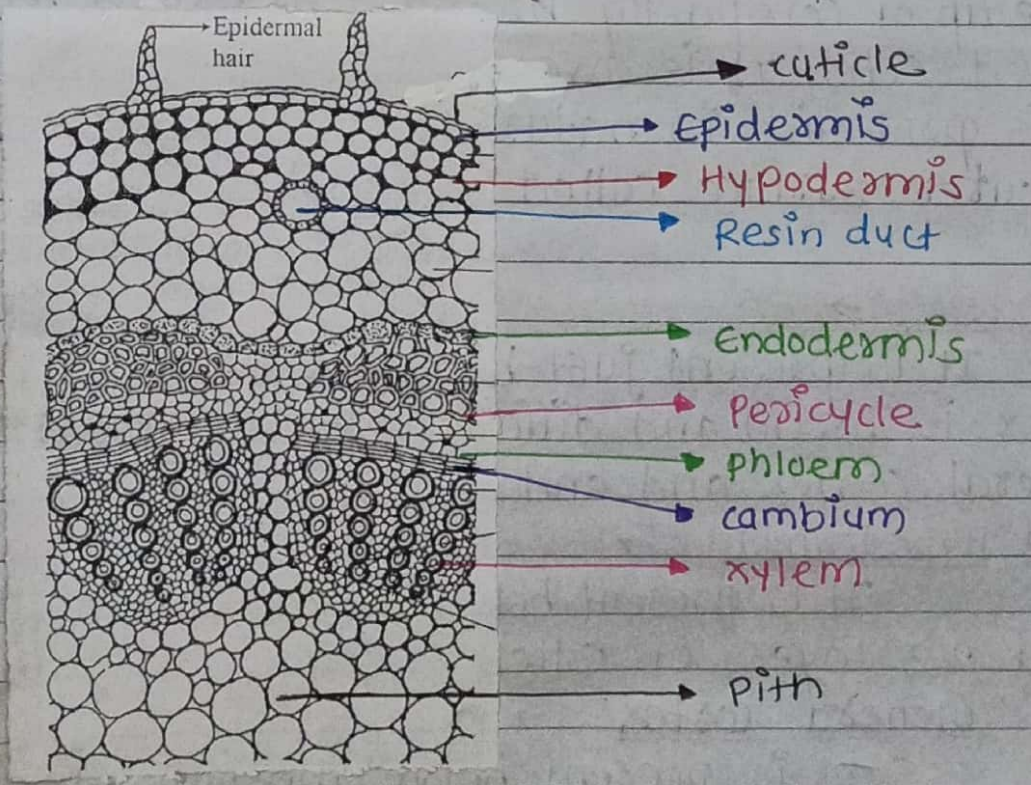


Fig. T.S. of sunflower stem shows cellular details

c) Endodermis :→

It is the innermost layer of the ~~stem~~ cortex. It is made up of single layered compactly arranged barrel shaped cells, which contains food material in the form of starch hence it is also called as starch sheath.

d) Stele :→

Stele is the innermost part of stem which is present below the endodermis. Stele is composed of pericycle, vascular bundle, medullary rays and pith.

Pericycle :→

It is present just below the endodermis made up of 2-3 layers of sclerenchymatous patches. Patch is also called as bundle caps or hard basts.

Vascular bundles :→

Vascular bundles are conjoint, collateral, open and endarch which are arranged in a ring. Cambium of vascular bundle is present in the form of strip or band. It is made up of few layers of thin walled rectangular or brick shaped meristematic cells. Parenchymatous tissues between vascular bundles are called medullary rays

~~Medullary rays~~ :→

Pith :→

It is central part of ~~stem~~ stele. It is made up of many layers of parenchymatous cells.

# PRIMARY STRUCTURES OF LEAF

Leaves are the important vegetative plant parts mainly concerned with photosynthesis and transpiration. A leaf shows the dermal, ground and vascular systems like root and stem. The dermal tissue system consists of upper and lower epidermis. The vascular tissue system consists of vascular bundles and the ground tissue system consists of mesophyll tissues. The tissue present between the upper and lower epidermis is known as mesophyll tissue. The mesophyll tissue may or may not be differentiated. The leaves in which mesophyll tissue is differentiated into palisade parenchyma on adaxial (upper) side and spongy parenchyma on abaxial (lower) side are called as bifacial or dorsiventral leaves. The leaves in which mesophyll tissue is not differentiated into palisade and spongy parenchyma are called as unifacial or isobilateral leaves. In unifacial or isobilateral leaves the mesophyll tissue is made up of only palisade parenchyma or spongy parechyma. Both the dorsiventral and isobilateral leaves show externally dorsal (upper) and ventral (lower) surfaces. The dorsiventral leaves are very common in dicotyledonous plants and isobilateral leaves are very common in monocotyledonous plants.

**Primary Structures of Sunflower (Dicot) Leaf:**

The leaves of sunflower are dorsiventral. The transverse section (T.S.) of dorsiventral leaf of sunflower shows following internal structures such as

1. Upper epidermis
2. Lower epidermis
3. Mesophyll
4. Vascular bundles

**Upper epidermis:**

It is outer most protective layer of dorsal surface of the leaf. It is made up of a single layer of compactly arranged barrel shaped, parenchymatous cells. It has thick cuticle few stomata and multicellular hairs on the outer surface.

**Lower epidermis:**

It is outermost protective layer of ventral surface of the leaf. It is made up of a single layer of compactly arranged parenchymatous cells.It has thick cuticle, many stomata and multicellular hairs on the outer surface.

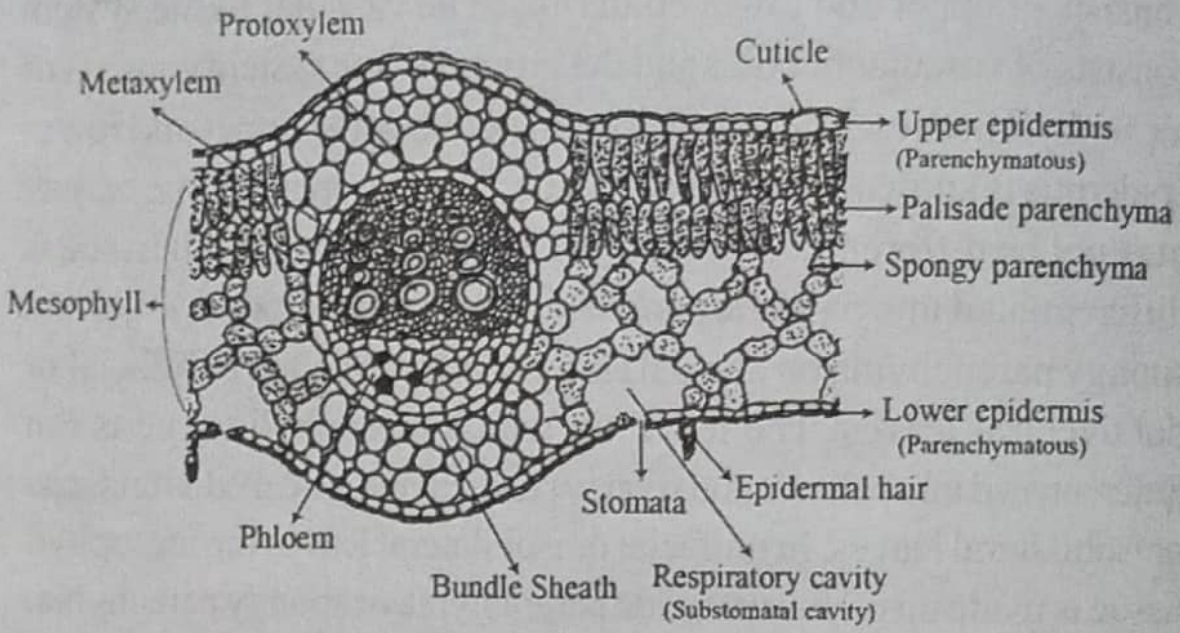


**Fig.3.5.** T.S. of Sunflower leaf

**Mesophyll** (Meso = in the middle, phyllome = leaf)**:**

It is a tissue present between upper and lower epidermis of the leaf.It is differentiated into palisade parenchyma and spongy parenchyma. The palisade parenchyma is present just below the upper epidermis. It is made up of 1-2 layers of compactly arranged columnar, green cells right angle to the upper epidermis. The spongy parenchyma is present just below the palisade parenchyma. It is made up of loosely arranged cells with large intercellular spaces between them. The cells of the spongy parenchyma are irregular in shape. The intercellular spaces or air spaces just below the stomata are called as substomatal cavities or respiratory cavities.

**Vascular bundles:**

The vascular bundles are present in the veins of the leaf.They are conjoint, collateral, exarch and closed. They are irregularly scattered in the spongy parenchyma. They are composed of xylem and phloem. The xylem is present towards the upper epidermis and the phloem present towards the lower epidermis. The xylem consists of larger

vessels called metaxylem and smaller vessels called protoxylem. The metaxylem is present towards the lower epidermis and protoxylem towards the upper epidermis. The xylem is made up of tracheids, vessels and xylem parenchyma. The phloem is made up of sieve tubes, companion cells and phloem parenchyma. The vascular bundles are surrounded by a compact layer of parenchymatous cells called bundle sheath or border parenchyma.

The bundle sheath has a multilayred patch or mass of parenchymatous cells with intercellular spaces just opposite to xylem and phloem. The parenchymatous patch extends up to both upper and lower epidermis.

**Primary Structures of Maize (Monocot) Leaf:**

The leaves of maize are isobilateral or unifacial. The transverse section (T.S.) of a isobilateral leaf of Maize shows following internal structures such as

1. Upper epidermis
2. Lower epidermis
3. Mesophyll
4. Vascular bundles

**Upper epidermis:**

It is outermost protective layer of dorsal surface of the leaf. It is made up of a single layer of compactly arranged barrel shaped, parenchymatous cells. It has thick cuticle and stomata on the outer surface. A few large, empty colourless cells are also present in the upper epidermis called bulliform cells or motor cells.

**Lower epidermis:**

It is outermost protective layer of the ventral surface of the leaf. It is made up of a single layer of compactly arranged parenchymatous cells. It has thick cuticle and stomata on outer surface.

**Mesophyll:**

It is a tissue present between the upper and lower epidermis of the leaf. It is made up of many layers of similar, isodiametric, compactly arranged, and green parenchymatous cells with few intercellular spaces.

The mesophyll cells occupy the entire region extending from upper epidermis upto lower epidermis. The intercellular spaces just below the stomata are called as sub-stomatal cavities.

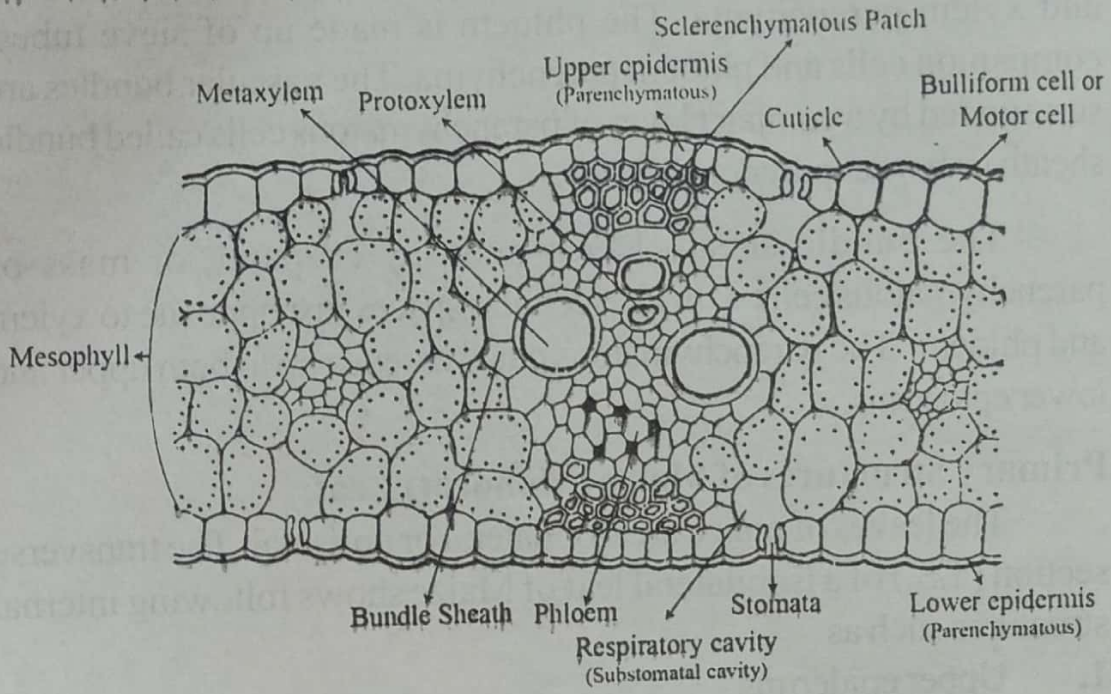


**Fig.3.6.** T.S. of Maize leaf

**Vascular bundles:**

They are present in the veins of the leaf. They are conjoint, collateral, exarch and closed. They are small and arranged in a parallel series in the mesophyll. They are composed of xylem and phloem. The xylem is present towards the upper epidermis and phloem towards the lower epidermis. The xylem is made up of tracheids, vessels and xylem parenchyma. The vessels are larger and smaller. The larger vessels called metaxylem present towards lower epidermis and smaller vessels called protoxylem present towards upper epidermis. The phloem is made up of sieve tubes; companion and phloem parenchyma. The vascular bundles are surrounded by a single layer of compactly arranged parenchymatous cells rich in plastids and starch grains called bundle sheath or border parenchyma. The bundle sheath has a multilayered patch of sclerenchyma just opposit to the xylem and phloem. The slerenchymatous patch extends towards both the epidermis.

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