Main Parts of Primary Dicot Stem in Plants (With Diagram)

The following points highlight the eight main parts of primary dicot stem in plants. The parts are: 1. Epidermis 2. Hypodermis 3. General Cortex 4. Endodermis 5. Pericycle 6. Vascular Strand 7. Medullary or Pith Rays 8. Pith or Medulla.

Dicot Stem: Part # 1. Epidermis:

Epidermis is the outermost layer of the stem. It is made up of compactly arranged elongated parenchymatous cells, which look rectangular-barrel shaped in a transverse section. The cells are transparent and devoid of chloroplasts.

The outer walls are convex, thickened and cutinised. On the outer side they possess a layer of cuticle. The internal walls of the epidermal cells are thin. The radial walls are thick towards the outer side and gradually become thin towards the inner side. Pits occur in the radial walls.

The epidermis of Sunflower stem bears several un-branched multicellular hair or trichomes. Like epidermis, they are covered by cuticle. At places the epidermis contains minute pores called stomata or stomata's.

Each stomate or stoma (sing, of stomata) has a pair of specialised kidney shaped cells called guard cells. The guard cells have a few chloroplasts. By their swelling, the two guard cells can form a pore in between them.

The various functions of the epidermis are:

(i) Protection of internal tissues,

(ii) Prevention of entry of harmful organisms,

(iii) Minimising surface transpiration by having thick cuticle,

(iv) Exchange of gases through the stomata,

(v) Protection against excessive heating up and sudden changes in temperature with the help of hair (as in Sunflower).

The tissue between epidermis and pericycle is called Cortex. It has three parts hypodermis, general cortex and endodermis.

Dicot Stem: Part # 2. Hypodermis:

The hypodermis is made of 3-4 layered sub-epidermal collenchyma tissue. Its cells possess extra cellulose thickening in various regions— on the tangential walls (lamellate collenchyma, e.g., Sunflower), at the angles (angular collenchyma, e.g., Castor) and near the intercellular spaces (lacunate collenchyma, e.g., Cucurbita). Collenchyma cells are green and enclose small intercellular spaces.

Hypodermis functions in:

(i) Providing mechanical strength as well as, flexibility,

(ii) Storage of food and

(iii) Manufacture of food with the help of chloroplasts.

Hypodermis is absent or inconspicuous below the stomata.

Dicot Stem: Part # 3. General Cortex:

It is a few to several cells in thickness. The cortex is made up of thin walled angular (e.g., Castor), oval or rounded (e.g., Sunflower) parenchymatous cells. They enclose intercellular spaces.

In the young green stem, the outer cortical cells possess chloroplasts (chlorenchyma) and manufacture food. However, major function of the cortex is storage of food. In Sunflower the cortex contains a number of longitudinally running oil ducts. Each oil duct has a channel which is lined by an epithelium of small glandular cells.

Dicot Stem: Part # 4. Endodermis:

It is a wavy layer of one cell in thickness. The endodermis lies at the innermost boundary of cortex. It is made up of barrel-shaped cells which do not enclose intercellular spaces. Casparian strips are generally absent. The endodermal cells often contain conspicuous starch grains as food reserve. Therefore, the stem endodermis is also called starch sheath.

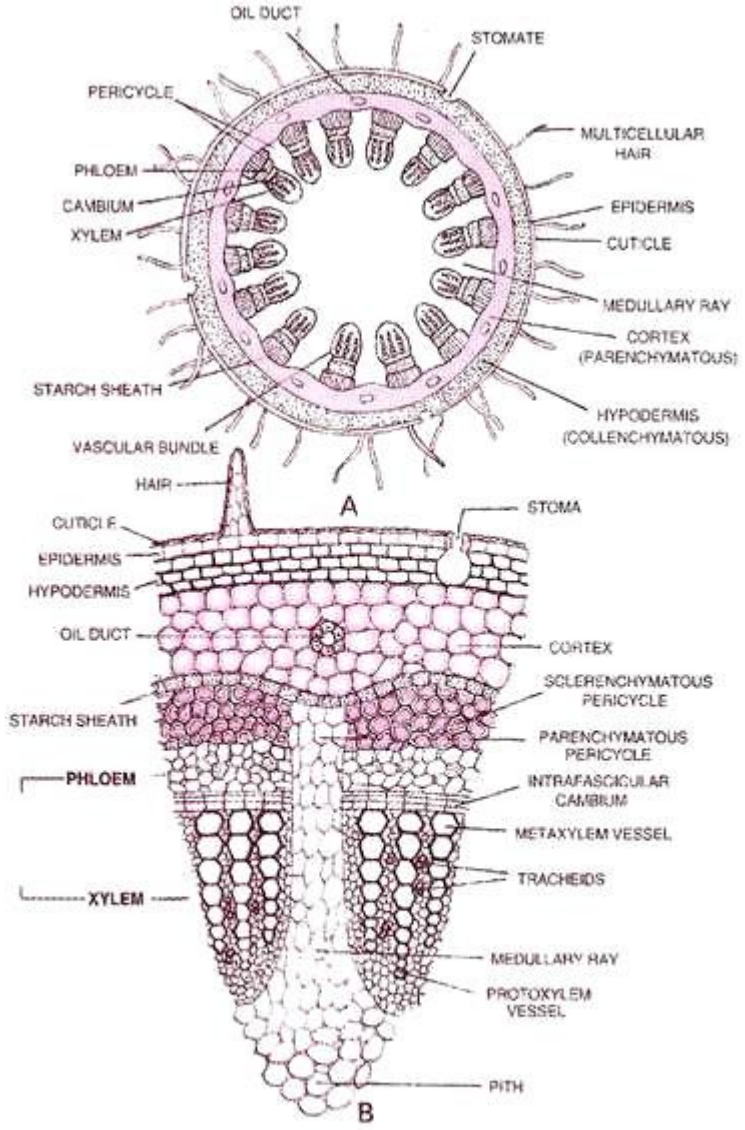


Fig. 6.26. A, T.S. Primary dicot stem of Sunflower (Diagrammatic); B, detailed structure of a part of T.S. stem of Sunflower.

Dicot Stem: Part # 5. Pericycle:

It is few layered thick tissue. It lies inner to endodermis and outside the vascular strand. The pericycle is heterogenous. It is made up of both parenchyma and sclerenchyma fibres. Sclerenchyma lies on

the outside of vascular bundles in the form of semicircular to semilunar patches called bundle caps.

As the bundle caps are associated with phloem part of vascular bundles, the sclerenchymatous pericycle is also called hard bast. Parenchymatous pericycle is present outside medullary rays.

In Cucurbita, pericycle is homogeneous. It is a completely sclerenchymatous wavy layer of 4-5 celled thickness. The sclerenchymatous pericycle provides mechanical strength to the young stem. The parenchymatous pericycle stores food.

Dicot Stem: Part # 6. Vascular Strand:

The vascular strand is in the form of eustele or a ring of vascular bundles present around the central pith and inner to the pericycle. The vascular bundles are definite in number. They are obtusely wedge shaped. Each vascular bundle consists of phloem (primary) on the outside, xylem towards the inner side and strip of cambium in between the two. Phloem and xylem tissues lie on the same radius.

Such vascular bundles are known as conjoint (with both phloem and xylem), collateral (phloem and xylem on the same radius) and open (with a strip of cambium in between phloem and xylem). Bi-collateral open vascular bundles occur in the stem of Cucurbita and its relatives

(a) Phloem:

It lies towards the pericycle on the outer side of vascular bundle. Phloem consists of sieve tubes, companion cells, phloem parenchyma and some phloem fibres. The companion cells and phloem parenchyma are connected with sieve tubes through pits. They help in the lateral flow of the organic food. The companion cells also control the functions of the sieve tubes. The sieve tubes conduct organic food longitudinally.

(b) Xylem:

It is found towards the pith or the inner portion of the vascular bundles. Xylem consists of two parts, smaller protoxylem (of

narrow elements) and larger meta-xylem (of broader elements). Protoxylem or first formed xylem lies at the tip of meta-xylem towards the pith or centre of stem. Therefore, xylem is endarch (development centrifugal).

Xylem consists of tracheids, vessels, xylem parenchyma and xylem fibres. Out of these only the xylem parenchyma cells are living. They are smaller in size than the parenchyma cells found outside the bundles. Xylem parenchyma cells store food and help in the lateral conduction of the sap.

Vessels are present in the form of a few radial rows. They are angular in outline. The vessels of the protoxylem region are smaller and possess annular or spiral thickenings. These thickenings make the protoxylem vessels elastic and capable of stretching during the elongation of stem. The vessels of meta-xylem have pitted thickenings.

Tracheids are present in between and around the radial rows of vessels especially of the meta-xylem region. Xylem fibres lie scattered amongst the tracheids. The vessels, tracheids and xylem fibres, all provide mechanical strength to the stem.

However, the most important function of xylem is the conduction of water and mineral substances. This is carried out by two tracheary elements, vessels and tracheids.

(c) Cambium:
It is the left out portion of pro-cambium. Cambium is in the form of a narrow strip of primary meristematic cells that lie between the phloem and the xylem of a vascular bundle. It is called intra-fascicular or fascicular cambium.

Cambial cells are thin- walled fusiform cells which appear rectangular in transverse section. Cambium helps in increasing the girth of stem by producing secondary phloem towards outside and secondary xylem towards the inner side (secondary growth).

Dicot Stem: Part # 7. Medullary or Pith Rays:

They are the radial strips of parenchyma which are present between adjacent vascular bundles. The medullary rays connect the pith with pericycle and cortex. The ray cells are larger than cortical cells. They are polygonal in outline.

Intercellular spaces are small. Ray cells make intimate contact with the conducting cells of both phloem and xylem through pits. The medullary rays help in the radial conduction of food and water. They also transport gases from pith to cortex and vice versa.

Dicot Stem: Part # 8. Pith or Medulla:

It forms the centre of the stem. The pith is made up of polygonal oval or rounded parenchyma cells which enclose intercellular spaces. The pith cells store food. In some dicots, the central part of the pith disintegrates to produce a cavity (pith cavity), e.g., Cucurbita.

Primary Dicot Root in Sunflower

The following points highlight the six main parts of primary dicot root in plants. The parts are: 1. Epiblema 2. Cortex 3. Endodermis 4. Pericycle 5. Vascular Strand 6. Pith.

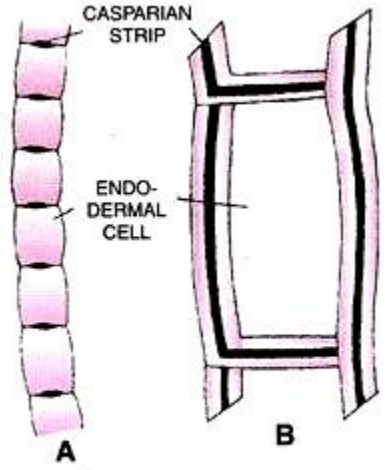
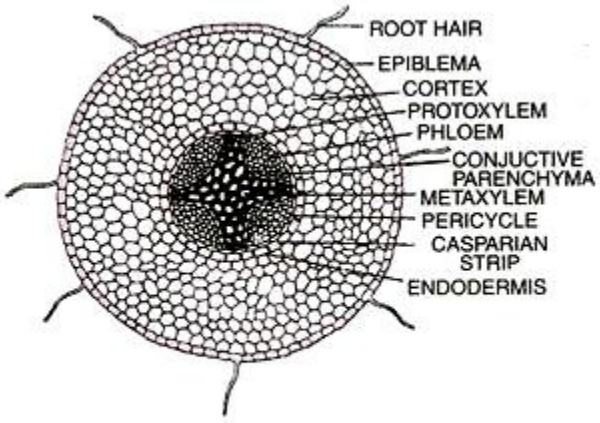


Fig. 6.20. Endodermal cells with casparian strip. A, T.S.; B, position of casparian strip in a cell.



. Fig. 6.21. T.S. Dicot root of Sunflower.

Dicot Root: Part # 1. Epiblema or Piliferous Layer (Rhizodermis):

It is the outermost layer of the root. It is made of compactly arranged thin-walled flattened and slightly elongated parenchymatous cells. Epiblema of root differs from the epidermis of stem in being devoid of distinct cuticle and stomata. Some cells of the epiblema give rise to thin-walled tubular outgrowths called root hairs. They are called trichoblasts. Trichoblasts are generally smaller than other epiblema cells.

The root hairs lie in between the soil particles and are in contact with the soil water. 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, the epiblema is also called piliferous layer (L. pilus— hair, ferre— to carry).

The root hairs and thin- walled epiblema cells absorb water and minerals salts from the soil. Root hairs commonly do not live for more than one week. With their death the epiblema cells become suberized and cutinised.

Dicot Root: Part # 2. Cortex.

It lies below the epiblema. The cortex is made up of many layers of thin walled parenchyma cells. The parenchyma cells may be rounded (e.g., Cicer) or angular (e.g., Sunflower). They enclose intercellular spaces for diffusion of gases. The cells of the cortex store food. They also conduct water from the epiblema to the inner tissues.

Dicot Root: Part # 3. Endodermis:

Endodermis is usually considered to be the innermost layer of the cortex. It is made up of a single layer of barrel-shaped cells which do not enclose intercellular spaces. The cells are rich in starch grains.

The young endodermal cells possess a band of thickening which runs along their radial and tangential walls. This band of thickening is called casparian strip (after Caspary, 1865). It is made up of both suberin and lignin (Esau, 1965).

In a transverse section, the casparian strip appears in the form of small lenticular swellings on the radial walls only. Casparian strips prevent plasmolysis of endodermal cells. Due to the presence of casparian strips, the endodermal cells do not allow wall to wall movement of substances between cortex and pericycle.

Substances must enter the cytoplasm of endodermal cells. As a result, endodermis functions as a biological check post. All tissues on the inner side of endodermis constitute stele. It consists of pericycle, vascular bundles and pith.

Dicot Root: Part # 4. Pericycle:

Endodermis is followed by one (e.g., Sunflower) or more (e.g., Mulberry) layers of pericycle. Pericycle is believed to represent the outer boundary of vascular strand. The cells of pericycle are thin-walled and parenchymatous in the young root.

Pericycle is a very important layer. A part of the vascular cambium is formed by the pericycle. The cork cambium also develops from it. All lateral roots originate from the pericycle. Pericycle is absent in the roots of some aquatic plants and parasites.

Dicot Root: Part # 5. Vascular Strand or Cylinder:

Inner to the pericycle are found a few (2-6) alternately arranged bundles of xylem and phloem. They are equal in number and lie on different radii. Such vascular bundles are called radial bundles. The various xylem bundles put together give a stellate or star-shaped appearance. The number of rays is equivalent to the number of xylem bundles (and phloem bundles).

According to the number of rays, the root may be diarch (with 2 xylem bundles, e.g., Tomato), triarch (Pea), tetrarch (Buttercup, Gram, Sunflower, Castor), pentarch (with 5 xylem bundles) or hexarch (with 6 xylem bundles). In some cases different divisions of roots possess different number of strands, e.g., two in lateral roots and four in main roots of Garden Nasturtium. Such roots are called heteroarch.

Protoxylem or the first formed xylem lies in contact with pericycle and at the tip of the rays while metaxylem or later formed xylem is present towards the centre of the root. Such a xylem is called exarch (L. ex— outside, Gk. arche— beginning)

The metaxylem elements of different xylem bundles may lie separate from one another so that a pith is present in the centre of the root (e.g., Gram, Bean). However, usually the xylem bundles extend along the radii so that metaxylem elements of different bundles meet in the centre to form a solid star-shaped structure. In such a case the pith is absent.

Xylem is made up of vessels and a few tracheids. Vessels and tracheids are polygonal in outline. Protoxylem elements are fewer, smaller and narrower. The metaxylem elements are larger and wider. They have pitted thickenings while protoxylem possesses spiral, annular, reticulate or scalariform thickenings.

Xylem performs two important functions:
(i) Mechanical strength

(ii) Conduction of water and mineral salts to the shoot.

In between the two adjacent xylem bundles is found a phloem bundle. It is oval in outline. Phloem and xylem bundles are separated from each other by one or more layers of small thin walled cells called conjunctive parenchyma or tissue. Later on the conjunctive tissue becomes meristematic to form vascular cambium.

Phloem consists of sieve tubes, companion cells and phloem parenchyma. It conducts organic food from the shoot to the root and its branches. Fibres may occur outside the phloem in some roots (e.g., Gram). Radial arrangement of vascular bundles is a mechanism to keep the xylem bundles in direct contact with the outer tissues of the root which conduct water absorbed by the root hairs to the inside.

Dicot Root: Part # 6. Pith:

It is often absent. When present, the pith is quite small. The latter is made of parenchyma cells. Intercellular spaces are absent. The cells store food as well as waste materials.

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