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SEMESTER – II

ANATOMY OF MULBERRY (Unit – 2)

MULBERRY STEM, ROOT & LEAF LAMINA

ANATOMY

4.1 Anatomy of the Root: Mulberry is a deep rooted perennial plant. Its root system is very well developed though the growth and spread of the root depend upon the texture of the soil. The root tip shows the same structure as in other dicotyledonous plants. There is a clear differentiation of root cap which protects the growing meristamatic tissue from dessication and injury by the various soil organisms. The root hairs which are ephemeral serve the function absorption of water and salts from the soil.

4.1.1: Internal structure of a root: The morphology of a transverse section of the root before the formation of the secondary tissues is described below.

There is a single layered epidermis which consists of tubular shaped cells, closely arranged without inter-cellular space. Its outer walls are not cutinised and a few of the epidermal cells enlarge into root hairs. Below the epidermis there is a large cortex which consists wholly of parenchyma cells. There is a clear single layered endodermis enclosing the pericycle and vascular bundles. The vascular bundles are diarch, sometimes triarch, radial and without cambium. The pericycle is many layered which later forms the cork cambium (Figure 24).

4.1.2: Structure of a secondary root: The knowledge of anatomy of a root is of primary importance in the vegetative propagation such as selecting a proper plant for preparation of cutting and stock for grafting. Some of the cells of parenchyma outside the protoxylem convert themselves into a small strip of cambium. These cambial strips divide and redivide to produce a sinuous cambium layer which later becomes circular. The cambium cuts off cells towards outside and inside. Simultaneously some of the cells of the pericycle also convert themselves into meristematic cells to form cork cambium. The cork cambium cuts off cells towards outside and inside, more cells towards inside than outside, thus more of secondary phloem is produced. The primary xylem strand remains undisturbed as main medullary ray. Thus in the secondary root, there is a thick bark including the primary cortex. The cork consists of rectangular cells whose contents are absorbed. Below the cork is the secondary phloem and secondary xylem are formed from the activity of the cambium. The roots with two or three layers of cambium are preferred for purposes of grafting or cutting (Figures 25a, 25b and 25c).

4.2 Anatomy of stem: The anatomy of the stem is similar to that of any dicotyledenous stem. The primary stem consists of a single-layered epidermis with tubular shaped cells closely arranged without inter-cellular space. The outer cells of the epidermal cells are cutinised.

Some of the epidermal cells are drawn into unicellular hairs which protect the plant from injurious insects and also minimize the rate of transpiration. These epidermal hairs are coarse and profuse in polyploidy species. Below the epidermis is a multilayered cortex which consists of colio parenchyma cells. Some of the cells contain chloroplasts. There are many laticiferous cells in the cortex which are the storehouses of organic excretory products. There is a single-layered endodermis with conspicuous barrel-shaped cells. The pericycle is many layered. The vascular bundles are few, collateral, conjoined, open and endarch. There is a conspicuous medulla (Figure 26).

4.2.1: Secondary stem: The secondary stem of mulberry shows the following tissues. With the union of the cambial strips of the vascular bundles, a continuous ring of cambium is developed which cuts off secondary xylem towards inside and secondary phloem towards outside. Due to increase in the girth of stem, the continuity of the epidermis is broken at various places. The function of protecting the inner tissues is taken up by some of the cells or collenchyma, converting themselves into cork cambium or phellogem, which cuts off more cells towards outside and a few cells towards inside. Those cells that are formed towards outside form the cork or phellum and those that are formed towards inside form the secondary cortex or phelloderm. The phellogen with phellem and phelloderm is the periderm. The removal of the periderm with the bud is the main operation of bud-grafting. The cork cambium at some places, where the epidermis is broken, do not form the cork cells. Instead a group of powdery cells known as complimentary cells are formed. The structure is called the lenticel which facilitates exchange processes (Figure 27). The secondary cortex consists of parenchyma cells, traversed by many laticiferous cells. A group of sclerenchyma cells are also found in the cortex. The secondary phloem consists of well-developed sieve tubes to conduct the food material. The cambium in between the phloem and the xylem cuts cells regularly, adding more of secondary tissues year by year. Due to increase in the girth of the stem, the primary xylem is pushed to the centre which is ultimately crushed to form the hard wood. Depending upon the requirement of the water in different seasons, the cambium cuts off xylem cells of high and narrow calibre. The amount of wood produced in one year is the annual ring. For instance, in the winter and autumn seasons, the plants under temperate climate, shed their leaves and practically there will be dormant condition. During this period the xylem cells of narrow calibre are formed. But during spring, as the plants put forth a large number of branches and leaves, it requires more water to be absorbed from the soil. Therefore, the xylem of high calibre are produced (Figures 28a and 28b). The shoots with active cambium, are selected for propagation through cuttings or scions in grafting.

4.3 Anatomy of leaf:

4.3.1: Anatomy of the Petiole: The internal structure of the petiole of mulberry is like the primary tissues of the stem. The epidermis is single layered. Some of the cells are drawn into epidermal hairs in certain species. Below the epidermis, there is a supporting tissue of four to five layers of collenchyma cells. The ground parenchyma is like the cortex of the stem. The vascular bundles are collateral and scattered in the ground parenchyma in a circular manner in early stages. The phloem is oriented towards the periphery of the petiole (Figure 29).

4.3.2: Anatomy of leaf blade: The leaves are dorsiventral with reticulate venation. The upper epidermis consists of a single layer of tabular shaped cells closely arranged without intercellular space. However, the continuity is broken at certain places due to enlargement of the cells in the form of idioblasts. The outer walls are cutinized and a layer of cuticle is found. The thickness of the cuticle varies with mulberry variety. The thickness of the cuticle, number of idioblasts and thickness of the blade have a significant role in determining the feeding quality of leaf. Those with thinner cuticle, thinner leaf blade and fewer number of cystoliths are more palatable to silkworms (Melikyan and Babyan, 1971).

The idioblasts contain deposits of calcium carbonate (Katsumata, 1970). The shape of the idioblast is taken into consideration in classifying the different species of *Morus*. Those with narrow beak are grouped under ''Dolichocystolithiae'' group as in *Morus bombycis*, *M. australis* and *M. kagayamae* and those with broken beak are grouped under ''Brachycystolithiae'' group as in *Morus latifolia*, *M. alba* and *M. tiliaefolia* (Hotta, 1932). The size of the idioblast varies with the maturity of the leaf. Generally the maximum sized idioblast is taken into consideration (Figure 30). The idioblasts connected with vein are bigger than those unconnected with vein. Those which are not connected with vein are taken for classification (Figure 31).

The lower epidermis is much like the upper epidermis but with a thinner cuticle and stomata. Idioblasts are absent. Number of stomata per unit area of the leaf, size of the stoma and the size of the guard cells varies from diploid to polyploids (Figure 33).

The palisade parenchyma is usually a single layer of closely packed, elongate-prismatic shaped cells with their long axes at right angles to the upper epidermis, with numerous chloroplasts along the inner sides. Sometimes, as in Goshoerami, more than one layer is seen.

Spongy parenchyma consists of isodiametric or slightly elongated cells with fewer chloroplasts. The cells are loosely packed leaving large inter-cellular space and respiratory cavities near the stoma.

Vascular bundle consists of xylem and phloem (Figures 32a and 32b). Xylem is arranged towards the upper epidermis and phloem towards the lower epidermis with a bundle sheath of a single layer of compactly arranged colourless parenchymatous cells extending on one or either side of the bundle towards epidermis in almost all the prominent veins (Esau, 1953). The bigger vascular bundles found to have a sclerenchyma sheath within the bundle sheath, covering completely the vascular bundle or as patches on one or both of the sides.

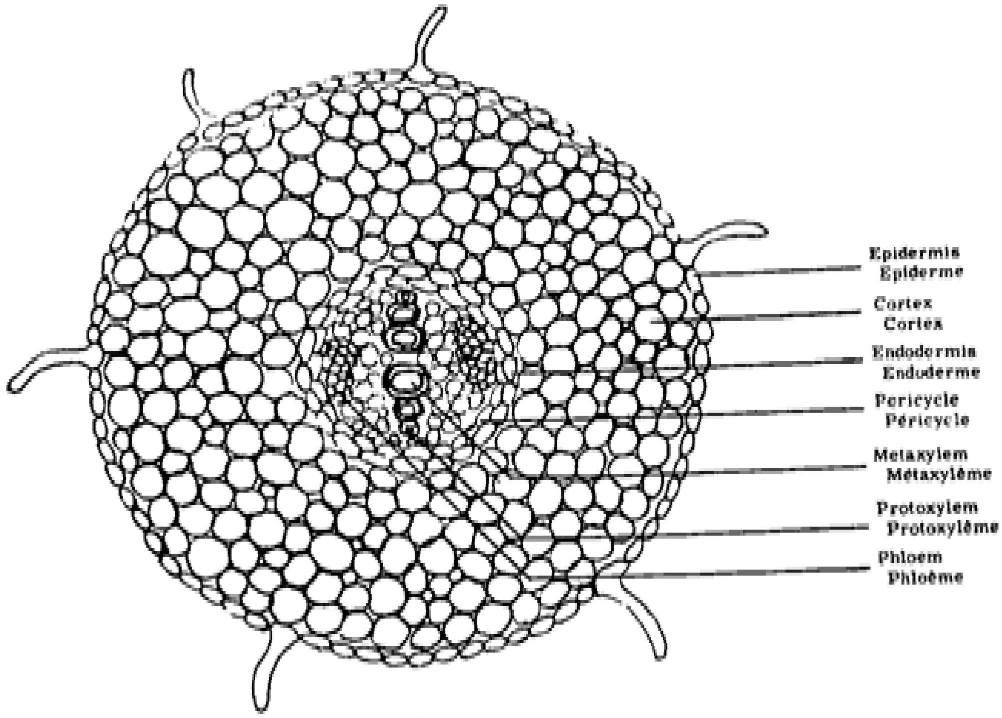


Fig. 24

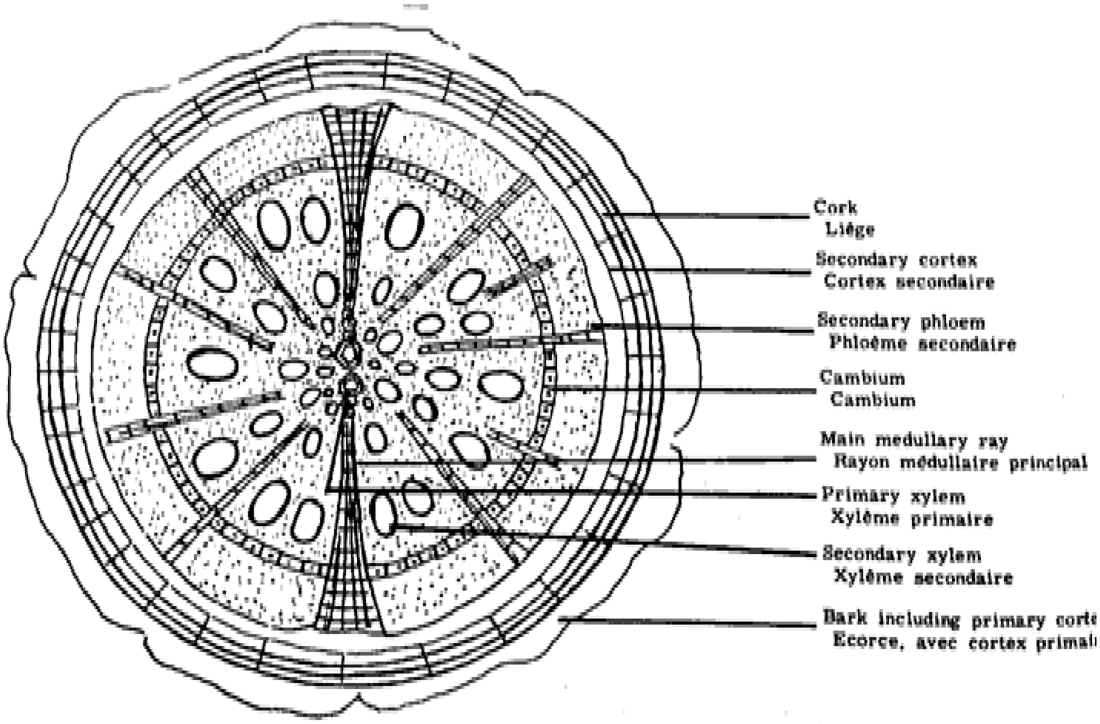
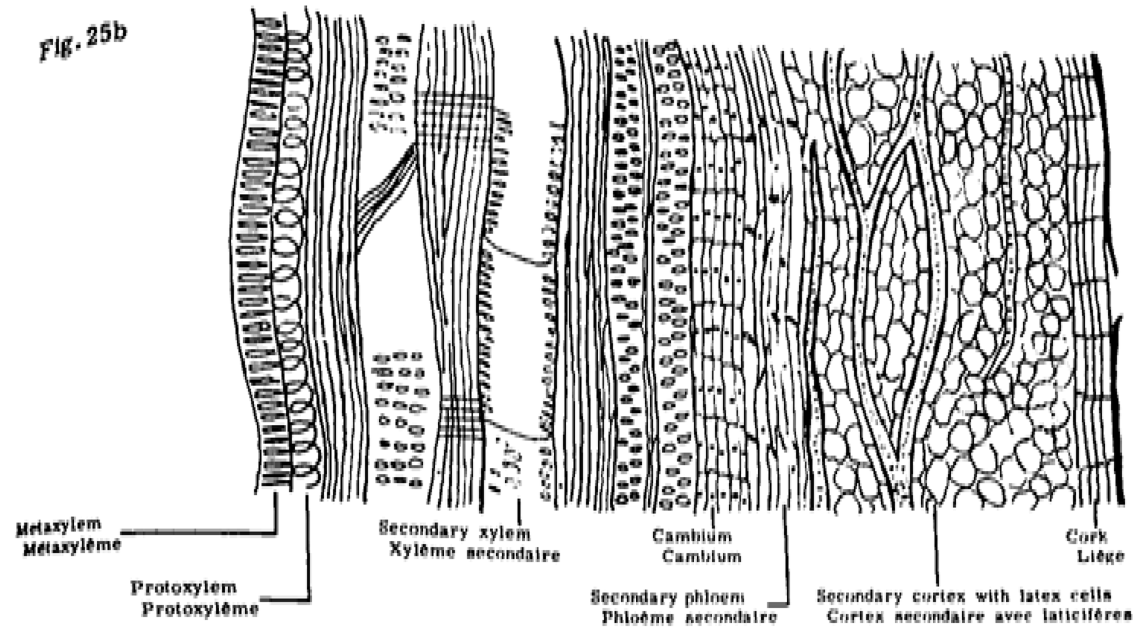


Fig. 25a

Fig. 25b



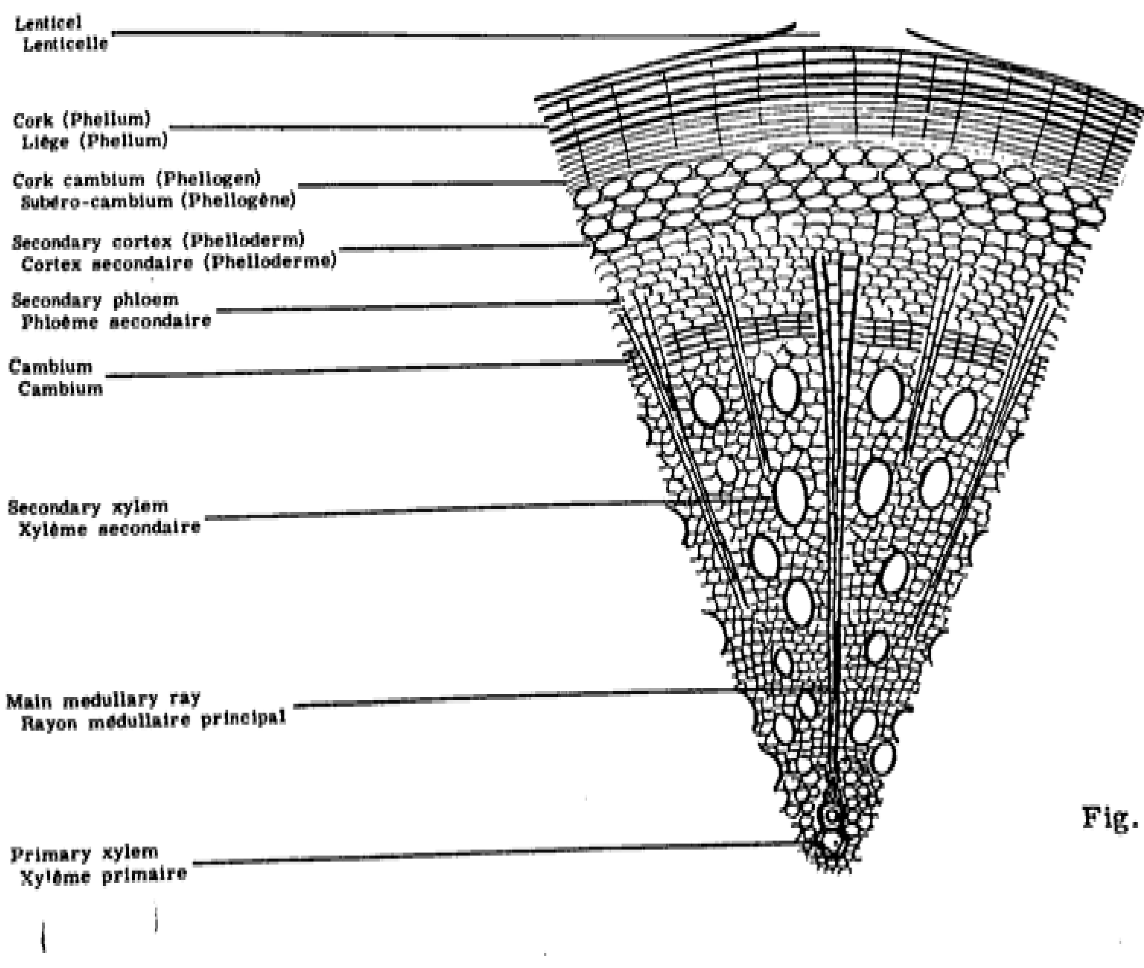


Fig. 25c

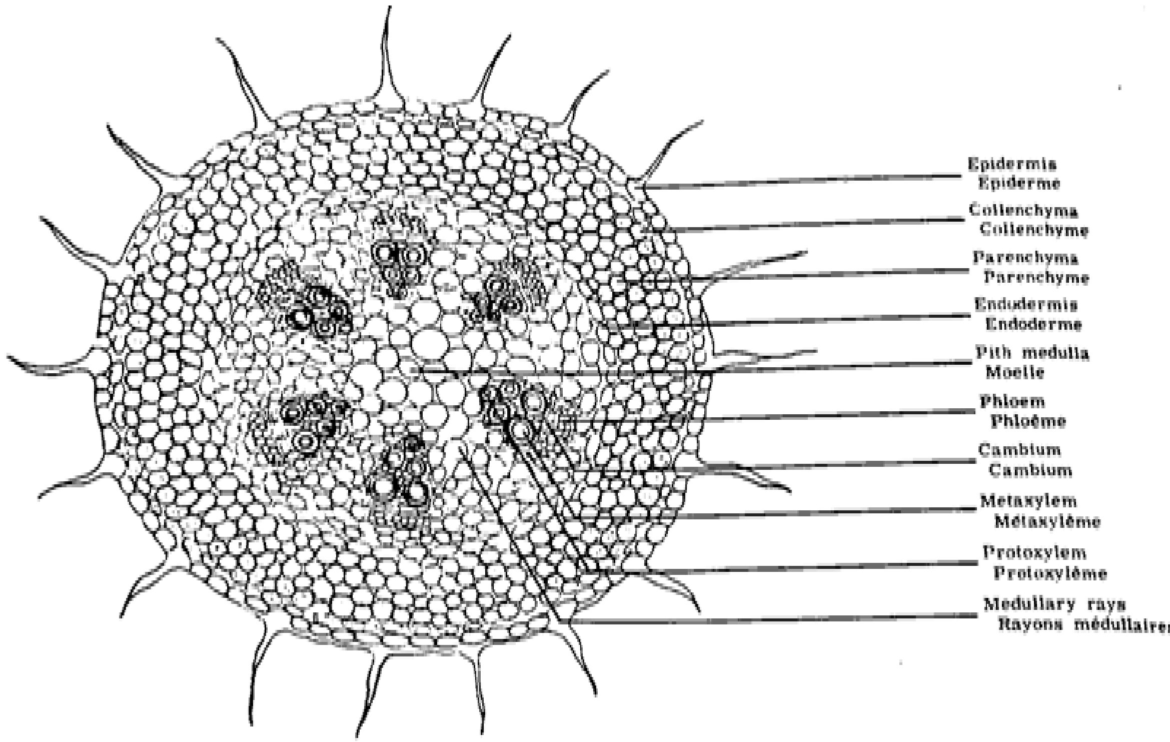

Epidermis
Epiderme
Collenchyma
Collenchyme
Parenchyma
Parenchyme
Endodermis
Endoderme
Pith medulla
Moelle
Phloem
Phloème
Cambium
Cambium
Metaxylem
Métaxylème
Protoxylem
Protoxylème
Medullary rays
Rayons médullaires

Fig. 26

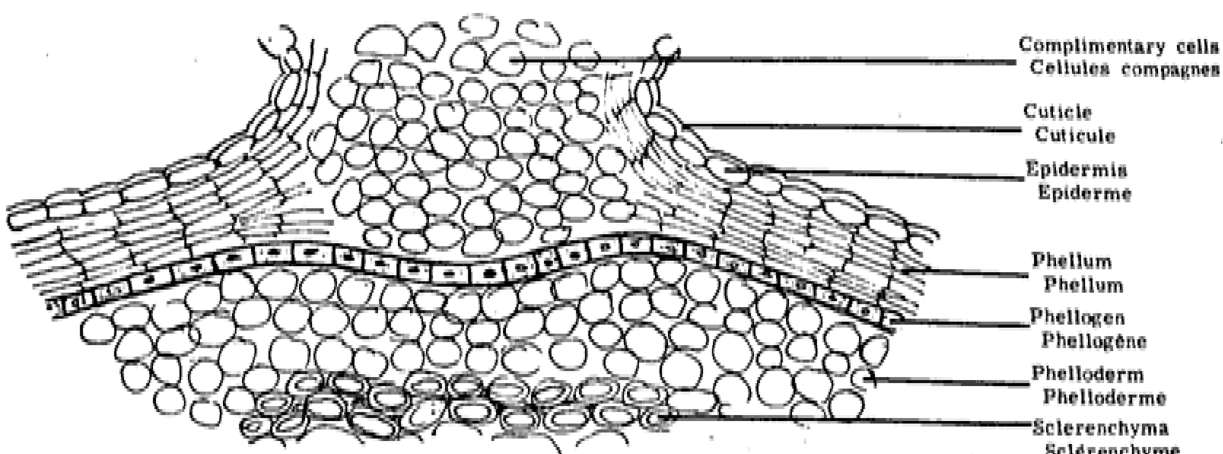
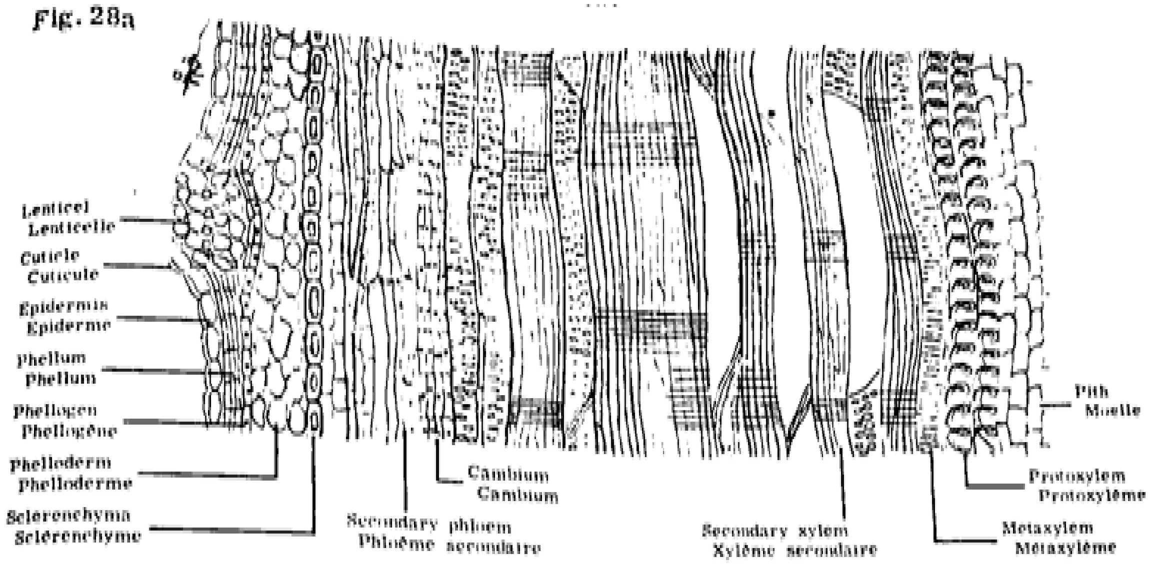

Complimentary cells
Cellules compagnes
Cuticle
Cuticule
Epidermis
Epiderme
Phellum
Phellum
Phellogen
Phellogène
Phelloderm
Phelloderme
Sclerenchyma
Sclérenchyme

Fig. 27

Fig. 28a



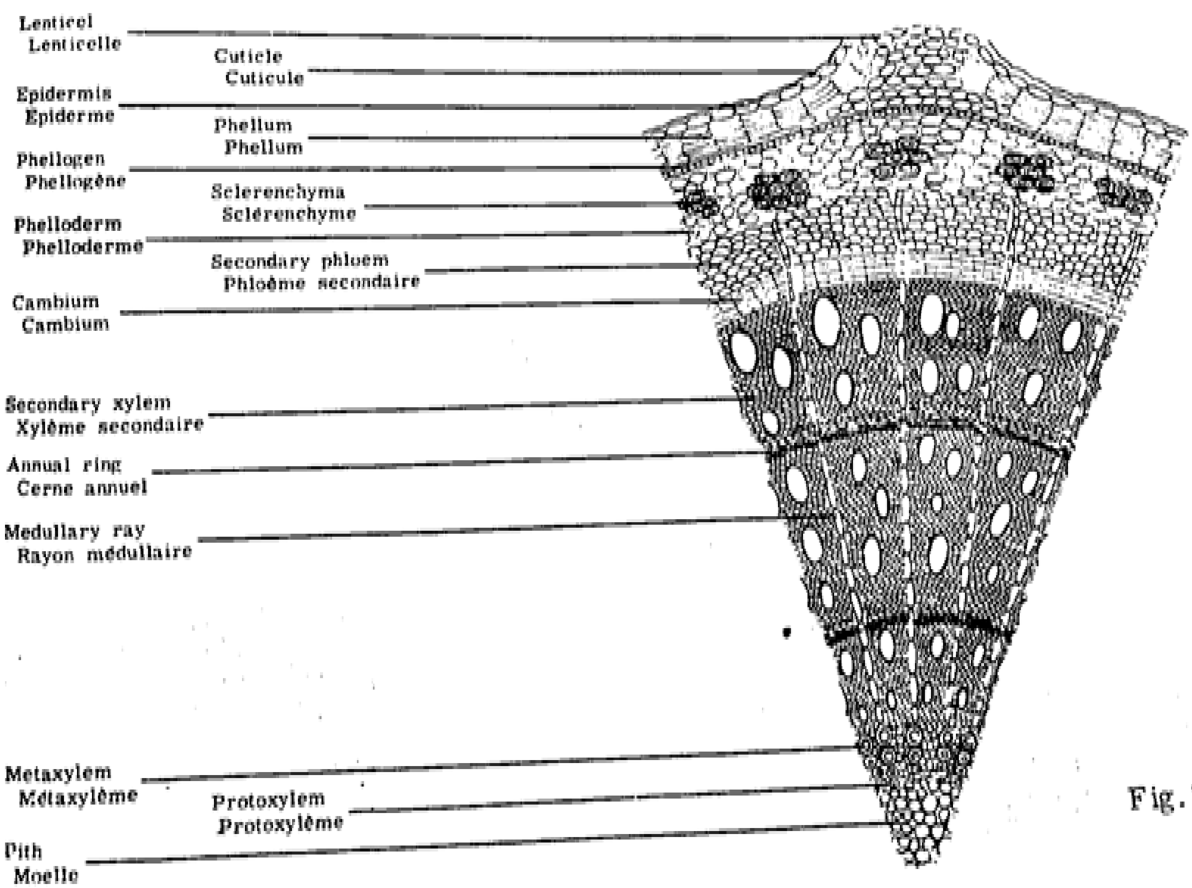


Fig. 28b

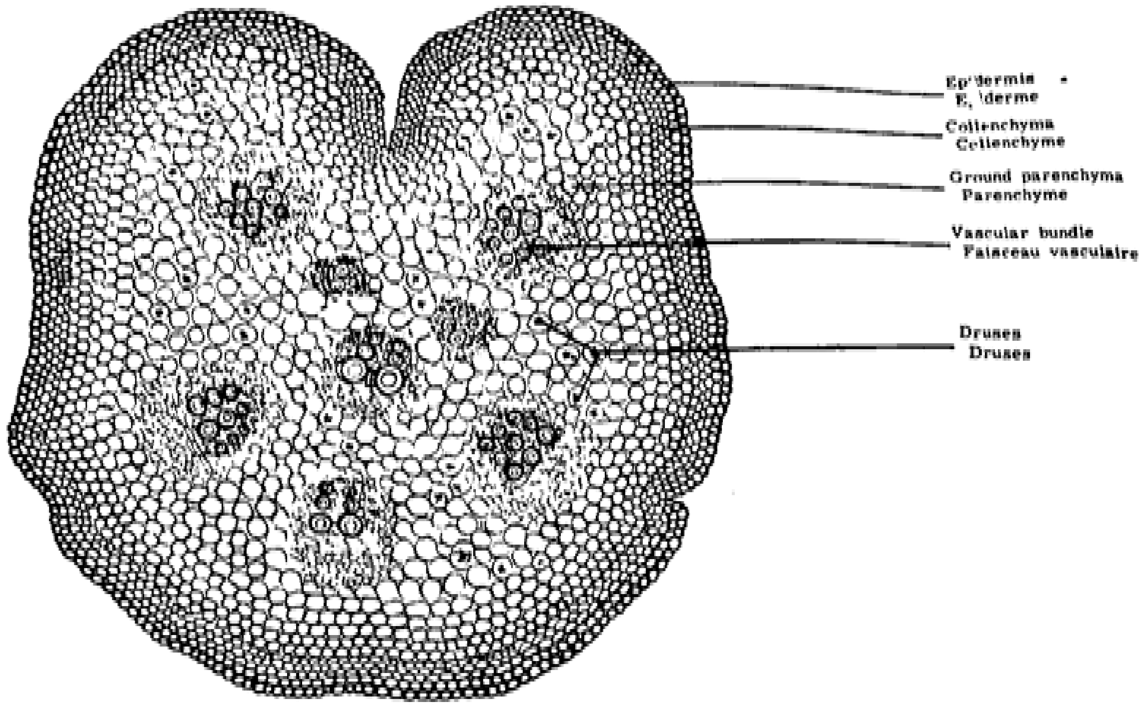


Fig. 29

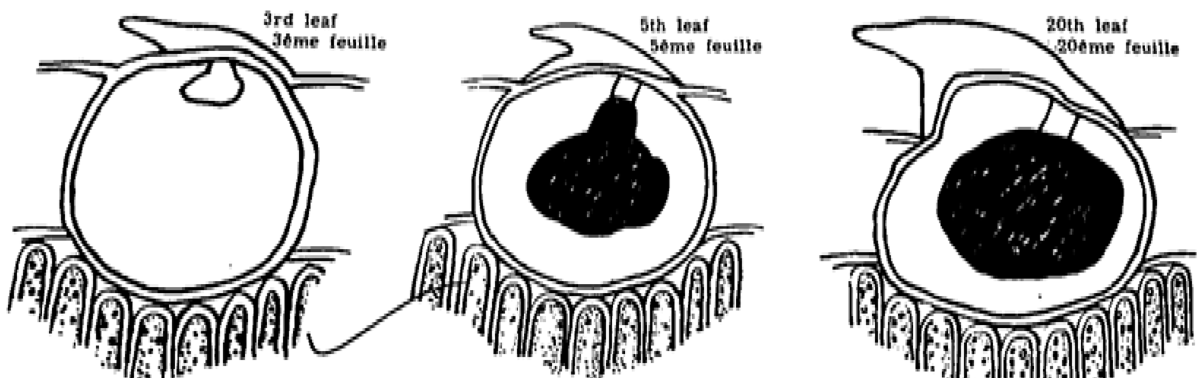
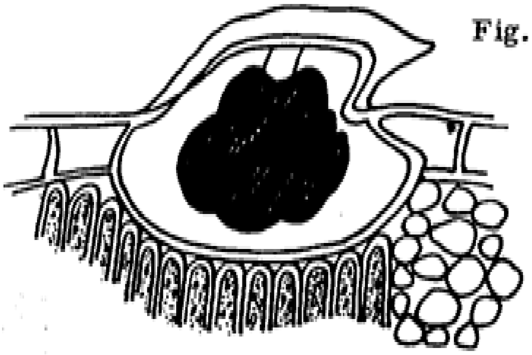


Fig. 30a Fig. 30b Fig. 30c

Fig. 31a



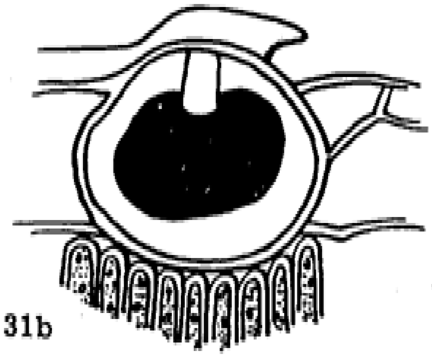


Fig. 31b

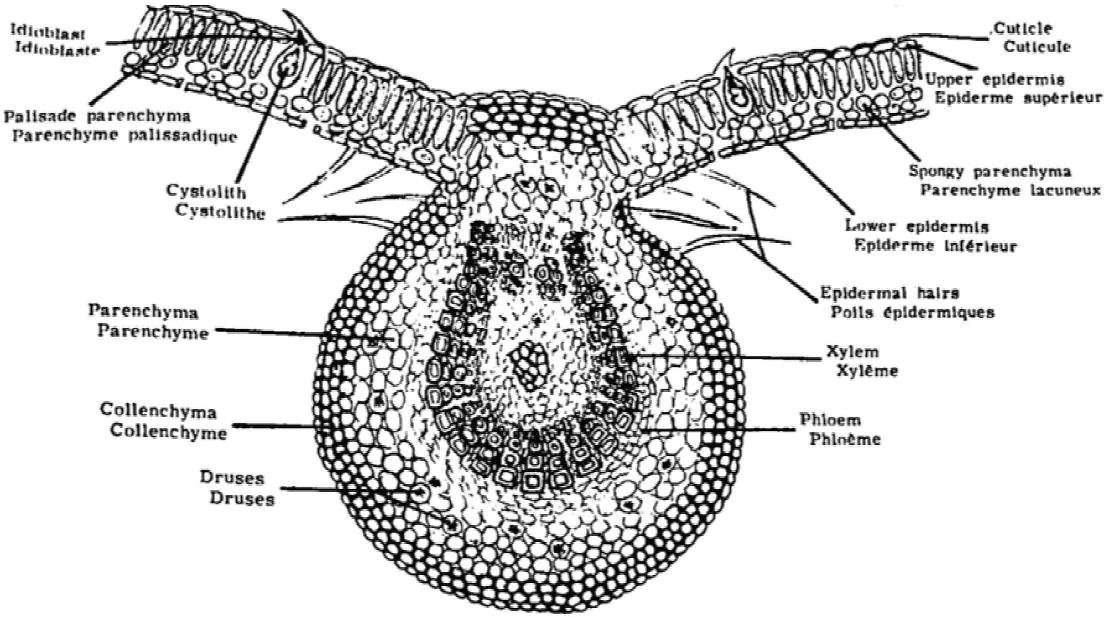


Fig. 32a

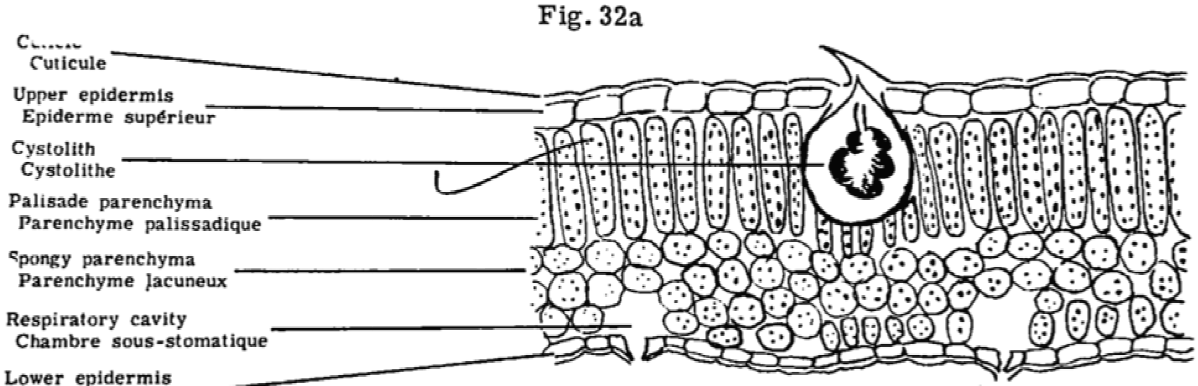


Fig. 32b

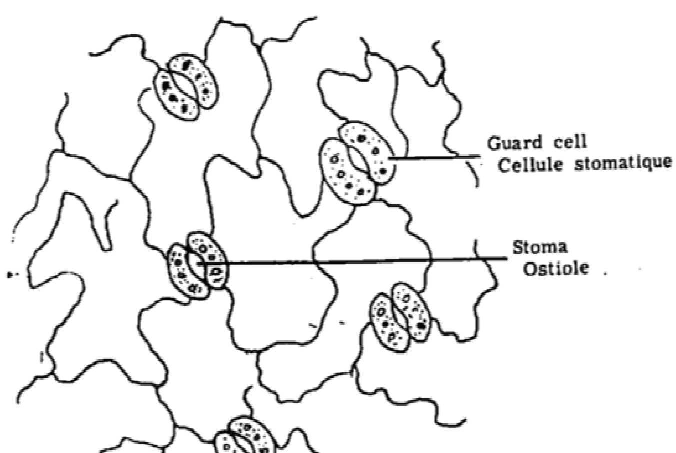


Fig. 33a

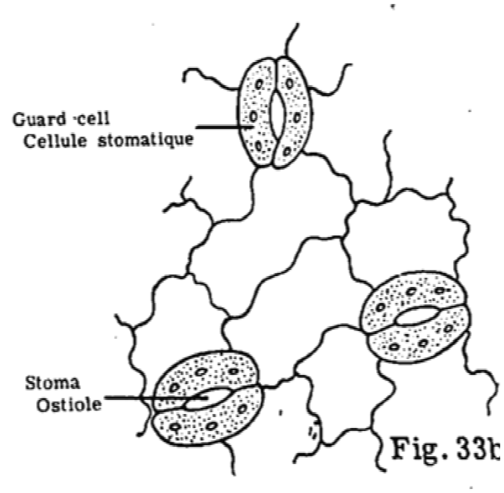


Fig. 33b