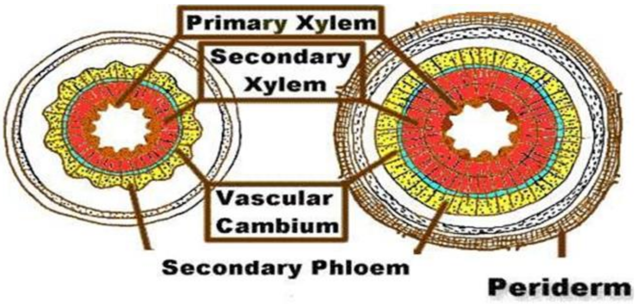
Topic: Structure, function and seasonal activity of cambium

VASCULAR CAMBIUM

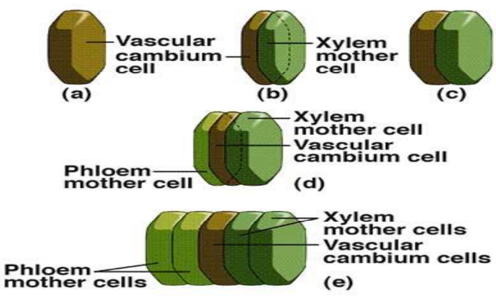
The **vascular cambium** (pl. cambia or cambiums) is a lateral meristem in the **vascular** tissue of plants. The **vascular cambium** is a cylindrical layer of **cambium** that runs through the stem of a plant that undergoes secondary growth.



The vascular cambium develops either as longitudinal strands or as a hollow cylinder. In the woody dicotyledons and gymnosperms the primary vascular tissues of the stem and root exist for only a relatively short period, and their function is taken over by the secondary vascular tissues which are produced by the cambium. In many herbaceous angiosperms, and also in most of the lower vascular plants, cambium is absent or vestigial.

Secondary growth occurs in all gymnosperms, many dicots and just a few monocots. Secondary growth of the plant body allows for the plant to increase in size radially and is brought about by the lateral meristems. There are two lateral meristems: the vascular cambium gives rise to secondary phloem and secondary xylem, whereas the Phellogen (cork cambium) gives rise to periderm.

The vascular cambium is unlike the primary meristems of the plant (root and shoot apex) in that it produces new cells and tissues which add to the axial system (i.e. the conducting system) as well as to the radial system (i.e. the lateral transport pathway), whereas the apical meristems of the shoot and root add only to the axial system.



Origin of Vascular Cambium:

The primary vascular skeleton is built up by the maturing of the cells of the procambium strands to form xylem and phloem. The plants which do not possess secondary growth, all cells of the procambium strands mature and develop into vascular tissue.

In the plants which have secondary growth later on, a part of the procambium strand remains meristematic and gives rise to the cambium proper. In roots the formation of cambium differs from that in stems because of the radial arrangement of the alternating xylem and phloem strands. Here the cambium arises as discrete strips of tissue in the procambium strands inside the groups of primary phloem. Later on, the strips of cambium by their lateral extension are joined in the pericycle opposite the rays of primary xylem. The secondary tissue formation is most rapid beneath the groups of phloem so that the cambium, as seen in the transverse section of older roots, soon forms a circle.

Location of vascular cambium

The vascular cambium in dicot stems and roots is located between the xylem and the phloem in the stem and root of a vascular plant, and is the source of both the secondary xylem (grow inwards, towards the pith) and the secondary phloem growth (outwards).

In Monocot plants such as corn, palms, and bamboos do not have a vascular cambium and do not exhibit secondary growth by the production of concentric annual rings. They cannot increase in girth by adding lateral layers of cells as in conifers and woody dicots.

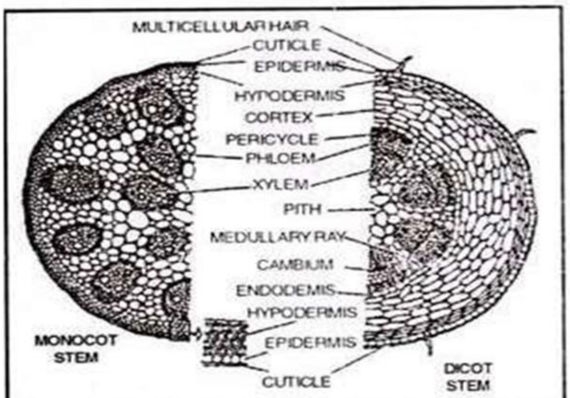
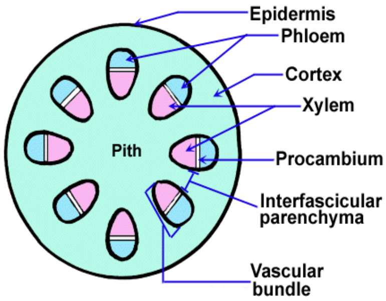


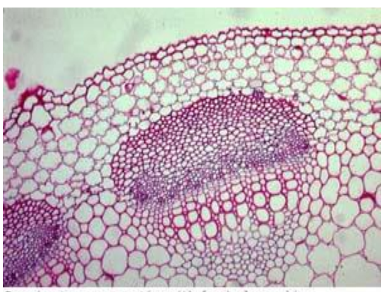
Figure 9.17 Comparison of the T.S. of monocot and dicot stem.

Fig.: Comparison of T.S. of Monocot and Dicot Stem

General development and structure of the vascular cambium

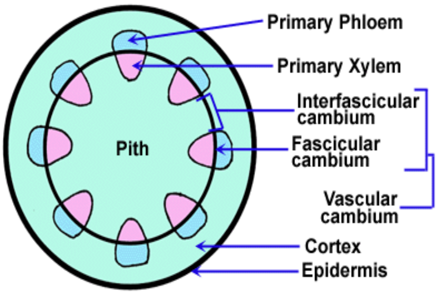
In certain plants, including monocotyledons, all the cells of the procambium undergo differentiation into primary vascular tissues. In almost all the dicotyledons, and gymnosperms a portion of the procambium remains meristematic even after the completion of primary growth and develops into the cambium of the secondary body. The cambium that arises within the bundles of primary vascular tissue of the stem is called ***fascicular cambium***.





Begonia stem cross section with fascicular cambium.

The strip of fascicular cambium usually becomes joined by additional strips of cambium which constitute the ***interfascicular cambium***. The interfascicular cambium is not a continuation of the pro-cambium but develops from the interfascicular parenchyma. Therefore this part of the cambium constitutes a secondary meristem also from the point of view of its origin.



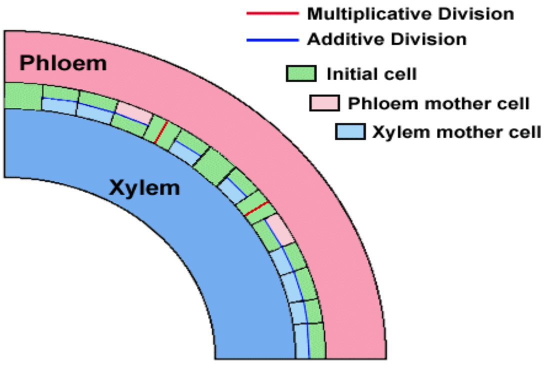

Medicago old stem cross section with fascicular and interfascicular cambia.

Thus a complete hollow cylinder of cambium is developed which is present throughout the length of the main plant axis and to which narrower cylinders of cambium, belonging to the stem and root branches, are connected. Sometimes the cambium extends into the leaves.

In most dicotyledons and gymnosperms the cambial cylinder develops between the primary xylem and phloem, a position that is retained throughout the life of the plant. From this position the cambium produces the secondary xylem centripetally and the secondary phloem centrifugally.

Divisions in Vascular Cambium

A close observation of the cells of the vascular cambium reveals two patterns of division. Initial cells can undergo multiplicative divisions (red line in the following diagram) or they can undergo additive divisions (blue line).



Multiplicative divisions produce more initial cells and result in the increased circumference of the vascular cambium. Of the two cells produced from an additive division one is retained as an initial cell that will divide again and the other will become a phloem mother cell or a xylem mother cell. These mother cells will differentiate into their respective cell types.

The meristem that forms secondary tissues consists of a uniseriate sheet of initials that form new cells usually on both sides. The cambium forms xylem internally and phloem externally. The tangential division of the cambial cell forms two apparently identical daughter cells. One of the daughter cells remains meristematic, i.e., the persistent cambial cell, the other becomes a xylem mother cell or a phloem mother cell depending upon its position internal or external to the initial. The cambium cell divides continuously in a similar way. One daughter cell always remains meristematic i.e. the cambium cell, whereas the other becomes either a xylem or a phloem mother cell.

Probably there is no definite alternation and for brief periods only one kind of tissue is formed. Adjacent cambium cells divide at nearly the same time, and the daughter cells belong to the same tissue. This way, the tangential continuity of the cambium is maintained.

Structure of Cambium:

There are two general conceptions of the cambium as an initiating layer:

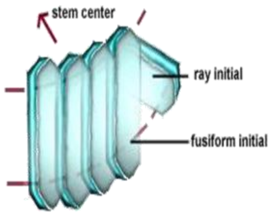
1. That it consists of a uniseriate layer of permanent initials with derivatives which may divide a few times and soon become converted into permanent tissue;

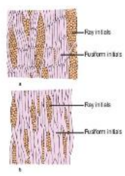
2. That there are several rows of initiating cells which form a cambium zone, a few individual rows of which persist as cell forming layers for some time. During growing periods the cells mature continuously on both sides of the cambium it becomes quite obvious that only a single layer of cells can have permanent existence as cambium.

Other layers, if present, function only temporarily and become completely transformed into permanent cells. In a strict sense, only the initials constitute the cambium, but frequently the term is used with reference to the cambial zone, because it is difficult to distinguish the initials from their recent derivatives.

***Cellular Structure of Cambium*:**

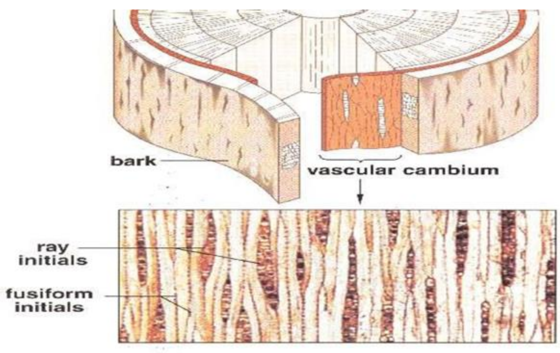
Vascular cambium is a very thin layer that lies between the primary xylem inside and primary phloem on outside. They contain meristematic cells that can form the secondary xylem inside and secondary phloem outside. There are two kinds of meristematic cells called ***fusiform initials*** which are vertically elongated and ***ray initials*** which are horizontally elongated.





The *Fusiform initials* are elongated cells with tapered ends. These cells are very long and for example, in old trunks of *Sequoia sempervirens*, they reach a maximum length of 8.7 mm. Fusiform initials are elongated but broadly flattened on the tangential face. Fusiform initials produce axial elements of secondary vascular tissues, such as fibers, tracheids, vessel members, companion cells, sieve-tube elements and axial parenchyma

Ray initials on the other hand are much smaller cells than the fusiform initial and are more or less isodiametric in shape. These are shorter cells, somewhat elongated on their radial axis. The ray initials form ray cells, found in xylem and phloem, which occur in transverse or horizontal series.



Duration of Cambium:

The duration of the functional life of the cambium varies greatly in different species and also in different parts of the same plant. In a perennial woody plant the cambium of the main stem lives from the time of its formation until the death of the plant.

It is only by the continued activity of the cambium in producing new xylem and phloem that such plants can maintain their existence. In leaves, inflorescence and other deciduous parts, the functional life of the cambium is short. Here all the cambium cells mature as vascular tissue. The secondary xylem is directly found upon the secondary phloem in such bundles.

SEASONAL ACTIVITY OF CAMBIUM

Cambium of some plants remains active for the entire period of their life, i.e., cambial cells divide and resulting cells mature to form xylem and phloem elements. This type of seasonal activity usually found in the plants present in the tropical regions. However, not all plants show cambial activity.

In regions with definite seasonal climate; seasonal activity of cambium ceased with onset of unfavorable conditions; In Autumn, it enters the dormant state and lasts for the end of summer. In spring, cambium again becomes active.

Duration of cambial activity is also affected by day length, e.g., In ***Robinia pseudoacacia,*** cambium is dormant under short-day condition.

In the tropical rain forest, relatively few species of trees, such as teak, have visible annual rings. However in majority of the plants, difference between wet and dry seasons is too subtle. This has result no visible differences in the cell size and density between wet and dry seasonal growth. As a result the trees become ring less. The percentage of ring less trees in the rain forests of India is 75%, whereas in Amazon it is 43% and in Malaysia it is 15%.

CAMBIUM IN HEALING OF WOUNDS:

One of the important functions of the cambium is the formation of callus or wound tissue, and the healing of the wounds. When wounds occur on plants, a large amount of soft parenchymatous tissue is formed on or below the injured surface; this tissue is known as callus. The callus develops from the cambium and by the division of parenchyma cells in the phloem and the cortex.

During the healing process of a wound the callus is formed. In this there is at first abundant proliferation of the cambium cells, with the production of massive parenchyma. The outer cells of this tissue become suberized, or periderm develops within them, with the result a bark is formed.

However, just beneath this bark the cambium remains active and forms new vascular tissue in the normal way. The new tissue formed in the normal way extends the growing layer over the wound until the two opposite sides meet. The cambium layers then unite and the wound becomes completely covered.