Secondary Growth in Dicotyledonous Stems

Introduction to Secondary Growth:

The growth in length of the axis is called the primary growth and produces primary tissues. The primary body of the plant is developed from the apical meristem.

Increases in girth or thickness of the axis is called secondary growth. The tissues, formed during secondary growth are called secondary tissues.

Sometimes as in monocotyledons and pteridophytes, does not grow in thickness by cambial activity **Secondary Growth** is absent.

Secondary tissues may be two types—the vascular tissues that are developed by the true cambium, and cork and phelloderm, which are formed by phellogen or cork-cambium.

In a typical dicotyledonous stem, the secondary growth starts in the intra- and extrastelar regions.

Secondary Growth takes place by the following steps:

1. **Formation of cambial ring**
2. **Activity of cambium ring**
3. **Secondary vascular tissue**
4. **Formation of Periderm**

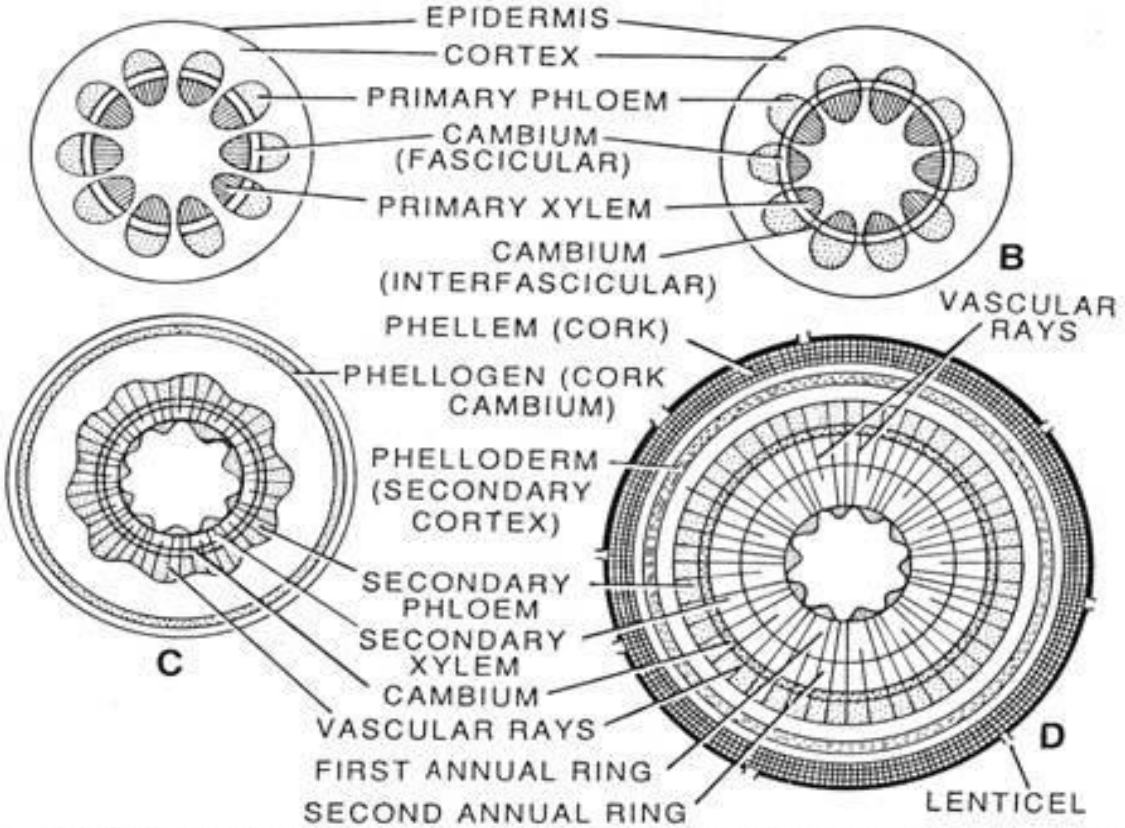


Fig. 40.36. Secondary growth in thickness. A – D, diagrams showing stages in the secondary growth of a dicotyledonous stem upto two years.

Formation of cambial ring:

- The cambium present in the primary vascular bundles is known as **fascicular cambium** it is also known as vascular cambium . it is primary in origin it is present in between xylem and phloem.
- Before secondary growth starts the parenchymatous cells of the medullary rays which are in line with the fascicular cambium become meristematic and form inter fascicular cambium.
- The inter fascicular cambium extend laterally and join with the fascicular cambium forms a continuous **cambial ring**.
- The cambial cells are of two kinds namely the **Fusiform initials** and **Ray initials.** The Fusiform initials produce secondary tissues and ray initials gives rise to ray cells of xylem and phloem.

Activity of cambium ring

- The cambial ring cuts of vascular tissues on either side. The cells that are produced outwards become differentiated into secondary phloem and the cells that are formed inwards become differentiated into secondary xylem.
- Due to the formation of secondary xylem, the primary xylem masses are push towards the centre.
- Due to the formation of secondary phloem the primary phloem masses are push outwards. The primary phloem gets crushed and the primary xylem remains intact at the centre.
- The ray initials of the cambial ring cuts of narrow secondary medullary rays which extend both into the secondary xylem as well as secondary phloem.

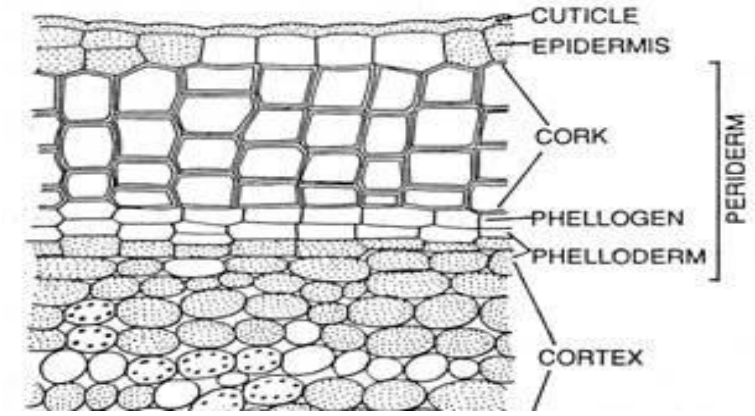
Secondary vascular tissue:

- Secondary vascular tisses are the **secondary xylem** and **secondary phloem** they are formed by the fusiform initials of the vascular cambium.
- The secondary xylem is also known as **wood**.
- The cambium ring cuts off new cells on its inner side are gradually modified into xylary elements, called the secondary xylem.
- This tissue serves many important functions, such as conduction of water and nutrients, mechanical support, etc
- The cambial cells divide tangentially and produce secondary phloem elements towards outside of it.
- Secondary phloem is also known as **bast** and consist of sieve tube, campanion cells, phloem fibre or bast fibre and phloem parenchyma.
- Normally, the amount of secondary phloem is lesser than the amount of secondary xylem.usually the primary phloem becomes crushed and

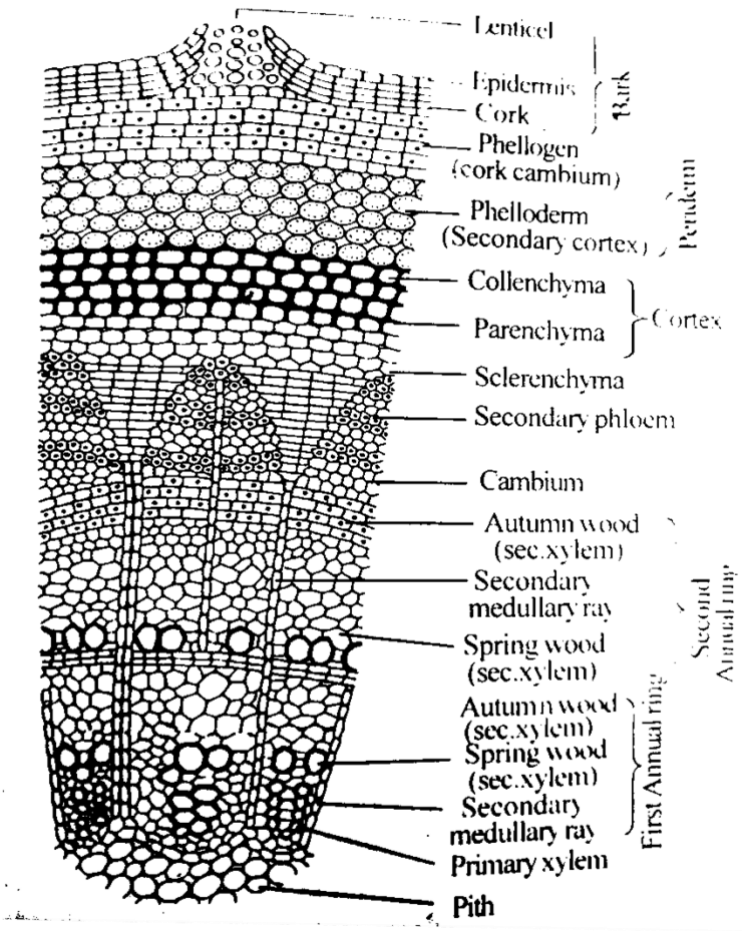
functionless and the secondary phloem performs all physiological activities for sufficiently a long period of time.

Formation of periderm:

- Due to continued formation of secondary tissues, in the older stem, the epidermis gets stretched and ultimately tends to rupture and followed by the death of epidermal cells and outer tissues, and a new protective layer is developed called **periderm**.
- The formation of periderm is a common phenomenon in stems of gymnosperms that increase in thickness by secondary growth.



Periderm



Secondary growth in thickness – T.S. of two year old dicotyledonous stem

Structurally, the Periderm consists of three parts:

1. The periderm is produced new lateral meristem called as phellogen or cork cambium. The cells of phellogen are living, thin walled and compactly arranged.

2. The layer of cells cut off by phellogen on the outer side are called **Phellem or cork.**

3. The cells cut off by phellogen towards inner side are called **Phelloderm** and it is also known as secondary cortex**.**

The periderm appears on the surface of those plant parts that possess a continuous increase in thickness by secondary growth.

Annual Rings or Growth Rings:

- The secondary xylem in the stems of perennial plants commonly consists of concentric layers, each one of which represents a seasonal increment. In transverse section of the axis, these layers appear as rings, and are called **annual rings** or **growth rings.**
- The wood developed in the summer or spring season is called **spring wood or early wood,** and the wood formed in winter or autumn season is known as **autumn wood or late wood**.
- The line of demarcation is quite conspicuous between the late wood of one year and the early wood of next year. An annual ring, therefore, consists of two parts—an inner layer, early wood, and an outer layer late wood.

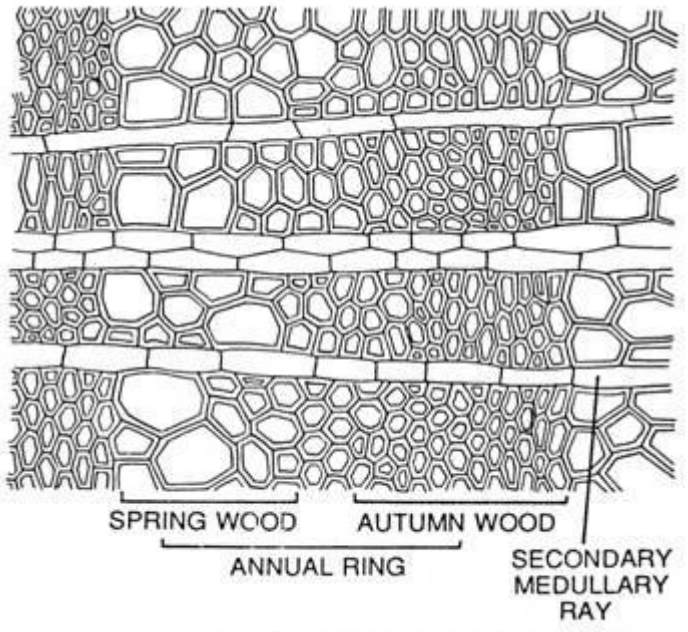


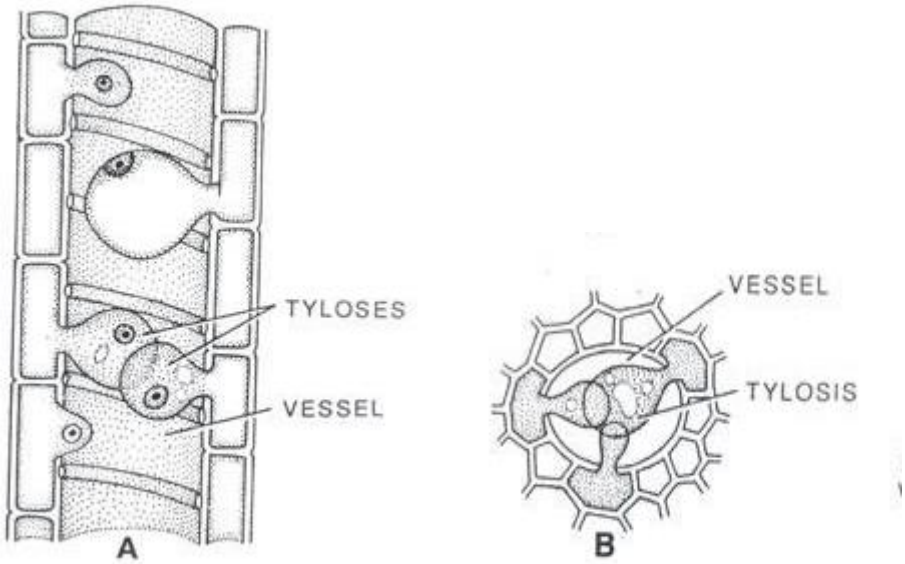
Fig. 40.43. Annual rings. An annual ring in sectional view (magnified).

Dendrochronology:

Each annual ring corresponds to one year's growth, and on the basis of these rings the age of a particular plant can easily be calculated. The determination of age of a tree by counting the annual rings is known as **dendrochronology**.

Sometimes two annual rings are formed in a single year, and in such cases the counting of the annual rings does not show the correct age of the tree. This happens perhaps because of the drought conditions prevailed in the middle of a growing season

Tyloses:



Tyloses. A- L. S. Of vessel with Tyloses. B- T.S. of Of vessel with Tyloses

In many plants, the walls of the xylem vessels produce balloon like outgrowths into the lumen of the vessels are called **tyloses.** Usually these structures are formed in secondary xylem but they may also develop in primary xylem vessels. Tyloses are formed by the enlargement of the pit membranes of the half-bordered pits present in between a parenchyma cell and a vessel or a tracheid.

They are commonly found in many angiospermic families. Normally they develop in the heart wood of angiosperms and block the lumen of the vessels, and thus add to the durability of the wood. **Tyloses prevent rapid entrance of water, air and fungus by blocking the lumen of the vessel.**

Sapwood and Heartwood:

The outer region of the old trees consisting of recently formed xylem elements is **sapwood or alburnum**. This is of light colour and contains some living cells also in the association of vessels and fibres.

This part of the stem performs the physiological activities, such as conduction of water and nutrients, storage of food, etc.

The central region of the old trees, which was formed earlier, is filled up with tannins, resins, gums and other substances which make it hard and durable, is called **heartwood or duramen**. It looks black due to the presence of various substances in it. Usually the vessels remain plugged with tyloses. The function of heartwood is no longer of conduction; it gives only **mechanical support to the stem**. The sapwood changes into heartwood very gradually. The proportion of sapwood and heartwood is highly variable in different species.

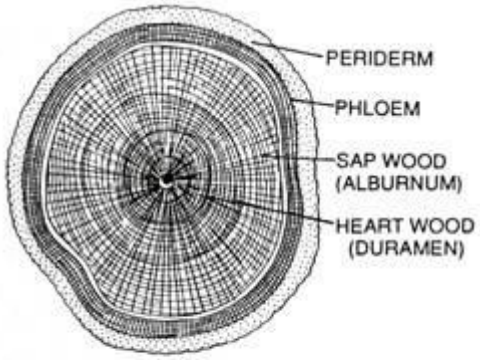


Fig. 40.47. T.S. branch of *Fraxinus*, showing heart and sapwood. (diagrammatic).

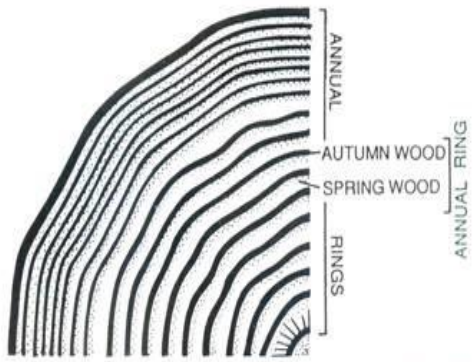


Fig. 40.44. Annual rings (growth rings)—cut surface of a stem showing annual rings.

Bark:

The term bark is commonly applied to all tissues outside the vascular cambium of the stem, in either primary or secondary state of growth. In this way, bark includes primary phloem and cortex in stem with primary tissues only, and primary and secondary phloem, cortex and periderm in stem with secondary tissues.

This term is also used to denote the tissue that is accumulated on the surface of the stem as a result of the activity of cork cambium.

Lenticels:

Usually in the periderm of most plants, certain areas with loosely arranged cells have been found, which possess more or less raised and corky spots where the underneath tissues break through the epidermis. Such areas are universally found on the stems of woody plants. These broken areas are called the lenticels.

Wutz (1955) defined a lenticel as a small portion of the periderm where the activity of the phellogen is more than elsewhere, and the cork cells produced by it are loosely arranged and possess numerous intercellular spaces.

The lenticels perform the function of exchange of gases during night or when the stomata are closed.

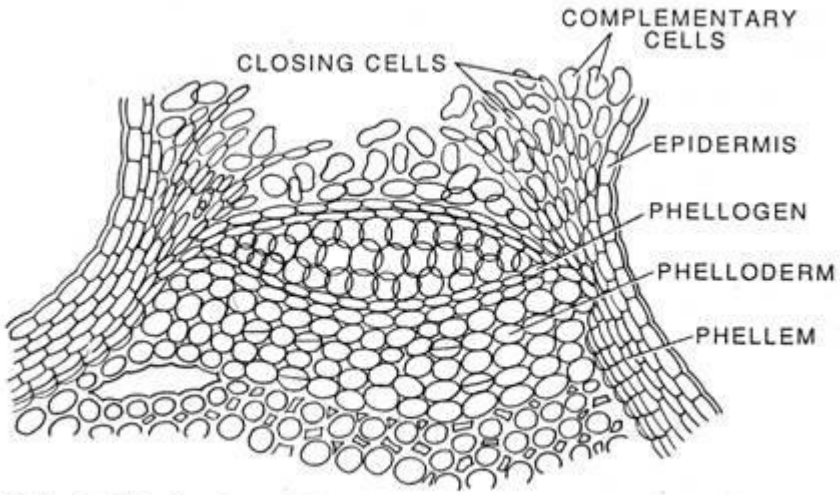


Fig. 40.58. The lenticel. A portion of T.S. of stem of *Prunus* showing lenticel. Successive layers of complementary and closing cells are visible.

The lenticels originate beneath the stomata, either just before or simultaneously with the initiation of the first layer of the periderm. In most of plants, lenticel formation takes place in the first growing season and sometimes previous to the growth in length has stopped.

The lenticels are filled up with complementary cells completely in the spring season whereas in the end of the spring season the lenticel becomes closed by the formation of closing layer.

The complementary cells are thin-walled, rounded and loose with sufficiently developed intercellular spaces among them. Their cell walls are not suberized. Due to the presence of profuse intercellular spaces, the lenticels perform the function of exchange of gases between the atmosphere and internal tissues of the plant.