# TOPIC: PLANT TISSUE SYSTEM-II

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CLASS:XI
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## SECONDARY GROWTH

- The growth of the roots and stems in length with the help of apical meristem is called the primary growth.
- Apart from primary growth most dicotyledonous plants exhibit an increase in girth. This increase is called the **secondary growth**.
- Secondary growth also occurs in stems and roots of gymnosperms. However, secondary growth does not occur in monocotyledons.
- The tissues involved in secondary growth are the two **lateral meristems: vascular cambium** and **cork cambium**.
- **Secondary growth due to Vascular Cambium**
- The meristematic layer that is responsible for cutting off vascular tissues – xylem and pholem – is called vascular cambium.
- In the young stem it is present in patches as a single layer between the xylem and phloem. Later it forms a complete ring.

**Formation of cambial ring**

In dicot stems, the cells of cambium present between primary xylem and primary phloem is the **intrafascicular cambium**. The cells of medullary cells, adjoining these intra fascicular cambium become meristematic and form the **inter fascicular cambium**. Thus, a continuous ring of cambium is formed.

**Cambium ring = inter + intrafascicular cambium**

**Activity of the cambial ring**

- The cambial ring becomes active and begins to cut off new cells, both towards the inner and the outer sides.
- The cells cut off towards pith,mature into **secondary xylem** and the cells cut off towards periphery mature into **secondary phloem**.
- The cambium is generally **more active on the inner side** than on the outer. As a result, the amount of secondary xylem produced is more than secondary phloem and soon forms a compact mass.
- The primary and secondary phloems get gradually crushed due to the continued formation and accumulation of secondary xylem.
- The primary xylem however remains more or less intact, in or around the centre.

- At some places, the cambium forms a narrow band of parenchyma, which passes through the secondary xylem and the secondary phloem in the radial directions. These are the **secondary medullary rays.**

**Spring wood and autumn wood**

- The activity of cambium is different in different conditions.
- As in temperate regions, where the climatic conditions are not uniform through the year, In the **spring season**, cambium is very active and produces a large number of xylary elements having vessels with wider cavities. The wood formed during this season is called **spring wood** or **early wood**.
- In winter, the cambium is less active and forms fewer xylary elements that have narrow vessels, and this wood is called **autumn wood** or **late wood**.
- The spring wood is lighter in colour and has a lower density whereas the autumn wood is darker and has a higher density.
- The two kinds of woods that appear as alternate concentric rings, constitute an **annual ring.** Annual rings seen in a cut stem give an estimate of the age of the tree.
- **Dendrochronology** – study/finding age of plant with the help of annual ring.

| Spring wood | Autumn wood |
|---|---|
| Cambium is very active. | Cambium is less active. |
| Large no of xylary vessels are produced. | Fewer xylary elements. |
| Vessels with wider cavities. | Vessels with narrow cavities. |
| Lighter in color | Darker in color. |
| Lower density | Higher density. |

**Heartwood and sapwood**

- In old trees, the greater part of secondary xylem is dark brown due to deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oils in the central or innermost layers of the stem. These substances make it hard, durable and resistant to the attacks of micro-organisms and insects. This region comprises dead elements with highly lignified walls and is called

  The heartwood does not conduct water but it gives mechanical support to the stem.

- The peripheral region of the secondary xylem, is lighter in colour and is known as the It is involved in the conduction of water and minerals from root to leaf.

| Heartwood (Duramen) | Sapwood (alburnum) |
|---|---|
| Central part of secondary xylem | Peripheral part of secondary xylem |
| Dark brown in colour | Lighter in colour |
| deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oils | No deposition of organic matter. |
| Resistant to the attacks of micro-organisms and insect. | Not Resistant to the attacks of micro-organisms and insect. |
| Comprises dead elements with highly lignified wall. | Walls are not highly lignified. |
| Provide mechanical support to stem | Conduction of water and minerals from roots to leaf. |

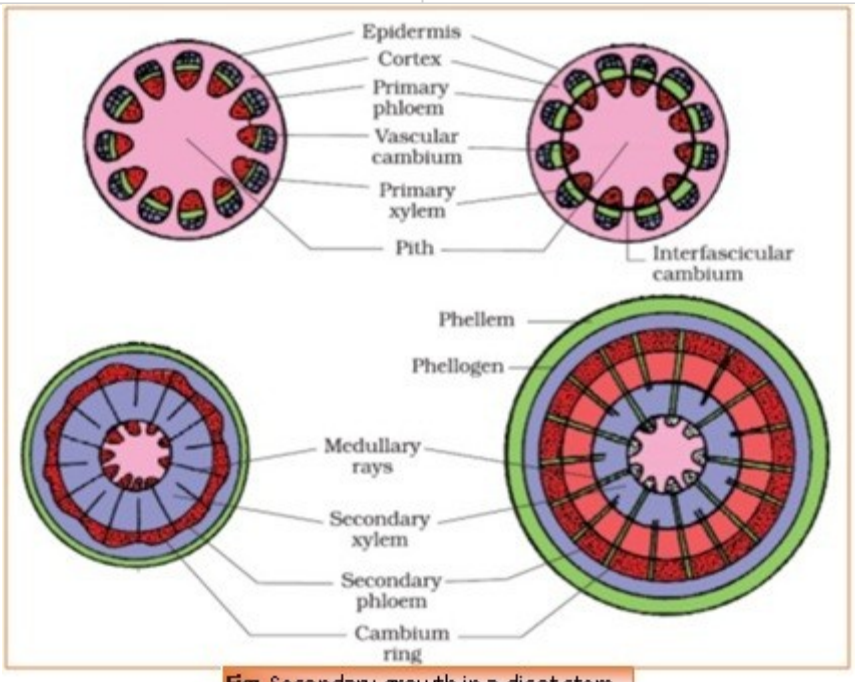


**Fig:** Secondary growth in a dicot stem

**Secondary growth due to Cork Cambium**

- As the stem continues to increase in girth due to the activity of vascular cambium, the outer cortical and epidermis layers get broken and need to be replaced to provide new protective cell layers.
- Hence, another meristematic tissue called **cork cambium** or **phellogen** develops, usually in the cortex region.
- Phellogen is a couple of layers thick. It is made of narrow, thin-walled and nearly rectangular cells.
- Phellogen cuts off cells on both sides. The outer cells differentiate into **cork** or **phellem** while the inner cells differentiate into **secondary cortex** or
- The cork is impervious to water due to suberin deposition in the cell wall. The cells of secondary cortex are parenchymatous.
- Phellogen + phellem + phelloderm =
- Due to activity of the cork cambium, pressure builds up on the remaining layers peripheral to phellogen and ultimately these layers die and slough off.
- **Bark** refers to all tissues exterior to the vascular cambium (includes secondary phloem).

- Bark that is formed early in the season is called **early** or **soft** Towards the end of the season **late** or **hard** bark is formed.
- At certain regions, the phellogen cuts off closely arranged parenchymatous cells on the outer side instead of cork cells. These parenchymatous cells soon rupture the epidermis, forming a lens shaped openings called **lenticels**. **Lenticels** permit the exchange of gases between the outer atmosphere and the internal tissue of the stem. These occur in most woody trees.

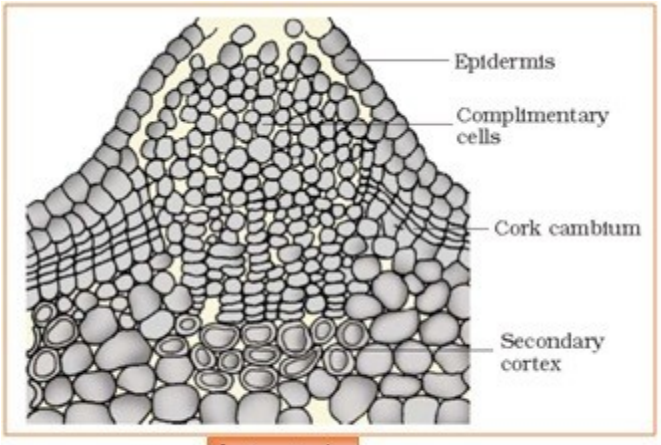

Fig: Lenticel

**Secondary Growth in Roots**

- In the dicot root, the vascular cambium is completely secondary in origin.
- It originates from the tissue located just below the phloem bundles, a portion of pericycle tissue, above the protoxylem forming a complete and continuous wavy ring, which later becomes circular.

- Further events are similar to those already described above for a dicotyledon stem.

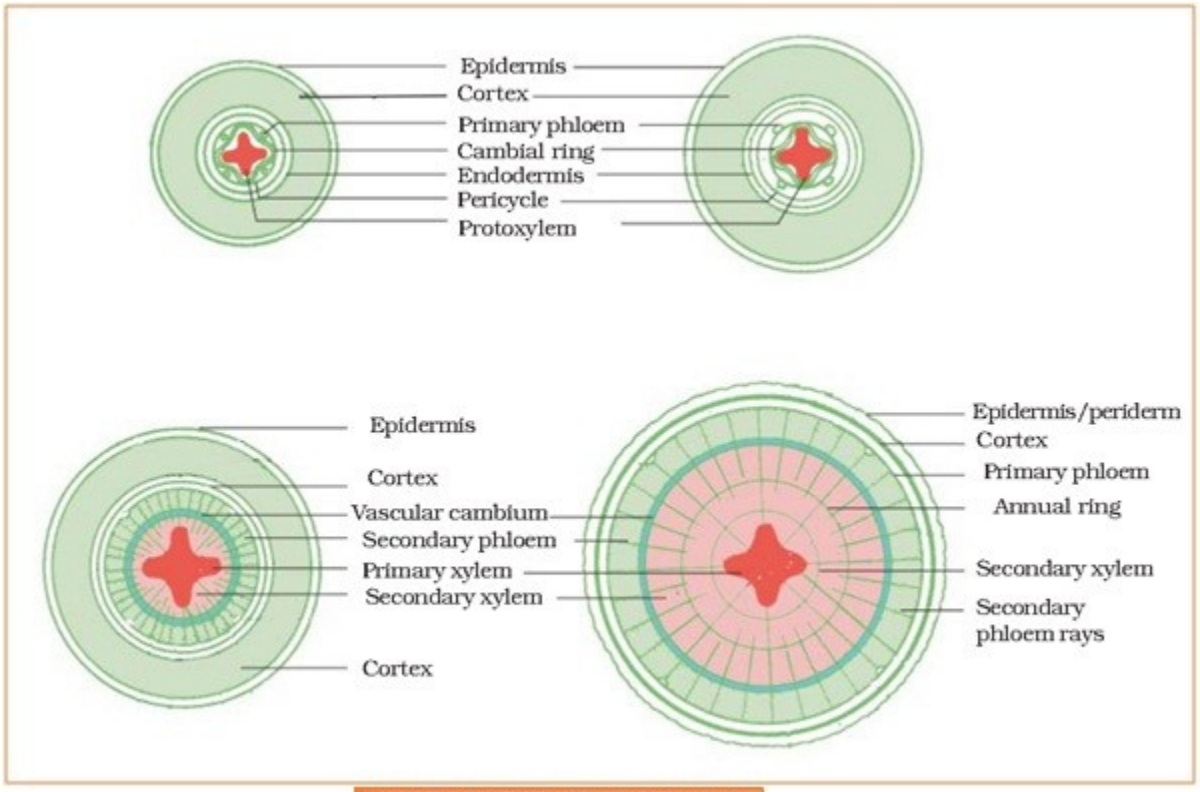


**Fig:** Secondary growth in a dicot Root