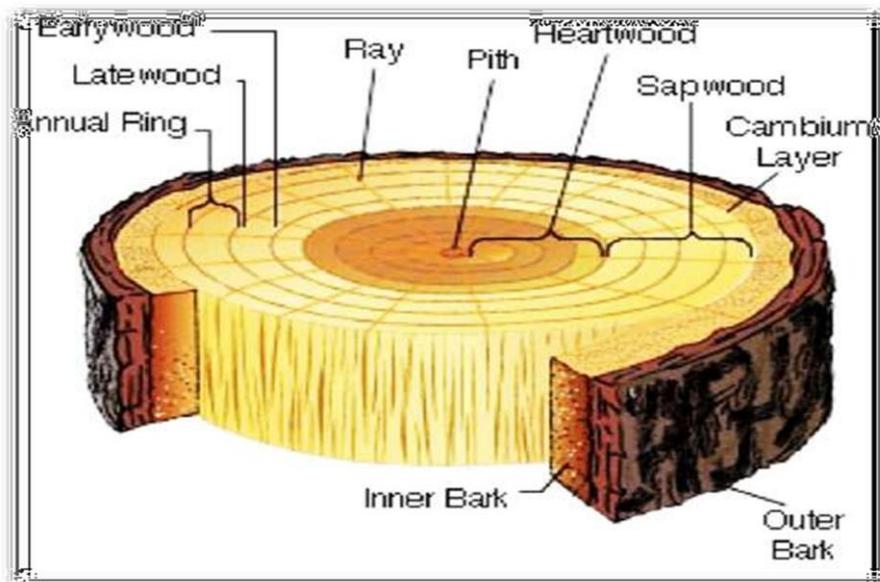


Heart wood and Sap wood:

Heartwood:

Heartwood is composed of dead cells, inner wood of a stem, branch or root of a plant. Their walls heavily impregnated with various compounds such as resins, gums, tannins, pigments or phenolic compounds and hence become unsuitable for conduction. It is also known as *Duramen*. It is dark in colour. Heartwood is mechanically strong, resistant to decay. The main function of the heartwood is to support the tree. The pigments found in heartwood in certain cases are of commercial importance, eg. Haematoxylin (*Haematoxylon campechianum*), Brasilin (*Caesalpinia sappan*), santalin (*Pterocarpus santalinus*), etc.

Heartwood as a rule, is more durable than sapwood in damp locations and less subject to attack by certain insects and by stain-and mold-producing fungi. It usually is colored and therefore considered more ornamental than the white sapwood, except in a few cases; in yellow pine interior finish and maple flooring, for example, the white sapwood is preferred. Heartwood is less permeable to liquid and therefore more suitable for tight cooperage, tanks, and conduits. The heartwood of some species contains more valuable extractable materials, such as tannin and dyes, than does the sapwood.



Sapwood:

Sapwood also called as *Alburnum* consists of living and functional cells of a woody stem, branch or root of a plant where sap flows i.e. involved in conduction of water. It is light coloured. Cells contain more water and lack darkly staining chemical substances commonly found in heartwood. In fact, the outer few layers carry on conduction process while cells of inner rings function as storage organ. Sapwood performs two functions - adding support to the tree, transportation of nutrients and xylem sap

As the growth process continues, the rings of sap wood bordering the heartwood keep on converting into heart wood. In the process, the living cells of sap wood lose their protoplast, water contents are reduced and vessels are blocked by tylosis. Simultaneously, deposition of

various substances like gums, resins or tannins also occurs. So with the increase in the growth amount of heart wood keeps on gradually increasing. In certain cases, distinction between sap wood and heartwood is not sharp as in *Holoptela integrifolia* and *Abies pindrow*.

In general, sapwood when green contains considerably more moisture than does heartwood, the difference being more pronounced in the softwoods. With few exceptions sapwood seasons faster per unit of time than does heartwood, but because of its higher percentage of moisture when green it dries in about the same time.

Difference between Sapwood and Heartwood

Sapwood

1. It is outer wood of an old stem.
2. It is light coloured.
3. Living cells are present.
4. Sapwood is the functional part of the secondary xylem or wood.
5. The tracheary elements are not plugged by tyloses.
6. Tracheary elements do not possess any deposition in their lumen.
7. Sapwood or alburnum is lighter.
8. It is less durable because it is susceptible to attack by pathogens and insects.

Heartwood

1. It is the central wood of an old stem.
2. Heartwood is dark coloured.
3. Living cells are absent.
4. Heartwood is the non-functional part of secondary xylem.
5. The tracheary elements are plugged by tyloses.
6. Tracheary elements have deposition of tannins, resins, gums, etc.
7. Heartwood is heavier.
8. It is more durable due to its little susceptibility to the attack of pathogens and insects

Porous and Nonporous wood:

These two types of wood are recognised on basis of presence and absence of pores of commerce i.e. vessels. The wood in which vessels are not found is called **non porous wood** such as that of gymnosperms. Whereas in dicotyledonous or angiospermic wood, which has vessels in xylem is known as **porous wood**. The non-porous wood is technically called soft wood and porous and the porous wood is called hard wood. Soft wood or hard wood terms are not at all related with softness or hardness of timber, e.g. hard wood of *Bombax ceiba* is very soft and soft wood of *Pinus* and *Cedrus* is very hard. The structure and composition of porous wood is more complex than non porous wood. In transverse section, the pores (or vessels) may appear circular or oval outline.

Ring and diffuse porous wood:

Several woods of commercial value are identified on basis of arrangement of pores. **On basis of distribution of pores the woods can be classified into ring porous and diffuse porous.**

Ring Porous Wood

In the ring porous wood, pores of early wood are larger than those of late wood and therefore, these appear distinctly arranged in the form of a conspicuous ring, such as in most temperate angiospermic trees. Ring porous wood is characteristic of *Lagerstroemia*, *Morus*, *Tectona*, *Toona* etc.

Characteristic features of Ring Porous Wood

1. In it the vessels are of different diameter.
2. The vessels are not uniformly distributed throughout the wood.
3. Vessels with wide and smaller diameter are formed in the early and the later part of the growth season respectively.
4. Vessels with wide diameter of early wood and vessels of smaller diameter of late, summer or autumn wood are distinguishable.
5. The development of vessel is sudden and rapid.
6. The vessels are longer in length than those of diffuse porous wood.
7. The rate of transport of water in plant with ring porous wood is ten times faster than those with diffuse porous wood.

Diffuse Porous Wood:

In diffuse porous wood, the pores are more or less uniformly distributed throughout the ring because there is no appreciable difference between early and late woods. Such as, in most tropical angiospermic trees. Most of the Indian hard woods come under category. Diffuse porous wood is characteristic of *Artocarpus*, *Acacia*, *Michelia*, *Adina*, *Terminalia*, *Mangifera*, *Shorea*, *Bombax*, *Dalbergia* etc.

Characteristic feature of Diffuse Porous Wood:

1. In it the vessels are more or less equal in diameter.
2. The vessels are uniformly distributed throughout the wood.
3. Vessels with more or less equal diameter are formed throughout the growth ring.
4. Vessels of early wood and late wood are indistinguishable.
5. The development of vessel is slow.
6. The vessels are shorter in length than those of ring porous wood.
7. The rate of transport of water in plants with diffuse porous wood is slower than those with ring porous wood.

Early and late wood:

The activity of fascicular cambium is affected by environmental fluctuations. Such fluctuations are pronounced in temperate regions in a span of year where spring and autumn are extreme seasons and well marked. During these seasons, the cambium shows marked variation in the activity, and as such there is annual alteration of growing and quiescent (very slow grow) periods. The cambium remains inactive in winter but most active in the spring season.

The secondary wood formed during spring season is profuse and consists of large vessels with wider lumen. This part of the wood is called **spring wood or early wood**. In summer or autumn, the activity of cambium is highly reduced, therefore, the secondary wood formed is not profuse and consist mainly the fibres and narrow vessels. This part of the wood is called **summer wood or autumn wood**. In a transverse section of stem, early and late woods appear in the form of distinct concentric rings which are commonly called annual rings. Hence, an annual ring consists of two parts, the spring ring and the autumn ring which are formed in a span of one year. The successive annual rings are formed year after year and likewise, these can be used in determining the age of a tree. Determination of age of a tree by counting the annual rings is called **dendrochronology**.

The variation in structure of spring and autumn wood is according to the requirements of the plant during these periods. In spring season, the vegetative activity is at peak and there is an increase in transpiring surface. So there is a great demand of rapid conduction of water and mineral salts and to meet it the cambium actively divides to form additional water channels with broader vessels. On the contrary, during autumn season, there is a leaf fall and less vegetative growth. There is no need of having well developed system of water conduction. Therefore, the activity of cambium is highly reduced and as a result, the autumn wood has relatively narrow vessels.

The seasonal activity of the cambium may be disturbed by the influence of external climatic conditions like drought, defoliation, and disease. As a result normal development of secondary vascular tissues is checked and two or more rings are formed in a year. These are called **multiple annual rings or false annual rings**.

In tropical regions, the climate is normally uniform and is generally wet so the number of growing rings formed does not correlate with age of the tree. Such growth rings are called **growth marks**. Sometimes, two rings may be produced in a year in tropical trees.