STRUCTURE OF TIMBER

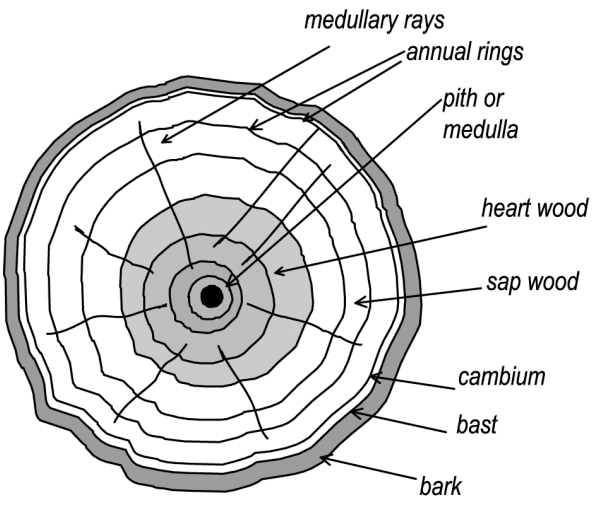
Students learn about:	*Students learn to:*
• *structure:* - *sapwood* - *heartwood* - *earlywood* - *latewood* - *cambium layer* - *growth ring* - *pith* - *xylem and phloem* - *bark* - *photosynthesis*	*describe the growth of trees and identify and recognise the various parts of a tree.*

The physical features of timber

Wood is the product of a class of plants called 'exogens', which grow by the addition of new wood on the outside of the trunk and branches. It is composed of minute, tubelike cells packed closely together and joined end to end or overlapping obliquely. The cells are made up of cellulose and lignin, a complicated organic material, which is a combination of carbon, hydrogen and oxygen. Inside the cells is a watery composition of starches, sugars, minerals, gums and resins. As the cells age, lignin is deposited in and between the cell walls, making the walls more rigid and the wood more durable.

How the tree grows

A tree makes its food through the process known as 'photosynthesis', which is the formation of sugar from carbon dioxide and water in the presence of sunlight. It takes place only where there is chlorophyll-the green colouring matter in leaves. Water and minerals in solution are absorbed from the soil by the fine



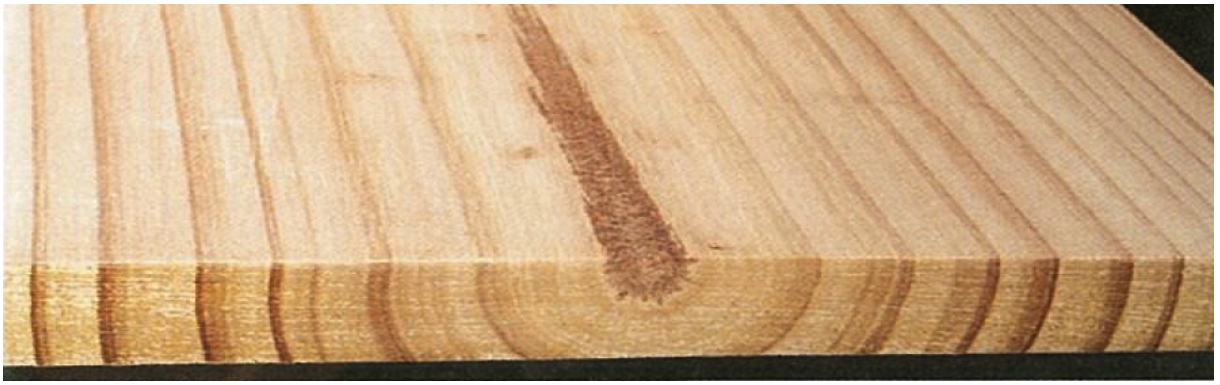
The tree trunk showing growth rings

hairs on the roots and transported by the sapwood, which is immediately beneath the cambium layer and bark, to the leaves. Here, a large proportion of the water evaporates, leaving the minerals and some water behind. This process is called 'transpiration'. Carbon, a basic element in all plants, is obtained from carbon dioxide (CO^2) in the air. Entering through minute apertures called 'stomata' on the underside of the leaves, the carbon dioxide is broken down by chlorophyll, with the aid of sunlight. The carbon combines with the water from the roots, while oxygen is returned to the air. The tree's food, which is manufactured in the leaves, is transported down the inner layers of the bark cells (phloem), thus providing the living cambium cells with materials for the formation of new wood and bark. On its way down some of the food material also reaches the living wood cells immediately inside the cambium layer by means of special cells called 'medullary rays' or 'ray parenchyma', which are produced for this purpose (and also for food storage). A ring-barked tree will eventually die as the food from the leaves cannot pass down through the inner layers of the bark to the roots. In addition, if the sapwood also is severed, the tree will generally die more quickly.

A tree grows in two ways:

1. in height
2. in girth or diameter.

Growth in height is due to the division and growth of numerous special cells at the extreme tips of the trunk and branches. These special cells are thin-walled and do not, in themselves, produce woody tissue. A short way back from the growing tip the inner cells form the pith or medulla, while the outside cells form the cambium layer. Once the wood is formed, it does not grow in length or height.



Cross section of Radiata Pine - note the pith in the centre.

Definitions:

Heartwood: The heartwood surrounds the pith at the centre of the trunk. Sap no longer flows in the heartwood as the cells have been blocked by natural substances which have been laid down to make the timber more durable as the tree grows older. It is darker in colour and is more resistant to insect and fungal attack.

Sapwood: The sapwood lies towards the outside of the trunk and surrounds the heartwood. It is the more living part of the tree and contains cellulose and lignin. It is lighter in colour and is not as durable as the heartwood. As in the cambium, xylem cells are found here that carry water and minerals up to the leaves.

Bark: The bark is a layer of tough fibres which protects the tree from insects, animals, fungi and the weather. It also retains moisture and minerals within the tree.

Bast or Phloem: The bast (also known as the phloem) lies just under the bark. Here phloem cells carry the sap manufactured in the leaves down to all parts of the tree. The sap is distributed towards the inside of the tree through the medullary rays.

Cambium layer: The Cambium Layer lies just under the bast. This is where most of the growth of the tree takes place. Here xylem cells grow and carry water and minerals up the trunk to the leaves.

Medullary Rays: Rays are cells which lie across the trunk. They radiate out from the medulla or pith of the trunk which lies at the centre. The rays distribute sap from the phloem cells in the bast inwards towards the pith.

Pith: The Pith is a small area at the very centre of the trunk. It is dark in colour and is all that is left of the young sapling.

Growth rings: Growth Rings show the plant's yearly growth. In spring the tree will grow fast and so the cells are thin-walled and lighter in colour. This is called the early-wood. The late-wood is darker in colour. It grows during the summer when growth is slower and the cell-walls are thicker.

The structure of wood

According to its botanical features, wood is classed as either 'hardwood' (pored wood) or 'softwood' (non-pored wood). Hardwood trees (Angiosperms) have leaves, are generally deciduous and have covered seeds; for example, gum nuts. Softwood trees (Gymnosperms) usually have needle-like foliage, and are generally from the pine/ conifer family with uncovered seeds that fall from the pine cone as it opens. Hardwoods do not necessarily have harder wood than softwoods; balsa wood, which is the lightest and softest commercial wood in the world (used in model airplane construction), is a hardwood. As far as the

woodworker is concerned, the main difference between softwood and hardwood is the cell structure.

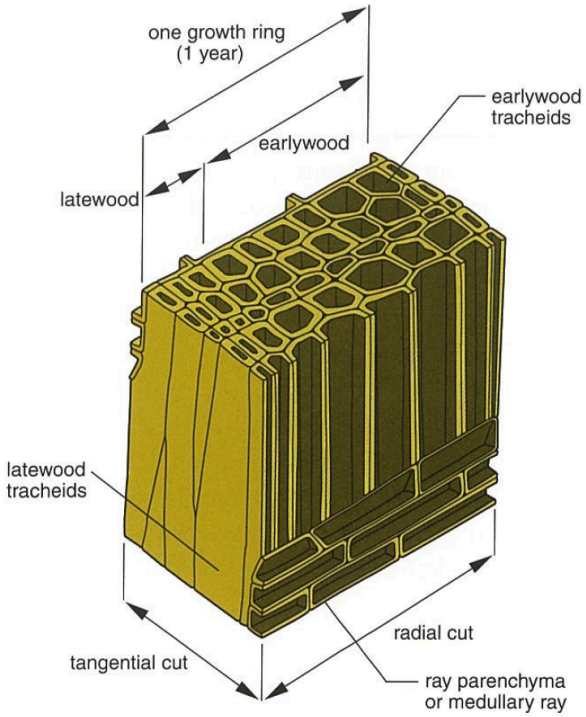
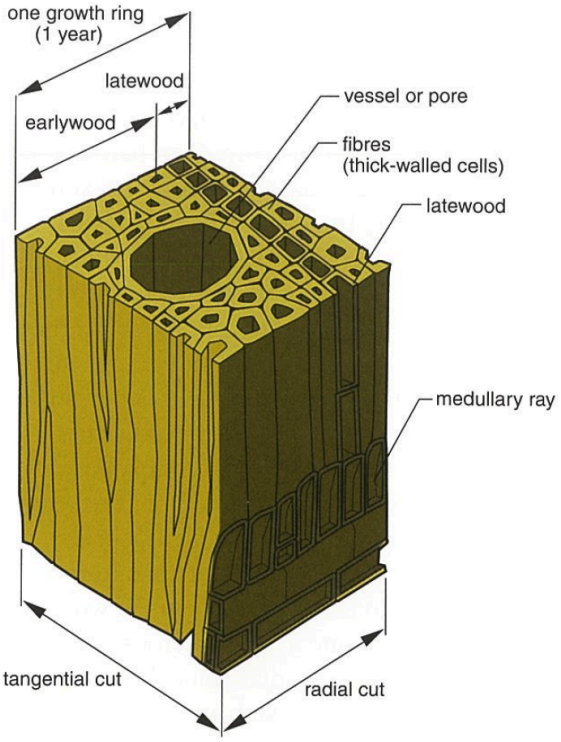
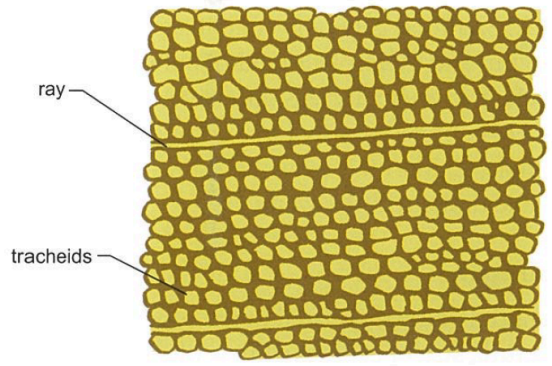


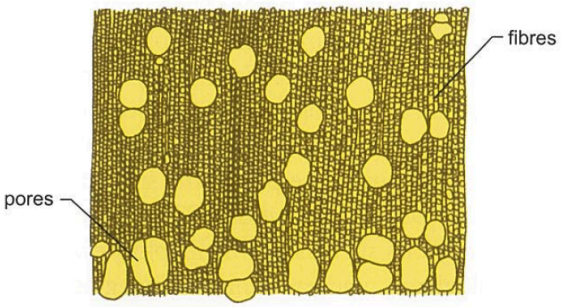
Figure 2.3a Cell structure of softwood



d Cell structure of hardwood



b Cross-section of softwood



e Cross-section of hardwood

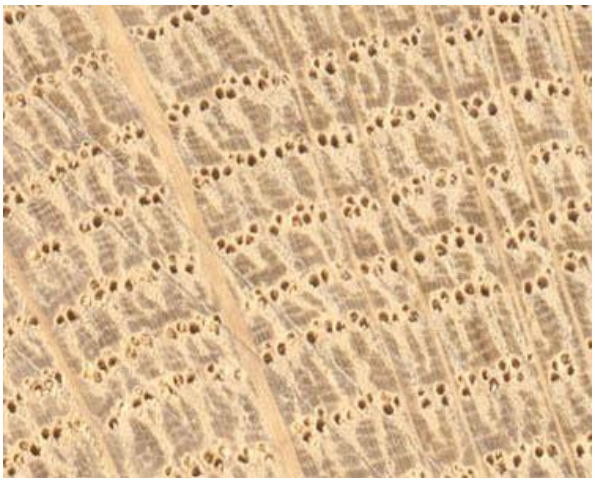
Softwood

Softwoods or non-pored woods have a simpler and more uniform cell structure than hardwoods. This is due to the fact that the bulk of the wood is made up of long, thin cells called 'tracheids', so thin that they are generally visible only under a microscope. These cells perform two functions: (1) they provide mechanical support and (2) they carry water and mineral salts from the roots to the leaves. Connection between the cells is by 'pits', which are minute holes in adjacent cell walls. Rays,

which are very small when compared with those in some hardwoods, radiate from the centre of the tree and at right angles to the tracheids, and store food and carry food materials from the phloem inwards to the living cells in the wood. All non-pored woods come from coniferous or pine trees (e.g. Oregon pine, radiata pine, hoop pine, cypress pine).

c A typical pine forest (softwood)

f Eucalypt trees (hardwood)



(Above left) Medullary ray in white oak (lines going from bottom to top) Also note the prominent pores. (Above right) Oak is often cut in such a way so as to make a feature of the prominent medullary rays.

Hardwood

Hardwoods or pored woods are characterised by large, tubelike vessels or pores. These consist of short stubby cells varying considerably in size and joined together to provide, when newly formed, a continuous means of conducting solutions from the roots to the leaves. The vessels frequently occur in groups and have pits in the side walls to allow the passage of solutions. The pores in some hardwoods such as pacific

maple are visible to the naked eye, whereas a magnifying glass is necessary to see those in coachwood. Smaller, thick-walled cells (called 'fibres') act simply as mechanical support for the tree, while the medullary rays have the same function as the rays in softwoods. Some of the more important
hardwoods are eucalypts, blackwood, maple, oak, walnut, ash, beech, willow, red cedar, mahogany, basswood and hickory.