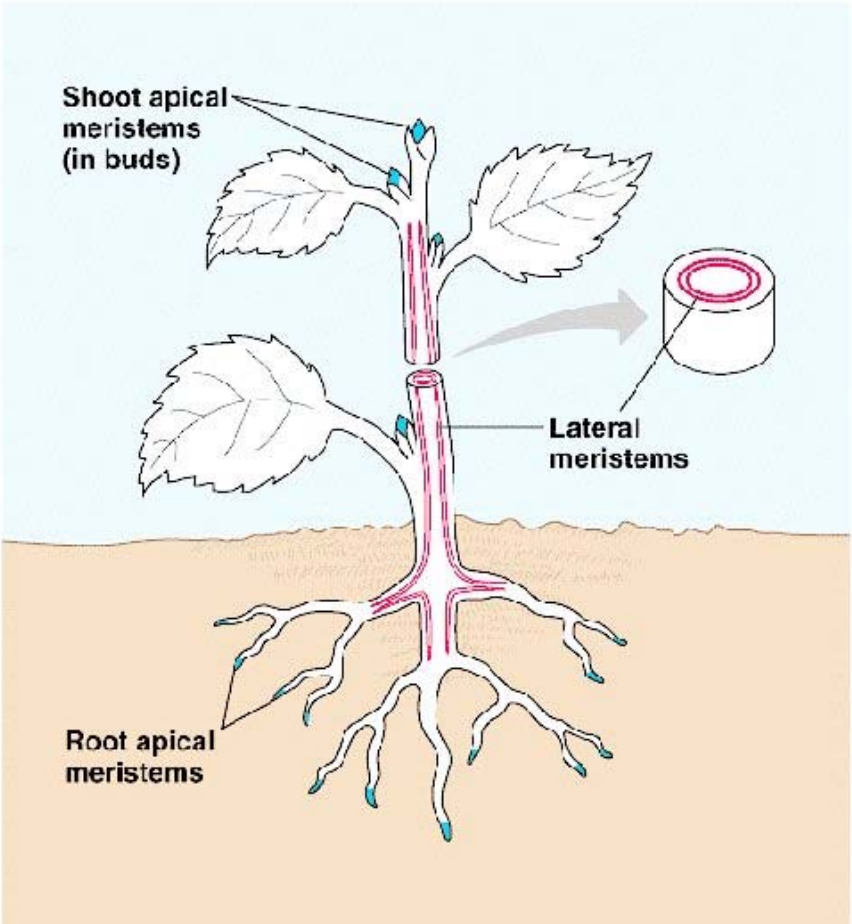
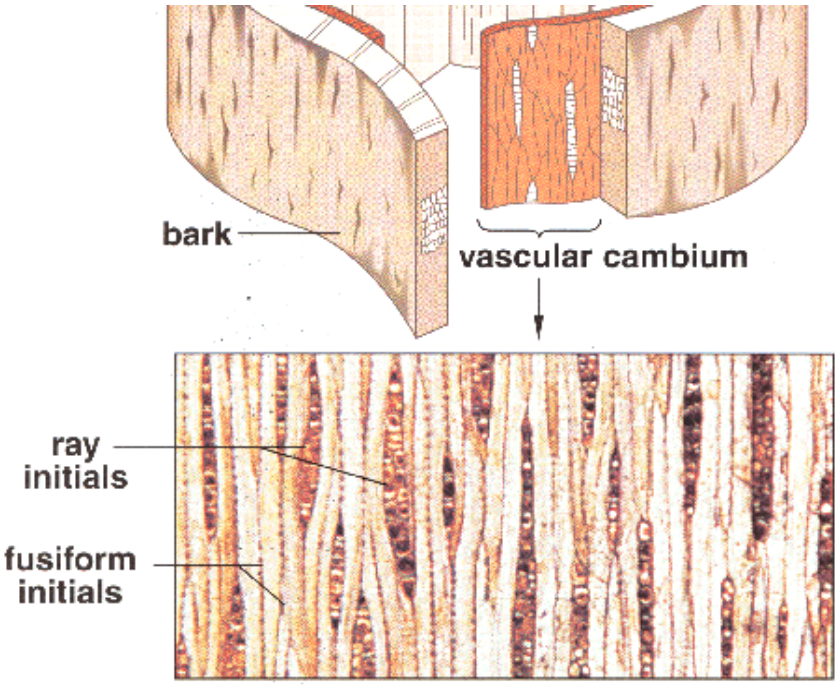
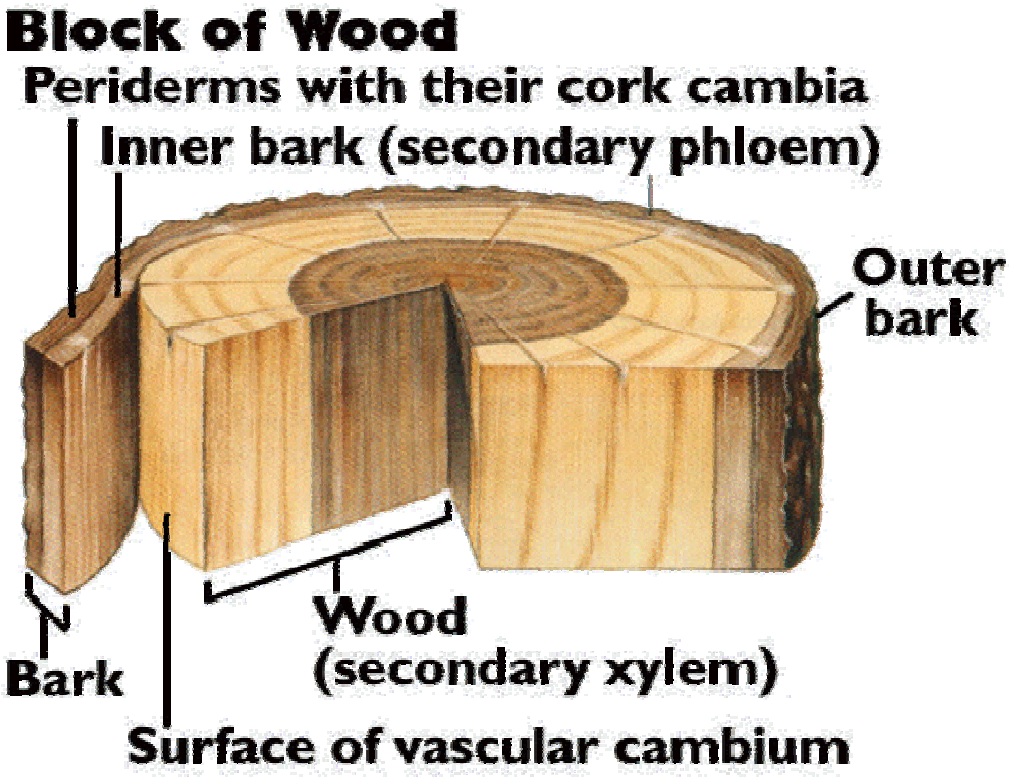
BACKGROUND ON TREE GROWTH:

The three component parts of a tree consist of: 1. Roots, which function to anchor the aerial components in the soil and absorb water and elements from the soil matrix. 2. Trunk, which functions to support the crown and transport water and elements from the roots to the leaves located in the crown and transport sugar from the leaves to parenchyma in the trunk and roots. 3. Crown, which consists of the entire collection of lateral branches connected to the trunk, which bear leaves and reproductive structures (flowers and fruits). All three of these parts have to be intact and functional in order for a tree to be considered healthy.

Healthy trees grow by the processes of cell division and cell expansion in primary meristems and lateral meristems. The primary growth of trunk and crown branches are initially formed by shoot apical meristems, which makes leaves, flowers, and primary stems; and the primary growth of roots are formed by root apical meristems, which makes terminal and lateral roots. Toward the end of a growing season, two lateral meristems are formed called the vascular cambium and the cork cambium. These lateral meristems represent the living components of the woody root, trunk, and crown. The vascular cambium which is a cylinder of living cells makes secondary xylem or wood, to the interior and secondary phloem, or inner bark, to the exterior of itself, on an annual basis. The main function of the wood is to conduct water and dissolved elements from the root up to the leaves in the crown. The main function of the inner bark is to conduct sugars from the leaves to storage parenchyma in the branches, trunk, and roots. The annual activity of the vascular cambium leaves a permanent record of the relative age of the woody structures in the form of annual growth rings in the secondary xylem. The cork cambium makes cork, or outer bark, to the outside of itself on an annual basis. The main function of the outer bark is to protect the inner living cells, i.e. the vascular cambium, from dessication and various disease organisms. All these components have to be intact and functional in order for a tree to be considered to be healthy.




bark
vascular cambium
ray initials
fusiform initials


Block of Wood
Periderms with their cork cambia
Inner bark (secondary phloem)
Outer bark
Wood (secondary xylem)
Bark
Surface of vascular cambium

It is possible for part of a tree to remain alive even if a portion of the vascular cambium is dead. The vascular cambium basically forms a living cylinder of cells between the wood and inner bark. If part of this cylinder dies, then no new wood or inner bark is formed and the continuity of the transport of water and elements and sugar solution is disrupted between the roots and crown in that area of dead vascular cambium. Over time, this leads to exfoliation of the inner and outer bark and exposure of the dead wood, which can then begin to decay over time. Typically such wounds are also associated with the death of branches and shoot apical meristems in that portion of the crown that can no longer receive water, elements, and sugar because of the death of the vascular cambium cells. The manifestation of such disruption in the crown can take 1 to 2 years to appear, depending on what time in the growing season the vascular cambium was damaged. Only the portion of the crown, for which the functional transport systems have been disrupted will die, since the transport systems associated with the remaining intact vascular cambium remains functional. If the entire circumference of the vascular cambium is disrupted, a process called girdling, the entire crown will eventually die, due to the disruption of the functional transport systems between roots and leaves within the trunk axis.

If the outer bark suffers damage, but the vascular cambium remains intact, the living cells produced to the outside of the vascular cambium will form a new cork cambium, which will produce new outer bark and eventually heal or seal over the wound area. If this occurs rapidly enough to prevent disease organisms from reaching the living cells of the vascular cambium, the tree continues to be healthy. The formation of wound outer bark can also heal natural or artificially pruned branches. The time that is required to heal over branches is roughly proportional to the cross sectional area of the pruned branch axis.

According to A Technical Guide to Urban and Community Forestry, which is sponsored by

U.S. Department of Agriculture, Forest Service, Pacific Northwest and Pacific Southwest Regions, Washington State Department of Natural Resources, Oregon Department of Forestry, and California Department of Forestry and Fire Protection, and is readily available to the general public at url:

http://www.na.fs.fed.us/spfo/pubs/uf/techguide/toc.htm

“Vigorous trees usually have full canopies and healthy leaves. Three conditions indicate poor tree health. First, the leaves are small and pale for the species. Second, some of the branches are dead. Finally, most of the foliage arises from short twigs along the major limbs, known as epicormic growth. Trees with large cavities or other structural weaknesses are not good candidates for preservation, unless the problems can be alleviated by pruning, cabling or bracing.”