Sonja Kuster 30/09/2023
Woody Plant Physiology
Unit Code: T/602/3921
UNIT GUIDE 2023-24

LO 2. Understand the function of cells found in ring porous, diffuse porous and coniferous woody plants

LO 2.1. Identify the function(s) of the cells found in woody plants
LO 2.2. Identify the difference in cell structure between ring porous, diffuse porous and coniferous woody Plants
http://agebb.missouri.edu/agforest/archives/v20n2/gh4.php

LO 2.1. Identify the function(s) of the cells found in woody plants

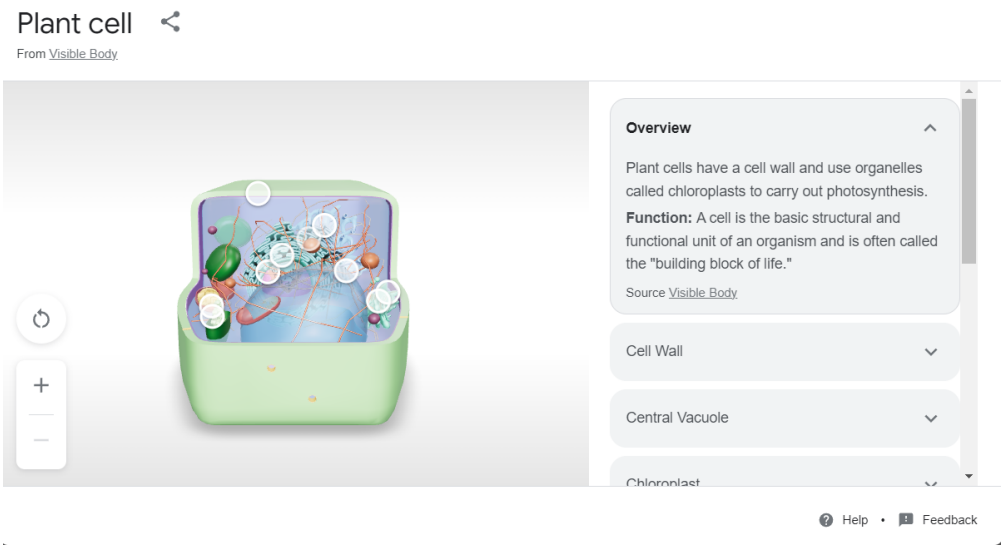
Plant cells are the fundamental building components of plants. Photosynthesis is the primary function of plant cells. Photosynthesis takes place in the chloroplasts of plant cells. It is the process through which plants prepare food by using sunlight, carbon dioxide, and water. A few plant cells aid in the transportation of water and nutrients from the roots and leaves to other sections of the plant.

Commented [1]: only for some cells. Other cells have other primary functions like transport or structural support

Plant cells are supported by a cell wall, use chloroplasts to carry out photosynthesis, and contain a large central vacuole that stores water. Plant cells have a cell wall and use organelles called chloroplasts to carry out photosynthesis. Plant cell walls have channels called plasmodesmata (sg. plasmodesma) that allow cells to communicate by passing sugars, ions, and even proteins and RNA from one cell to another.
Mitochondria are found in plant cells. Mitochondria carry out cellular respiration and produce ATP, a chemical that powers operations throughout the cell. Plant cells, in addition to mitochondria, have unique structures called chloroplasts that are required for photosynthesis. Plants employ light, water, and carbon dioxide to create glucose, which is then broken down by cellular respiration. The central vacuole is another feature found in plant cells. Central vacuoles are utilized in plant cells to maintain turgor pressure by keeping the big vacuole filled with water to support the cell.

Commented [2]: not all cells will have chloroplasts - only those that photosynthesise - so in leaves

A 3D Model can be found here: https://www.visiblebody.com/learn/biology/cells/eukaryotic-cells



Anatomy of a tree Overview

These several tree parts make up a tree's fundamental anatomy:
Leaves, stems, branches, the trunk, and the roots

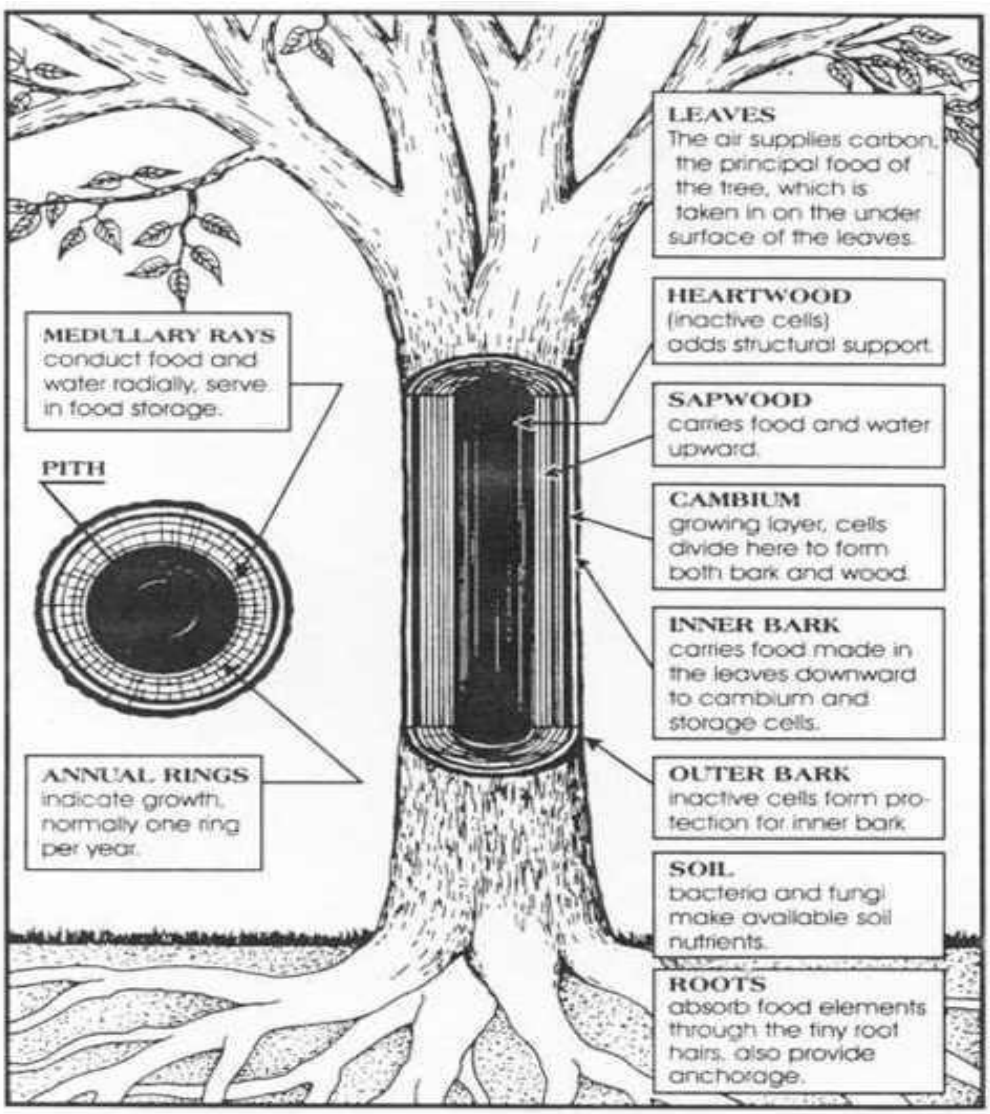


DIAGRAM SHOWING FUNCTIONS OF DIFFERENT PARTS OF A TREE

Courtesy of the *New Tree Experts Manual* by Richard R. Fenska

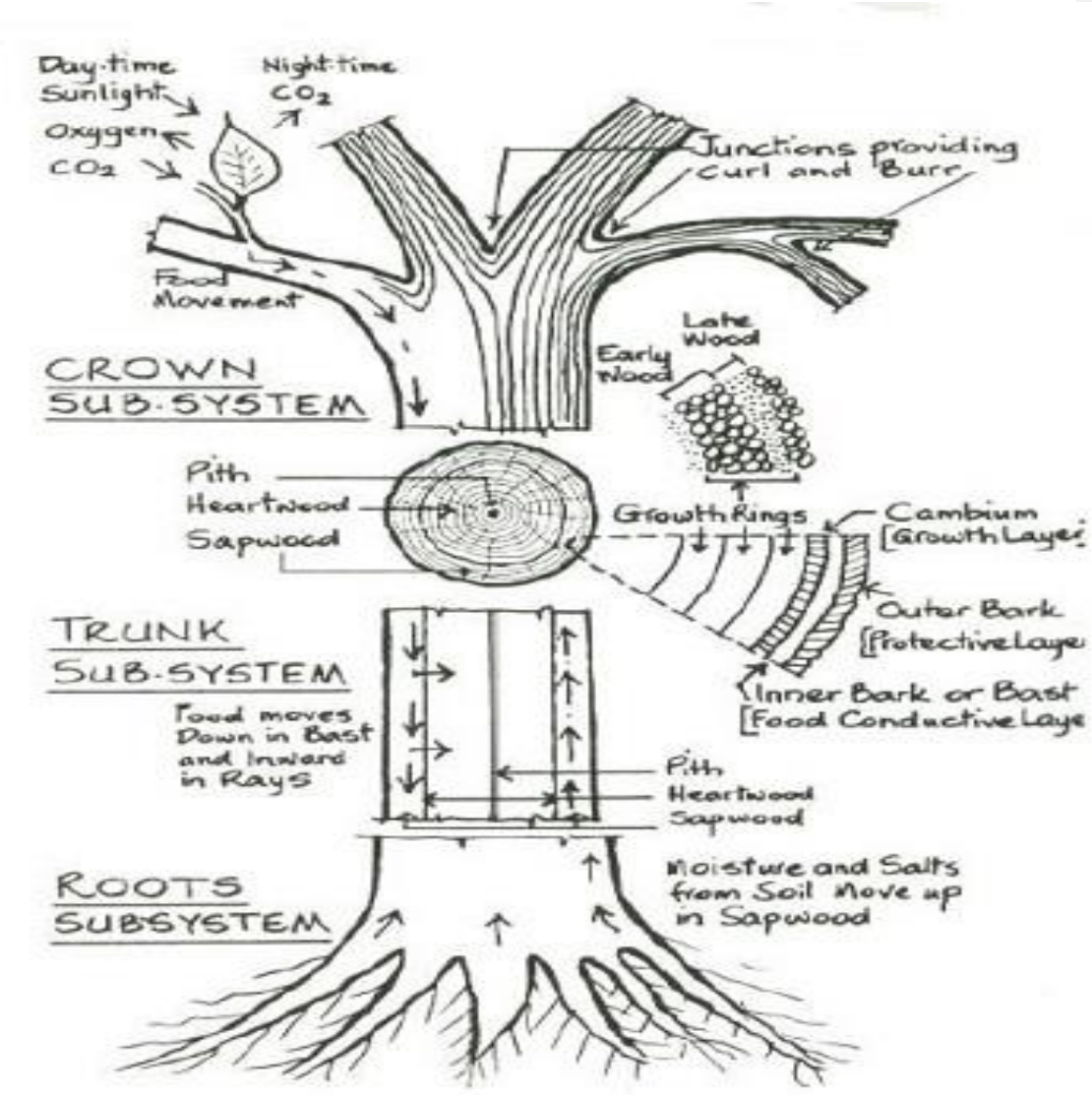
The trunk, the roots, and the crown are the three distinct parts of a typical tree. The primary organ of a plant that supplies the stiff woody structure is the stem or trunk of a tree or shrub. It serves as a conduit to transport nutrients and water between the roots and the crown while also supporting the crown. One trunk or several trunks may exist in a tree.

The following elements make up the tree's above-ground structure.

• **Bole**: The region from the trunk's base to the first offshoot.
• **Trunk**: The tree's basic support structure from which branches develop.
• **Branch**: An extension of the tree's trunk that normally develops horizontally and upward. Smaller branches are referred to as twigs while larger branches are referred to as boughs. The branches help the vegetation to grow.
• **Foliage**: A general term for a tree's leaves that also refers to the needles on pine trees and the scale-like substance on junipers. Normal foliage is green.
• **Crown**: The tree's peak.

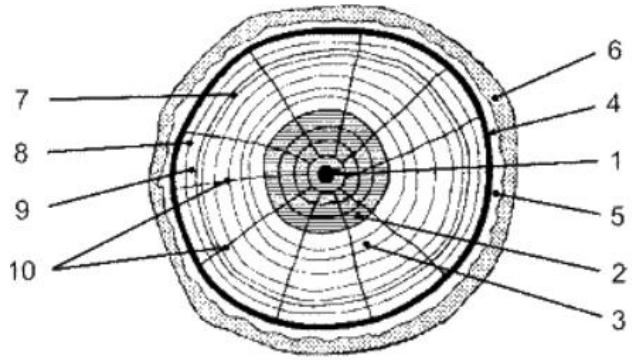
Trunk and Branches
Trees have a more permanent structure that includes a trunk and branches. This is the primary distinction between trees and plants. Wood at the core of trees is what makes them more durable, contributes to their incredible lifespans, and makes their branches ideal for artistic pruning.
The trunk's primary function is to raise the leaves above the ground, allowing the tree to access the light and thrive. It also transports water and nutrients from the roots to the tree's aboveground components and distributes the food produced by the leaves to all other parts, including the roots.

A cut across a tree trunk provides an inside view of the different layers.



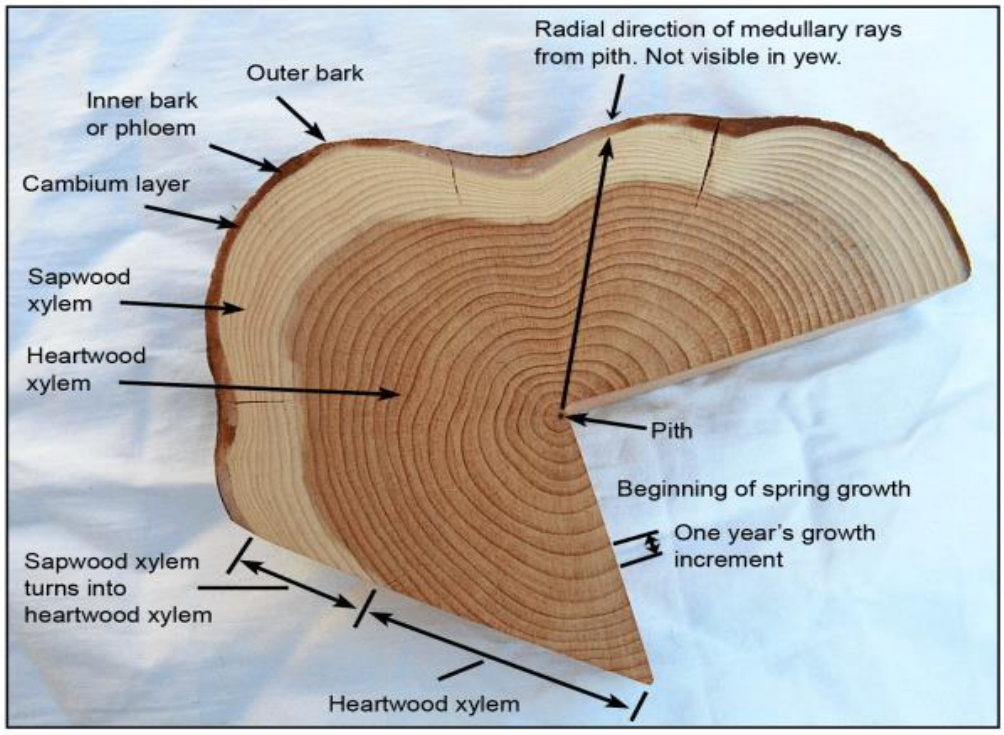
.

• **Pith**: The middle of the trunk and the sapling's first source of nourishment. Pith, also known as medulla, is a tissue found in the stems of vascular plants. Pith is made up of parenchyma cells, which are soft and spongy and store and distribute nutrients throughout the plant



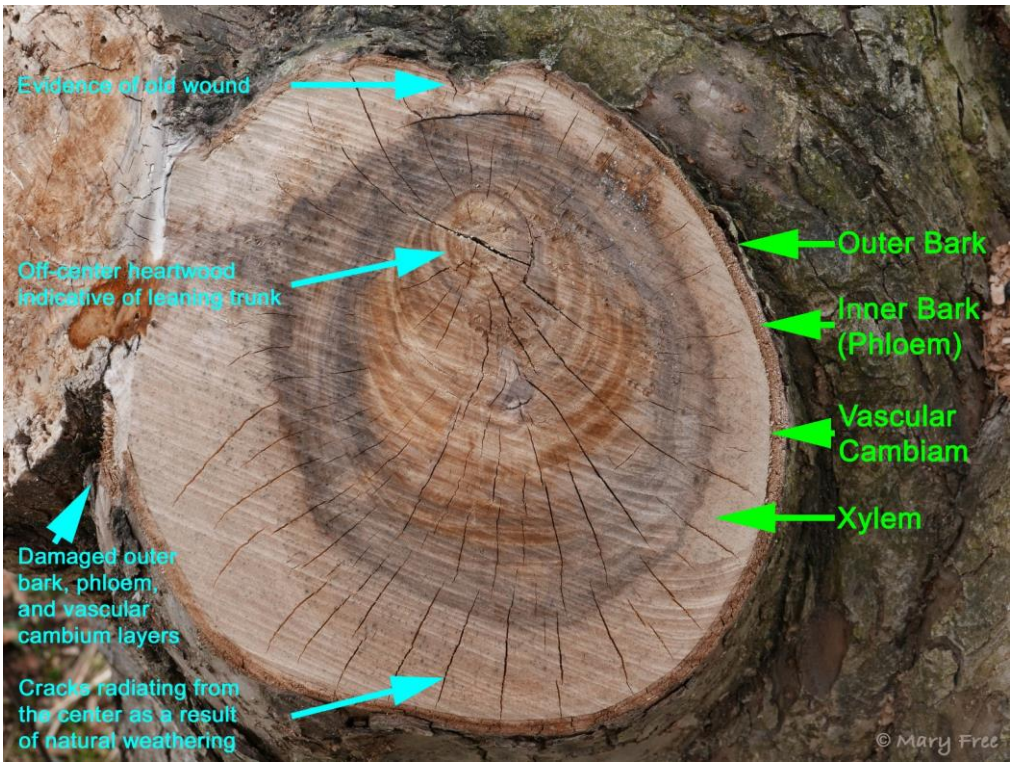
1 Pith	6 Bark
2 Hartwood	7 Annual Rings
3 Sapwood	8 Sping growth
4 Cambuim Layer	9 Autumn growth
5 Bast	10 Medullary Rays

• **Heartwood**: The densest, heaviest section of the trunk, with the darkest-colored wood. The inactive xylem cells of the heartwood serve primarily to strengthen and sustain the tree and are vital in tree physiology as a storehouse for sugars, pigments, and oils.

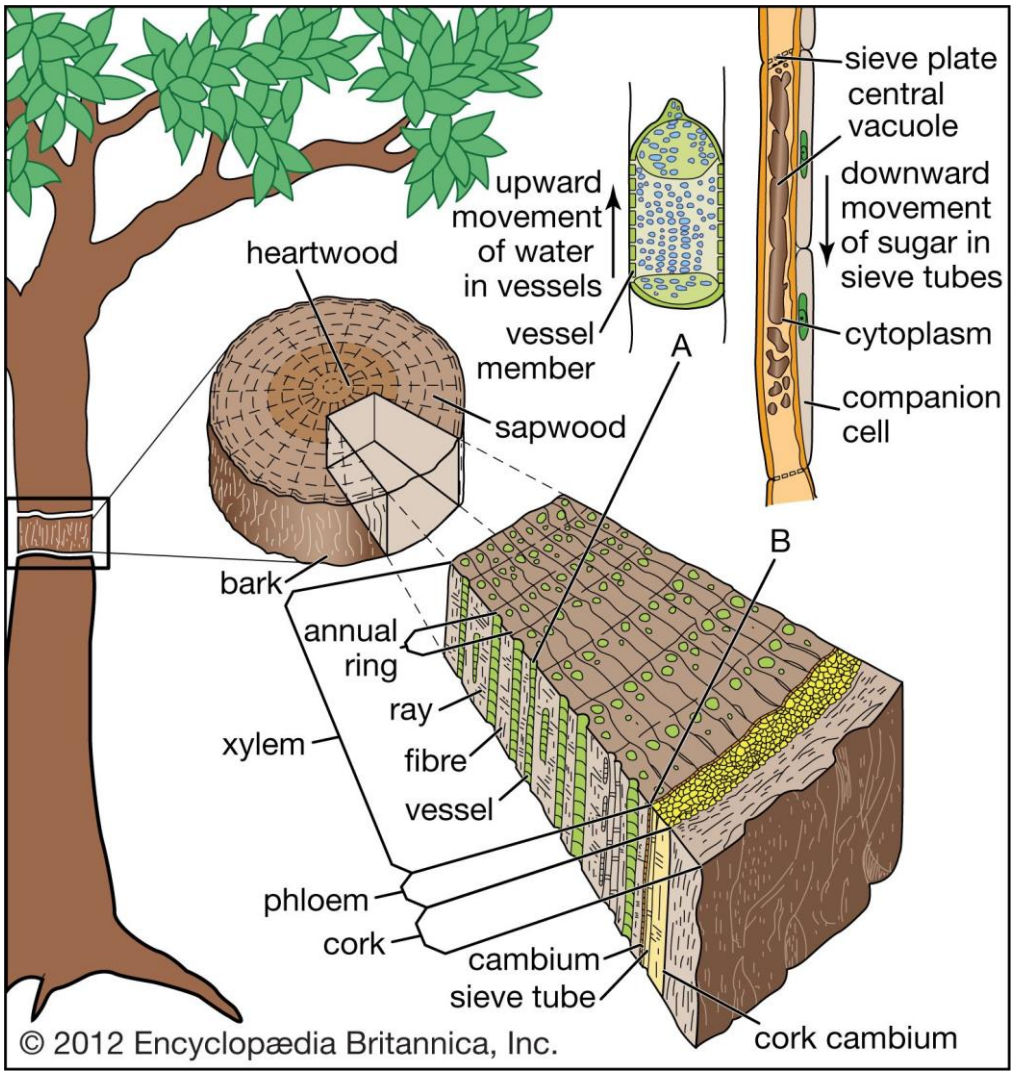


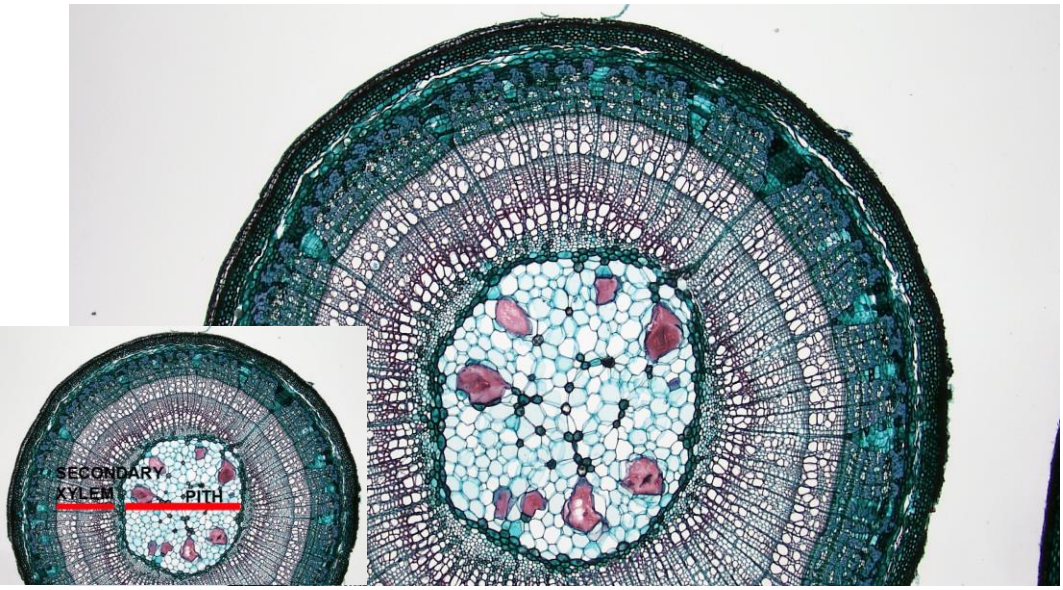
https://blog.lostartpress.com/category/cut-dried/page/2/

• **Sapwood**: The third layer of vascular tissue is xylem, also known as sapwood. It is made up of thick-walled cells that transfer sap from the roots to the crown in the same way that phloem does. Xylem is pale in colour and symbolises the tree's youthful wood. As xylem cells mature, they become dormant and form the heartwood of the tree.

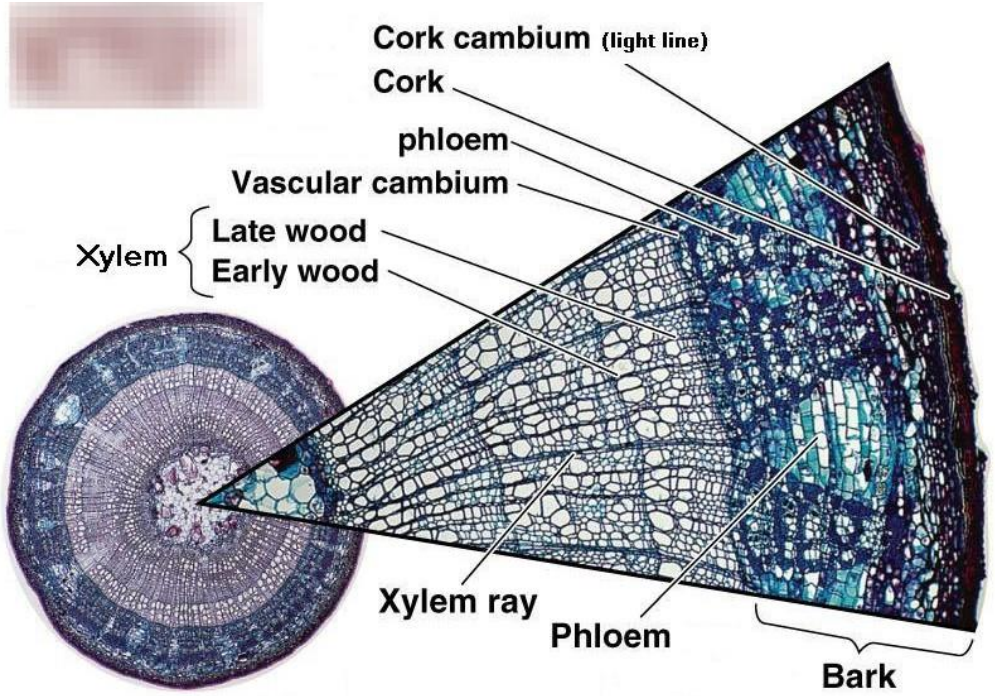


https://i1.wp.com/mgnv.org/wp-content/uploads/2019/03/1.-tree_stump_cross-section_feb_mmf.jpg?ssl=1

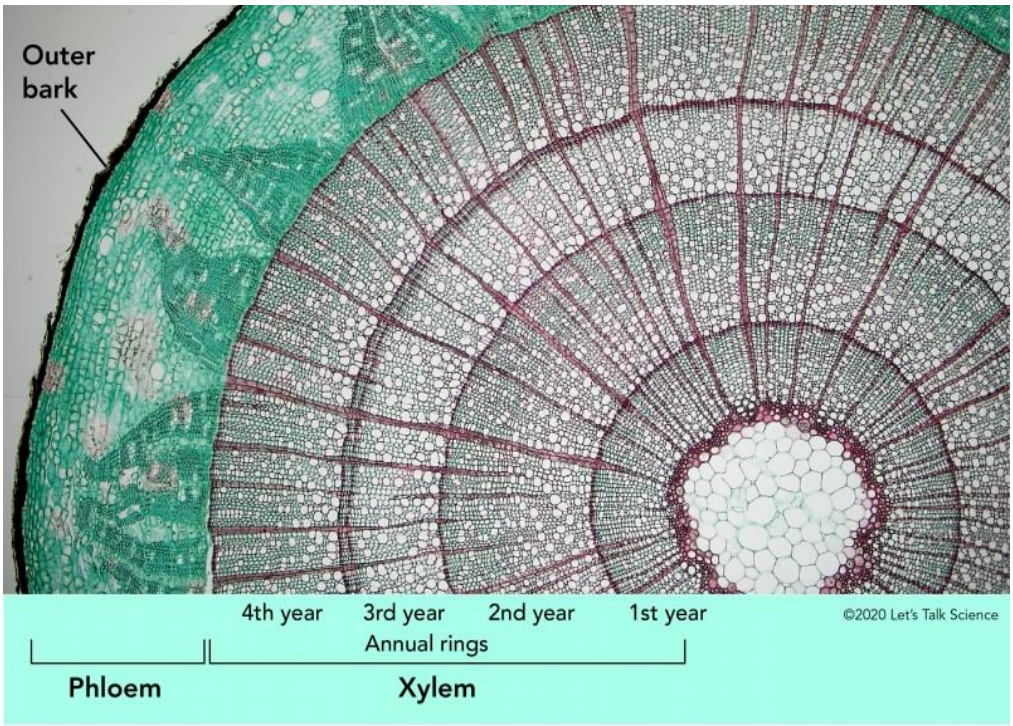

sieve plate
central vacuole
upward movement of water in vessels
downward movement of sugar in sieve tubes
heartwood
vessel member
cytoplasm
A
companion cell
sapwood
B
bark
annual ring
ray
xylem
fibre
vessel
phloem
cork
cambium
sieve tube
cork cambium
© 2012 Encyclopædia Britannica, Inc.



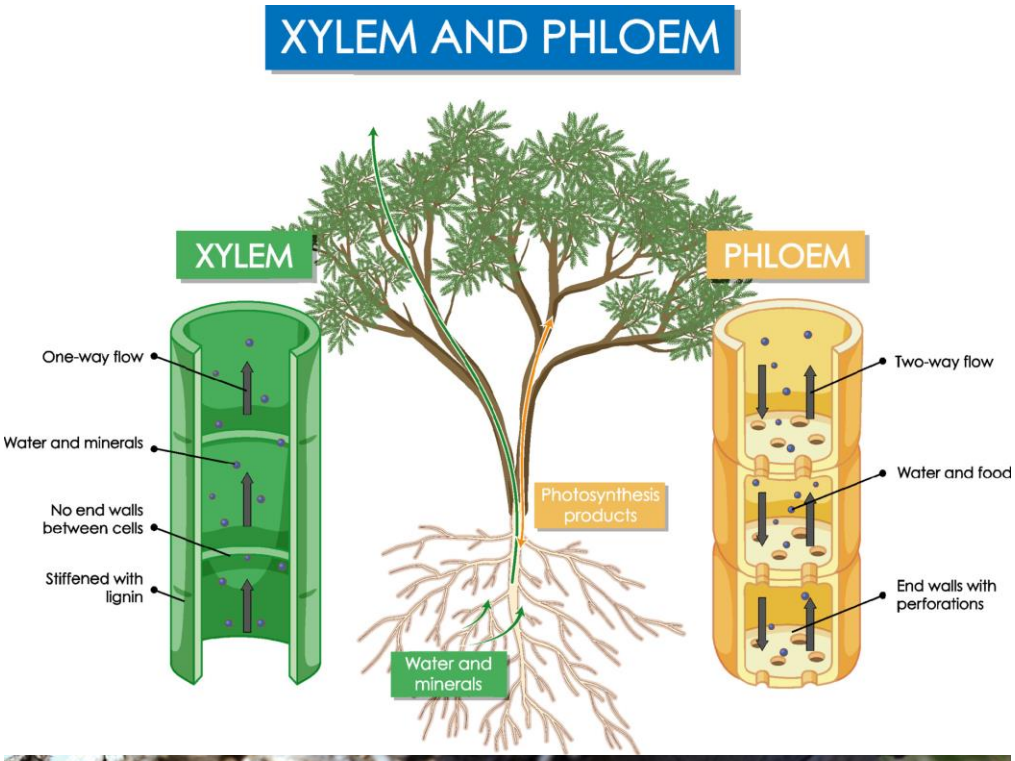
• **Cambium**: An exterior growth layer that produces sapwood and phloem, increasing the tree's thickness. Each growth season, the tree adds a new cambium layer in areas with different seasons. This causes the girth or trunk (and branches) to expand and forms annual rings, which can be evaluated by coring or felling to establish the age of the tree.



• **Phloem** (inner bark): The layer that follows the cambium tissue but before the bark. Its function is to transport sap containing sugar that has been transformed from leaf photosynthesis around the tree and back down to the roots.



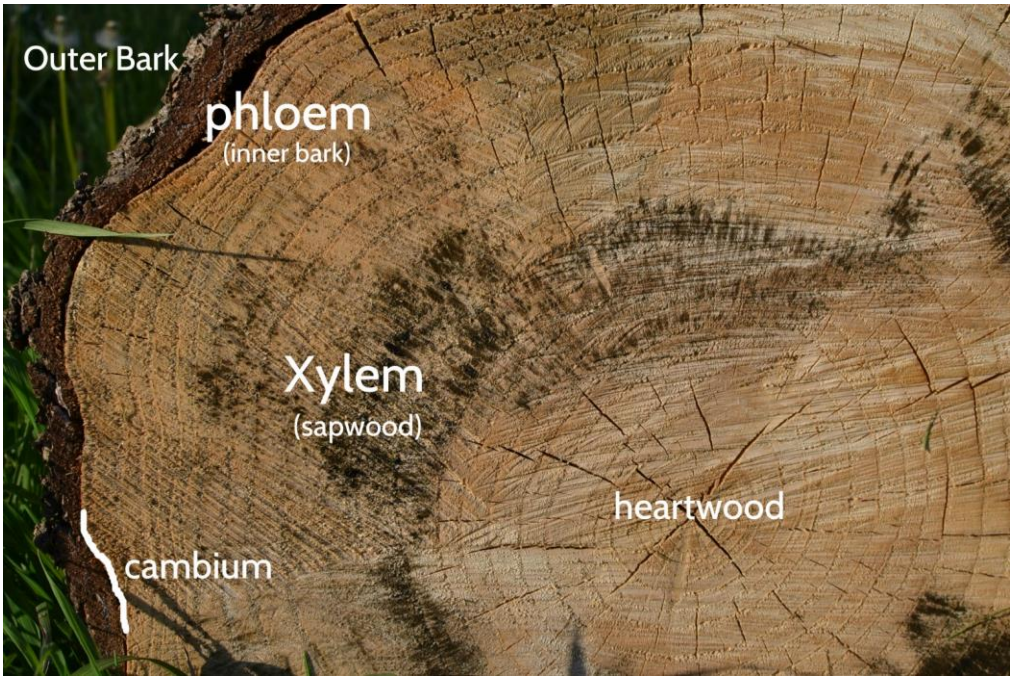
https://letstalkscience.ca/educational-resources/stem-explained/how-do-trees-survive-in-winter



Both xylem and phloem make up the vascular system of a tree. The xylem carries water and dissolved minerals from the roots to the rest of the tree, while phloem carry sugar from the leaves to the rest of the tree.

The xylem lives for only one year, and new xylem are grown each year from the cambium. The dead xylem is seen as the rings of a tree when it is cut down.

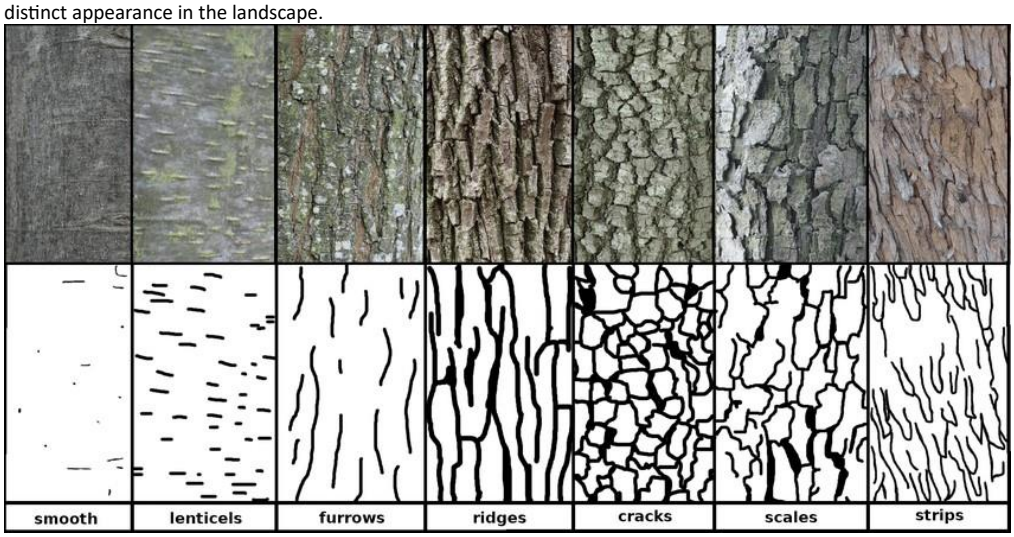
As the tree grows the inner rings of xylem become the heartwood, and the outer rings of xylem are sapwood. New xylem is produced each year by the cambium.



The phloem, on the other hand, remain alive. They create the inner layer of bark.

Xylem add strength to a tree. https://edenhills.wordpress.com/2012/05/02/xylem-and-phloem/

• **Bark**: The outer coat of the tree that protects it and varies from species to species. The trunk and branches of a tree are covered in bark. The bark is made up of dead phloem cells that are shed outward. It serves several purposes, including insulating the tree from excessive heat, which may include fire resistance, or cold, as well as providing protection against insects and illnesses. The bark of a cork oak can be very thin or up to 6 inches thick; it can be a variety of colours; it can include tannins; and the surface can range from smooth to severely wrinkled. Dead bark can flake or peel off in patches or strips depending on the species. Bark characteristics help identify trees and give them a distinct appearance in the landscape.



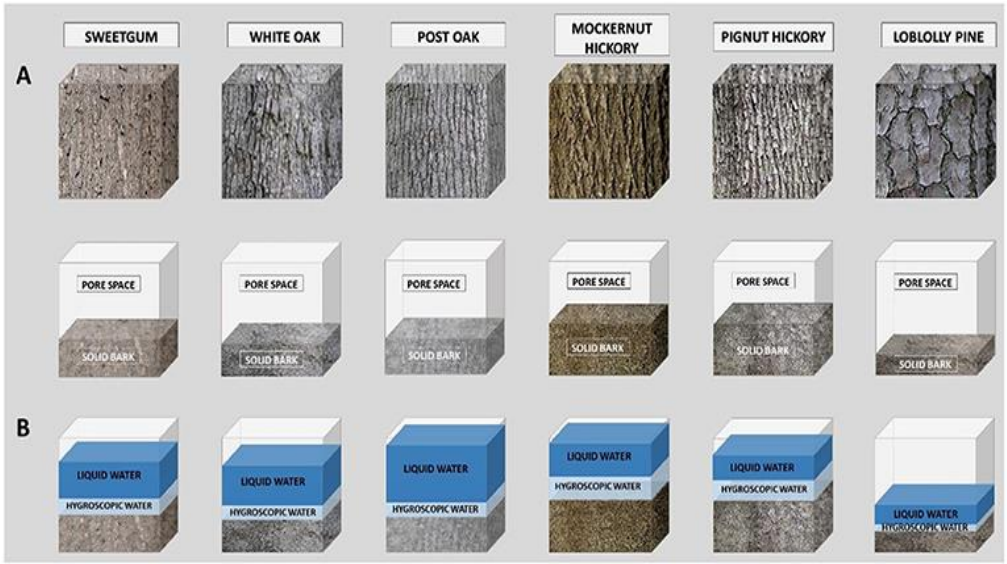
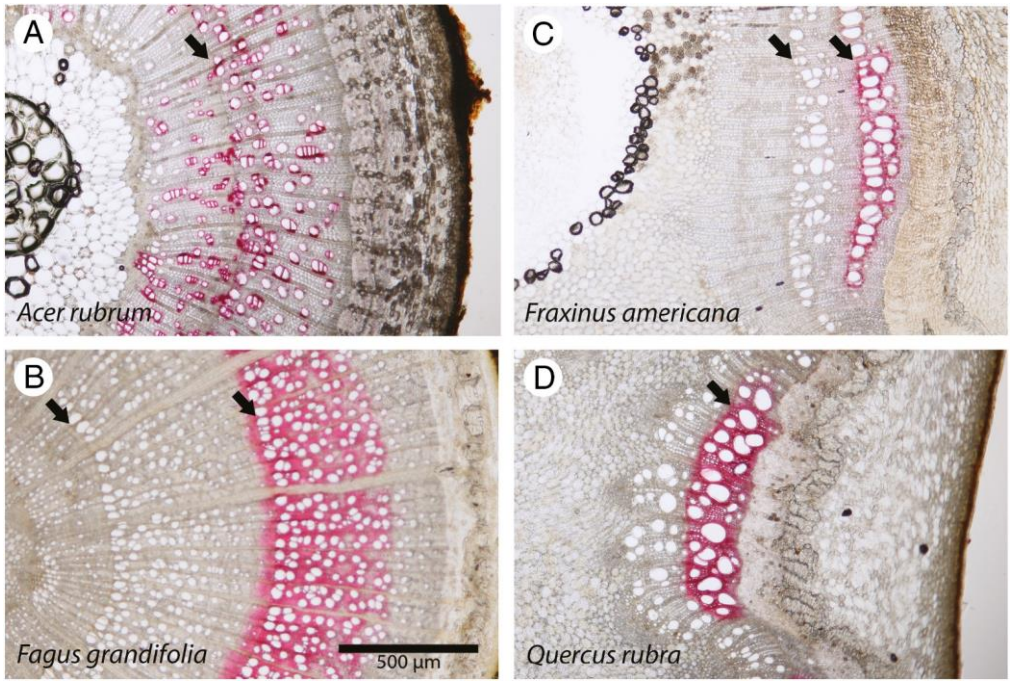


Figure 1 - The barks of different tree species absorb different amounts of water.
(A) The barks of various tree species are shown in the top row. If we squeeze all the solid bark together and separate it from the open pore space, we can see that some species have more open pore space and some have less. (B) Some of this pore space is always occupied by hygroscopic water, which is water absorbed from the atmosphere, and whatever pore space is left over determines the amount of additional water the tree bark can store from rain storms.

• **Growth Rings**: Each year of growth results in the formation of a new visible ring of sapwood.

Trees in temperate climates generate growth rings on an annual basis. The cambium layer of trees is dormant during the cold winter months. The cambium is the area of a tree where cell division occurs, adding new wood and increasing the diameter of the tree. When the weather warms up in the spring, activity in the cambium will resume. Temperature rise is one of the most critical elements influencing the start of cell division in the spring.



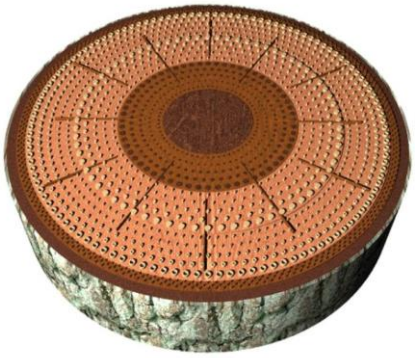
https://academic.oup.com/aob/article/124/2/297/5537005?login=false

Representative cross-sections of dye staining in 2- to 3-year-old stem sections. Stems were perfused with stain solution basipetally from the current-year shoot to determine whether the dye could reach previous growth rings. In each image, the pith and previous growth rings are to the left and the newer rings and epidermis are to the right. Arrows indicate growth ring boundaries. All vessels near the dye injection point in the current-year shoot were stained, and flow appeared to preferentially move through the largest-diameter vessels.

• **Medullary ray (wood ray):** Living cells that run across the growth rings and allow sap to be transported radially. These marks are caused by sap moving through the wood perpendicular to the rings as nutrition is transported from its core to the outer areas leaving silver or gold ribbons, as well as being an important part of the tree's growing process.

LO 2.2. Identify the difference in cell structure between ring porous, diffuse porous and coniferous woody plants

Based on the anatomical properties of their water conducting system, woody plants are classified as non-porous, diffuse-porous, or ring-porous. Softwood and hardwood species differ in their vulnerability to sap flow disturbance based on structural variations. Despite cavitation and embolism, ring-porous and diffuse-porous trees use different ways to restore conductivity during winter frosts.



Above: a model of a slice through a ring-porous tree such as a deciduous oak.
Xylem vessels transport xylem sap from the roots to the leaves and developing organs in deciduous wood.

There are three types of cells in xylem tissue: xylem parenchyma, tracheids, and vascular components.
Water is transported through the xylem vessels. Xylem is a network of interconnecting tubes that runs from the roots to the leaves. They appear as veins in leaves. Tracheids and vascular elements are two forms of modified cells found in xylems. Xylems are hollow tubes that function as pipes, allowing water and dissolved minerals to pass through. Lignin is a chemical found in the cell walls of xylem vessels. Lignin strengthens and structurally supports cells.

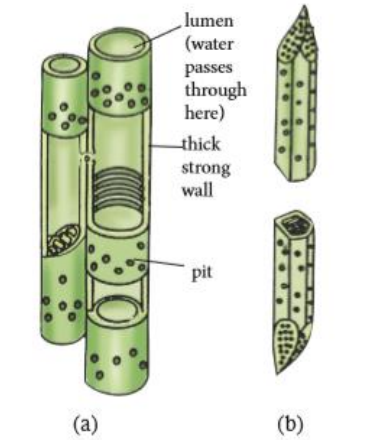
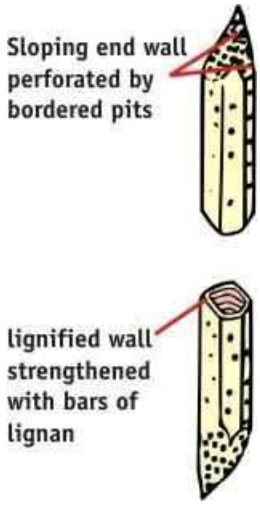


Fig 8.8: (a) Structure of element (b) Tracheid vessel



Earlywood created in spring in ring-porous trees has broader vessels than wood formed later in the year. As a result, the latewood is denser and slightly darker, resulting in an apparent annual growth ring.

As in horse chestnut, Aesculus hippocastanum, there is little or no change in vessel width between late and early wood in diffuse-porous trees. Rings may still be seen in diffuse-porous trees, particularly if they are separated by a layer of parenchyma cells. Some hardwoods are intermediate, with older vessels being wider but distributed amid narrower later vessels.

Conifers do not have this sort of vessel and instead have narrower tracheids that are neither ring-porous nor diffuse-porous. Tracheids are narrower and, like vessels, serve as conduits for the movement of xylem sap. However, they are not considered true vessels for reasons that will become clear when we examine their structure in greater detail.

Ring-porous species:
Oaks (*Quercus spp.*)
Catalpa (*Catalpa speciosa*)
Ash (*Fraxinus spp.*)
Chestnuts and chinkapins (*Castanea spp.*)
Black locust (*Robinia pseudoacacia*)
Honeylocust (*Gleditsia triacanthos*)
Elms (*Ulmus spp.*)

Diffuse-porous species:
American beech (*Fagus grandidentata*)
Birches (*Betula ssp.*)
Maples (*Acer spp.*)
American sycamore (*Platanus occidentalis*)
Sweet gum (*Liquidambar styraciflua*)
Sour gum (*Nyssa sylvatica*)
Aspens (*Populus spp.)*
Willows *(Salix spp.*)
Dogwoods (*Cornus spp.)*
Tulip-poplar (*Liriodendron tulipifera)*

Resources

https://tree.lightsource.ca/teaching-resources/modules/module-1-trees/section-1-1-tree-anatomy-functions
https://courses.lumenlearning.com/wm-biology2/chapter/stem-growth/
https://www.fs.usda.gov/learn/trees/anatomy-of-tree
https:/ https://blogs.berkshirecc.edu/bccoer/plants/
https://cronodon.com/BioTech/Plant_Bodies_Wood.html
www.arboristnow.com/news/The-Basic-Anatomy-of-a-Tree
http://www.nogimasaya.com/favorite/learn-the-wood-structures/
https://letstalkscience.ca/educational-resources/stem-explained/how-do-trees-survive-in-winter
https://kids.frontiersin.org/articles/10.3389/frym.2022.692203
https://www.americanforests.org/article/the-language-of-bark/
https://hort.ifas.ufl.edu/woody/compartments-xylem.shtml