Citizen Forester Training

BASIC TREE BIOLOGY

OBJECTIVES

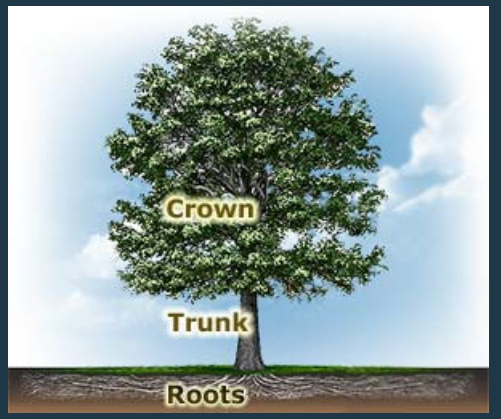
- Identify parts of a tree
- Determine:
  - How tissues and tree parts develop
  - How those function
  - The purpose each component serves
- Understand how those are impacted by humans and urban environments

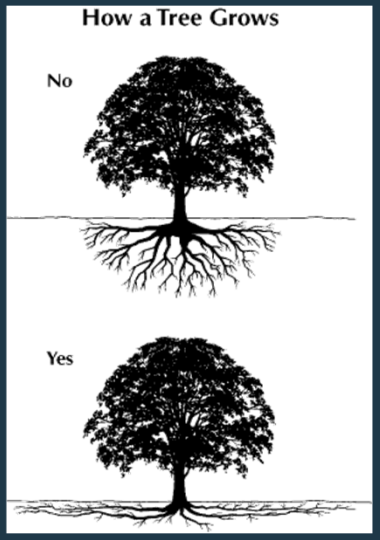
TREE BIOLOGY

- Why is tree biology important?
  - An understanding of how trees grow and survive is critical to understanding how we impact trees
  - Biology is the basis for decisions in tree care
  - Meaning behind pruning methods, tree selection, planting and watering requirements, and other material in this course
- Related terms:
  - Silviculture, arboriculture, dendrology

BASIC PARTS OF A TREE

- Canopy
  - Leaves- photosynthesis
  - Twigs- contain buds for leaf growth
  - Branches- support
- Trunk- support and transport
- Roots
  - Coarse roots- support
  - Fine roots- absorption



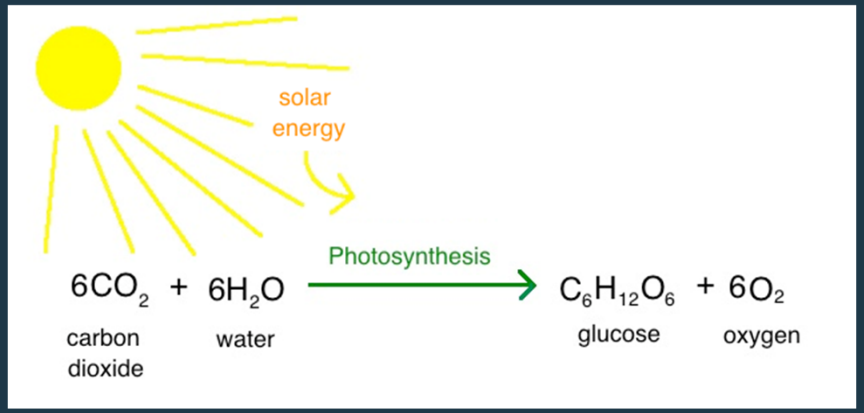


PHOTOSYNTHESIS

- Photosynthesis=converting light to energy
- Respiration=releasing and utilizing energy (all living organisms)
  - Plants use both photosynthesis and respiration
  - Both processes involve oxygen, CO_2, water, and energy
- Energy is used by the tree for growth and other processes such as repairing wounds
- Trees are striving to grow and reproduce

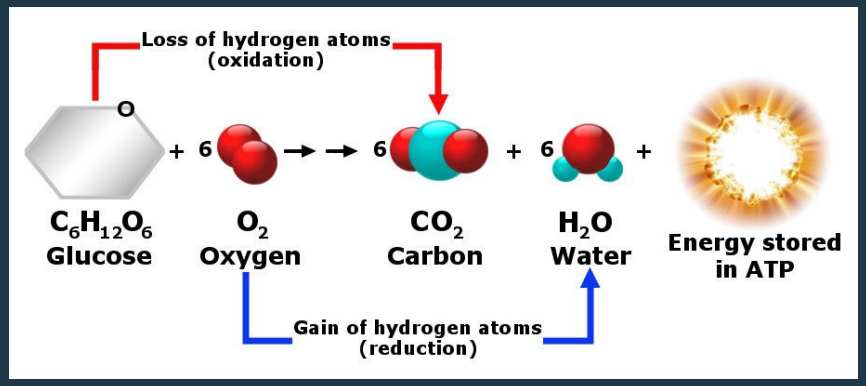
PHOTOSYNTHESIS

- Plants capture energy through photosynthesis
- Oxygen is a byproduct of photosynthesis
- The energy is stored in carbohydrates
- Different wavelengths of light are utilized more, particularly blue and red



RESPIRATION

- All living organisms respire, but not ventilate
- Oxygen is consumed
- The stored energy is released
- Examples: root growth, cellular maintenance, fire
- Energy is used even when the tree is dormant



TREE COMPONENTS

- Leaves/needles-photosynthetic tissue (the factory)
  - Chloroplasts-organelles in the leaf that contain chlorophyll and conduct photosynthesis
  - Stomata/stomates-pore for transfer of air in and out of the leaf, closed at high and low temperatures to prevent water loss
  - Cuticle-waxy coating on leaves of some species to reduce moisture loss

TREE COMPONENTS

- Catkins-male reproductive organ
- Cones/acorns-female reproductive organ

- Monoecious- One tree has both male and female parts. Many species are like this; however, they may not all be able to self pollinate
- Dioecious- "Two houses", male and female
  - Boxelder, *Juniper*, *Populus*, Persimmon, Ginkgo, Fringetree, Ash, Osage orange, Holly, Honeylocust, Pistache, and Willow
- Advantages to each strategy, both for the trees and for us

TREE COMPONENTS

- Stem and branches-support tree and ensure sunlight for leaves, storage space
- Roots-similar to branches, anchor and support tree, provide storage (resprout)
- Fine roots-small hair roots that collect water and nutrients

- *Mycorrhizae-mutualistic fungus that acts like very fine roots, symbiotic with the tree to help uptake of nutrients

TREE COMPONENTS

- Bark-protective layer on the outside of the tree
- Phloem-outer tissue that moves most of the carbohydrates from the leaves, particularly to the roots
- Cambium-layer that separates xylem and phloem, it is the actively growing tissue on the stem
- Xylem-inner tree tissue that conducts water and nutrients up (think "xy" like "sky")
  - Sapwood-"younger" xylem toward the outer part of the tree that is actively conductive
  - Heartwood-the inner part of the tree made up of xylem that no longer conducts water, a sort of storage facility for the tree

TREE COMPONENTS

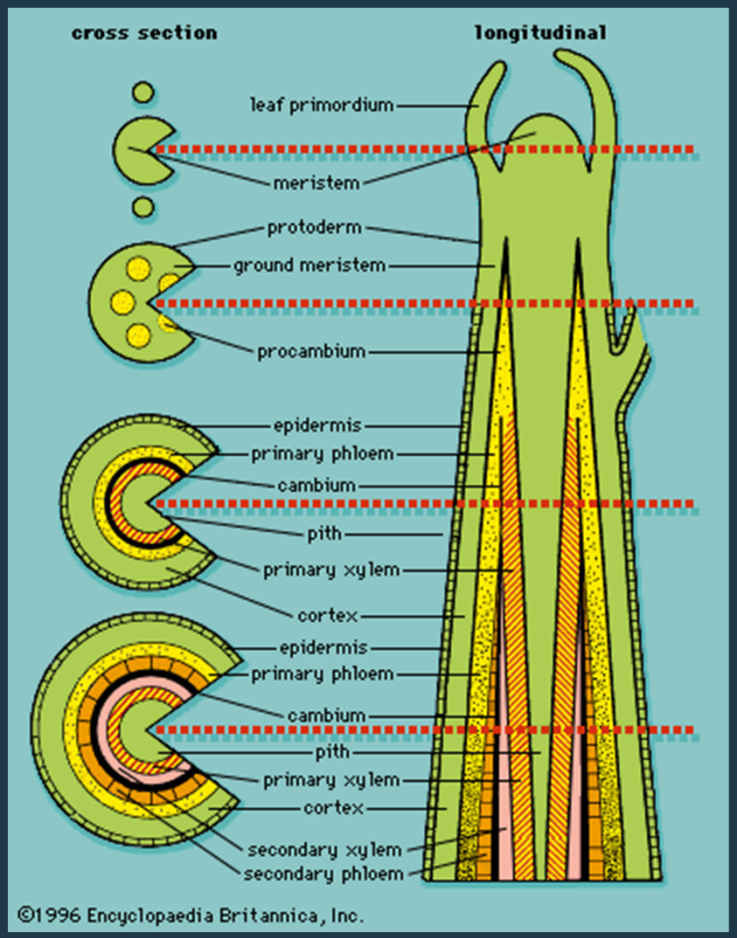
XYLEM COMPONENTS

- Tracheid & vessels- conductive tissue (tubes or straws) that allow vertical flow of water and nutrients
- Rays- conductive tissue to move nutrients horizontally within the stem

- Earlywood- xylem growth after trees break from winter dormancy, rapid expansion
- Latewood- xylem growth occurring late in the growing season, produces visible growth rings in most conifers

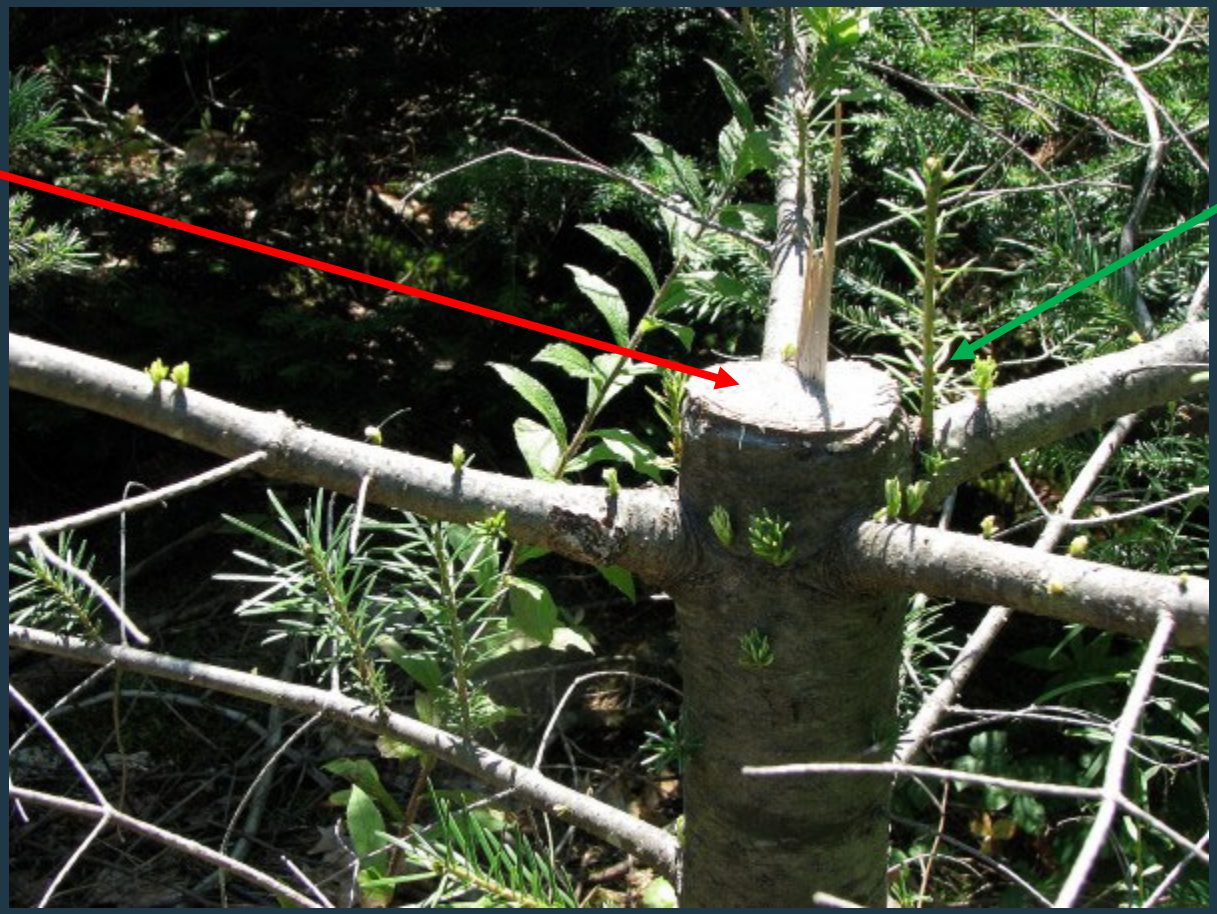
INITIAL GROWTH

- Trees have only a small layer of growth tissue
  - At the tip of twigs and buds is the meristem
  - Surrounding the branch, stem, and root is the cambium layer
- Unlike grasses, trees growth occurs at the end of existing tissue



SPROUTING

Tree top cannot regrow from this



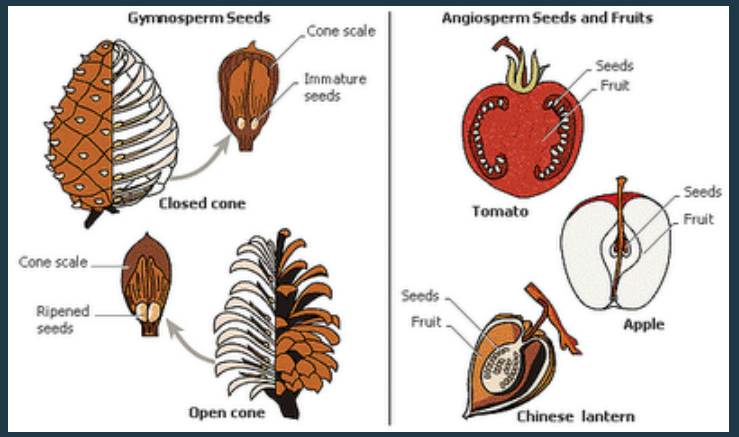
Sprout from living tissue in cambium

GROWTH

- Energy is sent throughout the tree based on predetermined growth patterns (genetics) and their environment
- Differences in growth patterns occur at species level
  - Fast vs slow (Bald cypress vs bur oak)
  - Root vs shoot (Oak vs pine)
- Ex. Slash pine grows rapidly, does not tolerate shade, reproduces quickly, seeds spread far, not exceptionally long lived

GROWTH

- Angiosperm: hardwoods, fruiting trees, large supply of resources
- Gymnosperm: softwoods, conifers, small seed with less energy stored



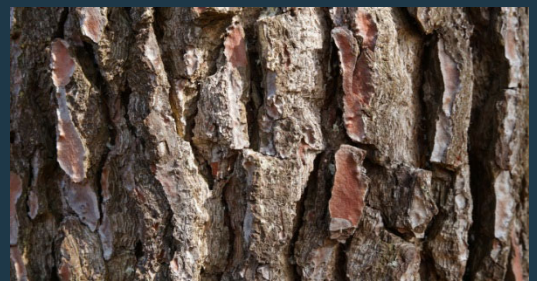
SECONDARY GROWTH

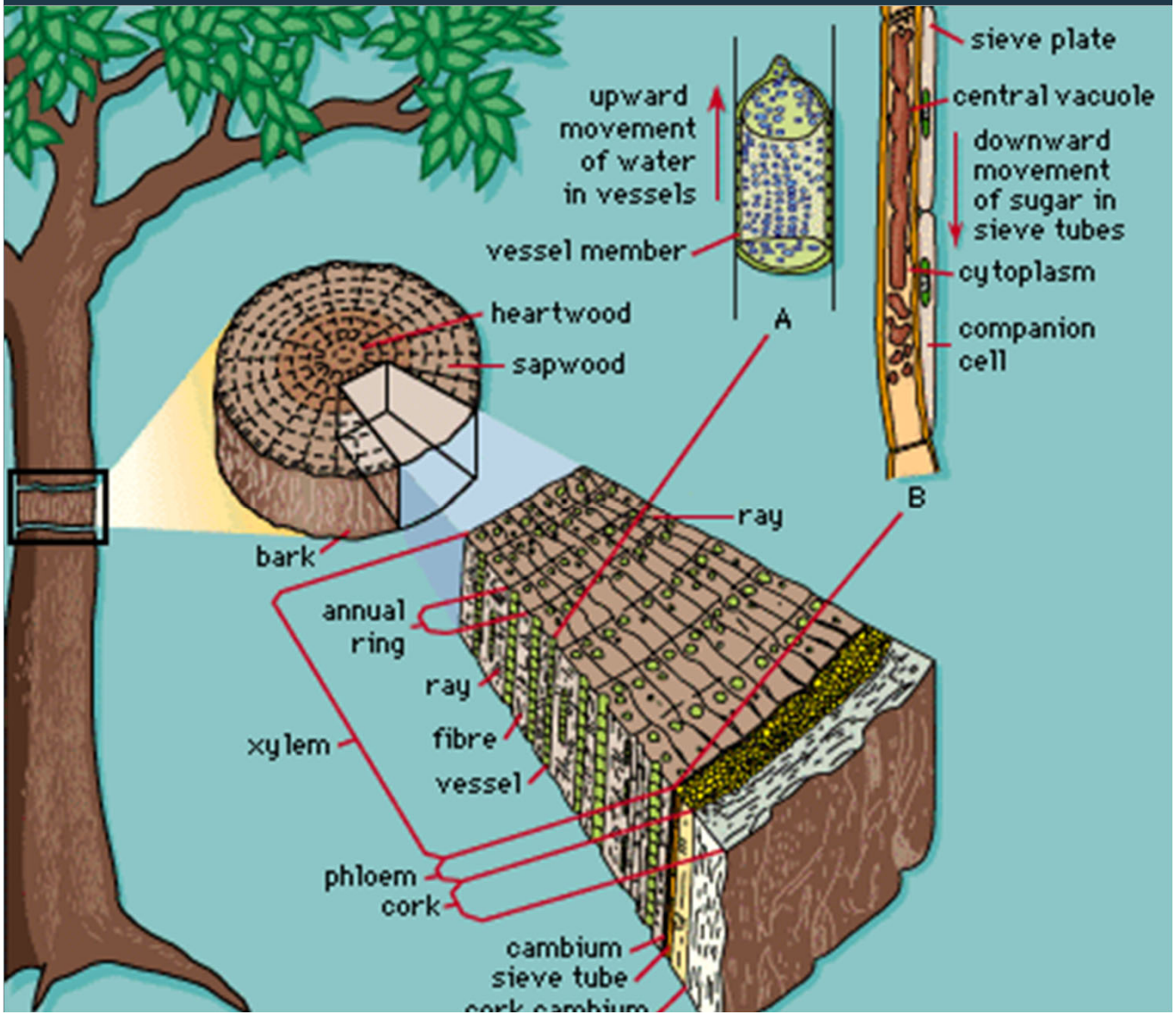
The inner part of the stem is often non-functional or dead and can be susceptible to rot.

The outer ring of live tissue is what allows the tree to grow and does most of the work moving water, nutrients, and energy.

The outer bark or cork is pushed away from the tree as it grows. That is why bark forms ridges, the bark expands as the tree grows.

The oldest tissue in the trunk is at the center of the tree and on the farthest outer ring of bark.





GROWTH

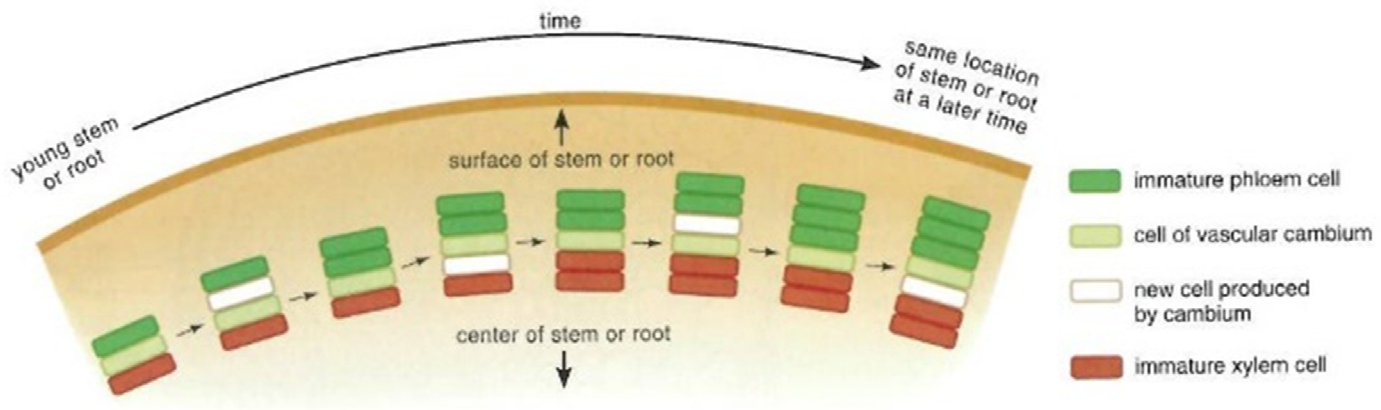


Figure 6.4 An illustration of how a cell of the vascular cambium produces new secondary phloem cells to the outside and new secondary xylem cells to the inside. Note, in cross section, that the cambium gradually becomes shifted away from the center as new cells are produced. Phloem is produced before xylem in secondary growth.

XYLEM AND PHLOEM

- What impact would cutting tissue all the way around the tree have, even if it was only half an inch deep?

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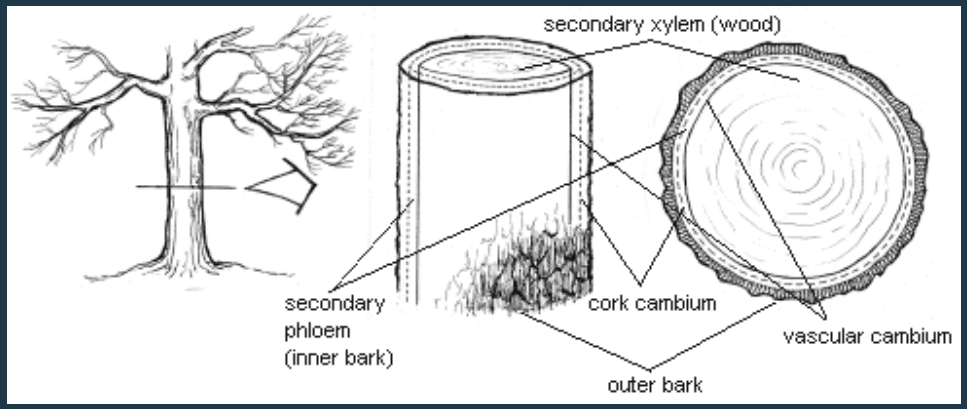
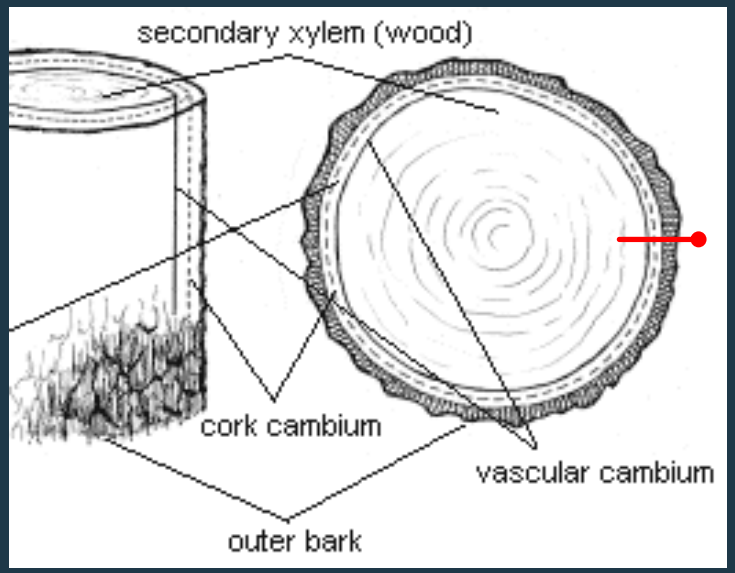
XYLEM AND PHLOEM

- Will a nail put in a tree be the same height in 10 years?



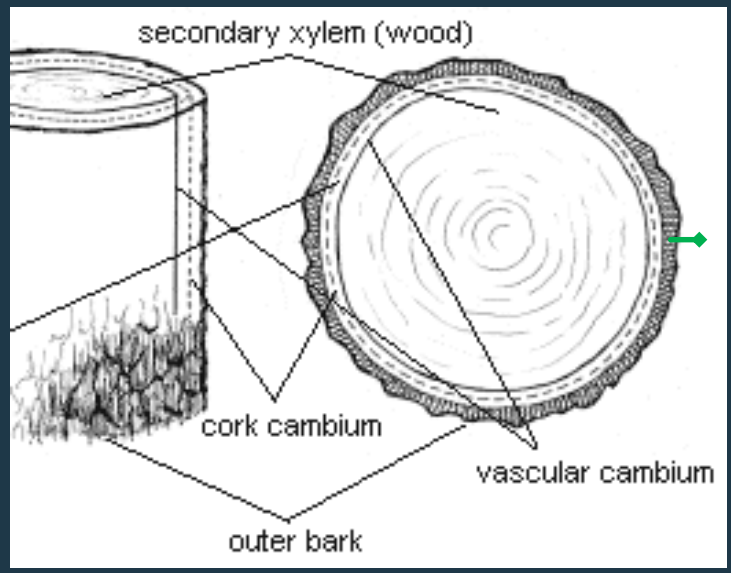
XYLEM AND PHLOEM

- Will a nail put in a tree be the same height in 10 years?
- Will the nail be visible?



XYLEM AND PHLOEM

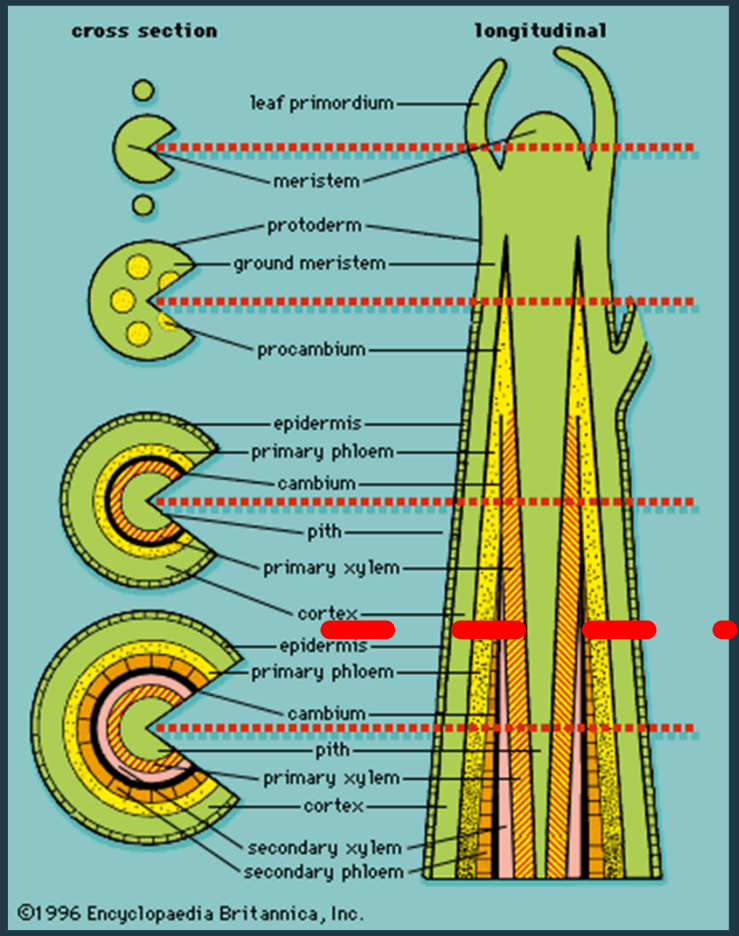
- Will a nail put in a tree be the same height in 10 years?
- Will the nail be visible?
- What about a tack?



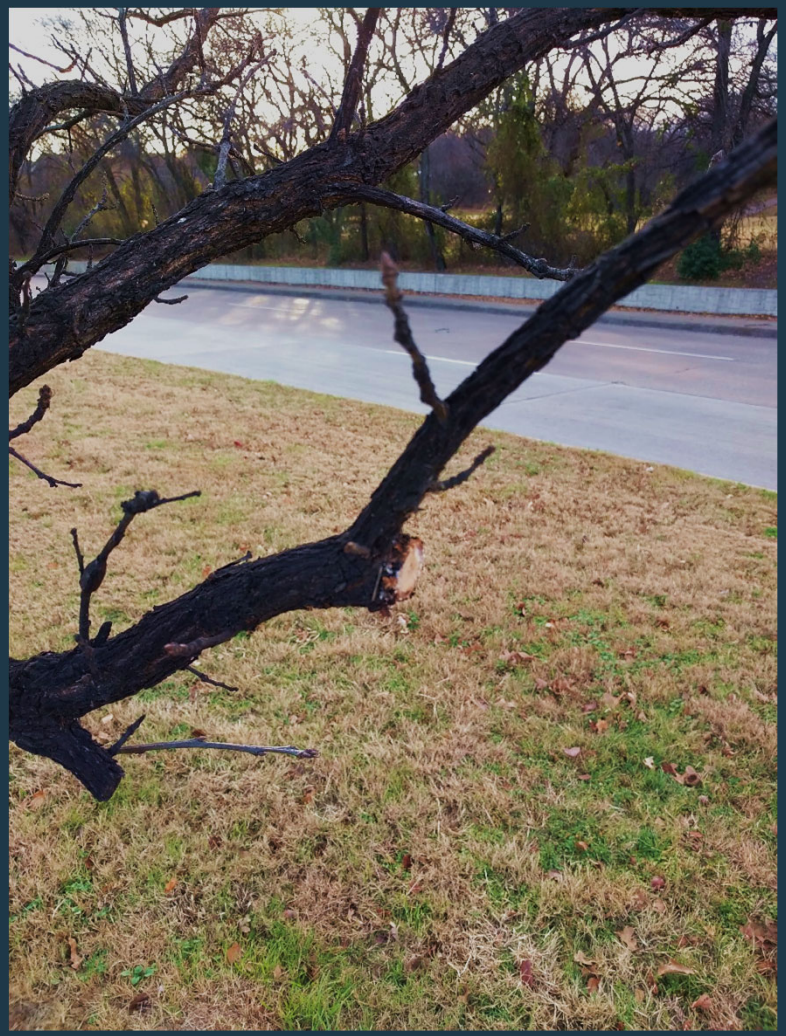
TREE GIRDLING

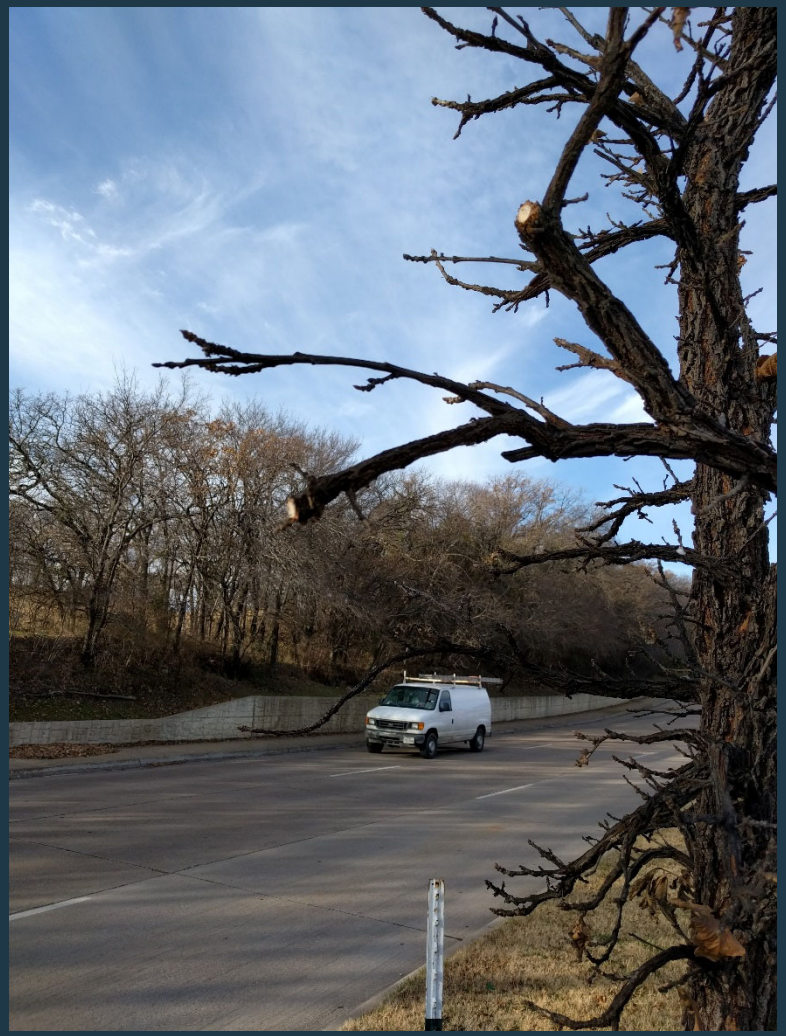
WOUND HEALING

- Cutting the tip of this twig would slow the branch growth outward
- It may heal or die back or extend the shoot through a lateral
- Good pruning considers the impact and resulting growth



BRANCH WOUND HEALING





CARBON BALANCE

- The overall productivity of a tree is described as the "carbon balance"
- Carbon stored from photosynthesis must be greater than or equal to the carbon lost from respiration for the tree to remain alive long-term
- Older trees may be able to survive for some time with negative carbon balance, but eventually they will run out of stored energy

CARBON BALANCE

- For younger trees it is almost essential to have a positive carbon balance as they have little stored carbon and must remain competitive to survive
- Applies to individual branches as well
- If a branch becomes shaded out or photosynthetic productivity no longer matches the respiration of the branch, the branch will likely die

CARBON BALANCE

- Branches that cannot be supported die back to the next productive branch or the stem
- Young trees are adapted to losing branches from shading, but older trees are less adapted to such wounds
- Some species have greater tolerance for shade, mainly when young

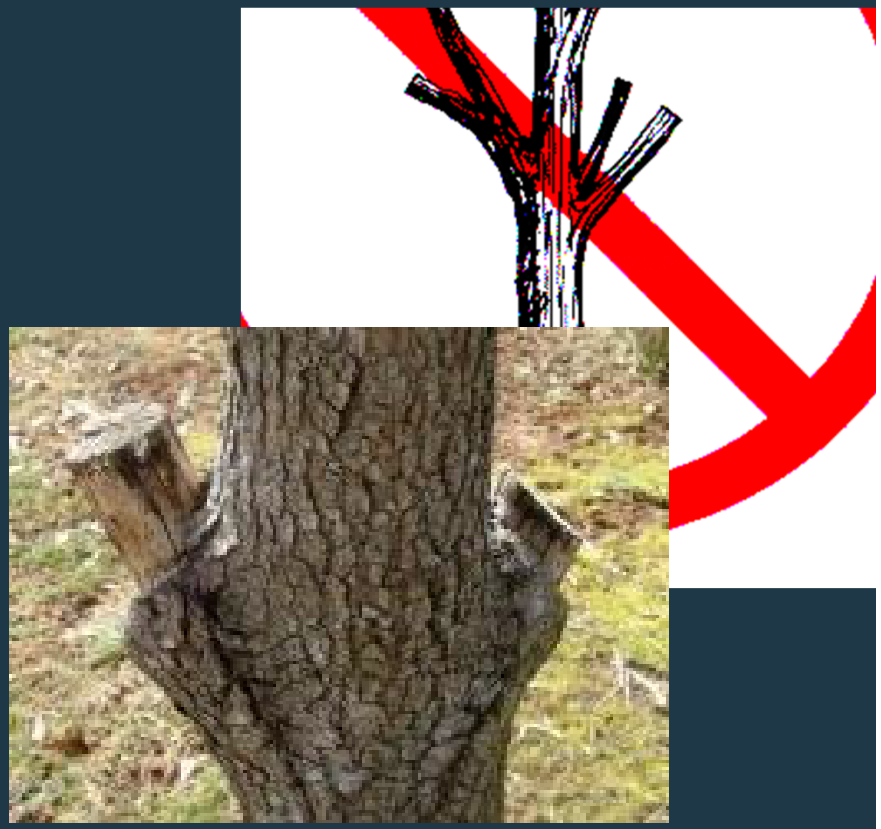
TREE DEFENSE

- Trees have adapted to most native pests, but may not be adapted exotic pests
- For the most part, the life cycles of natural trees are not severely hampered by pests
- However, we want our trees to live longer than just necessary to reproduce

COMPARTMENTALIZATION

- Wounds are a disease path until the stem can close the wound (stub cuts)
- Compartmentalization: the ability to lose sections without loss of functionality
  - Bark seals off decay by healing over wounds
  - Compartmentalization controls decay even when it reaches the interior of the tree

"Tree wounds don't heal, they seal"



COMPARTMENTALIZATION

- Compartmentalization is a tree's way of controlling infection
- Without an immune system or ability to actively ward off attackers, trees rely on sealing off diseased tissue
  - Tissue is sealed from vertical movement by plugging tracheids and vessels (weakest point of compartment)
  - Heartwood and sealed rays prevent inward and lateral movement
  - Living tissue closes wounds and effectively seals decay from spreading outward from a wound

A *NATURAL* TREE'S LIFE AND GOALS

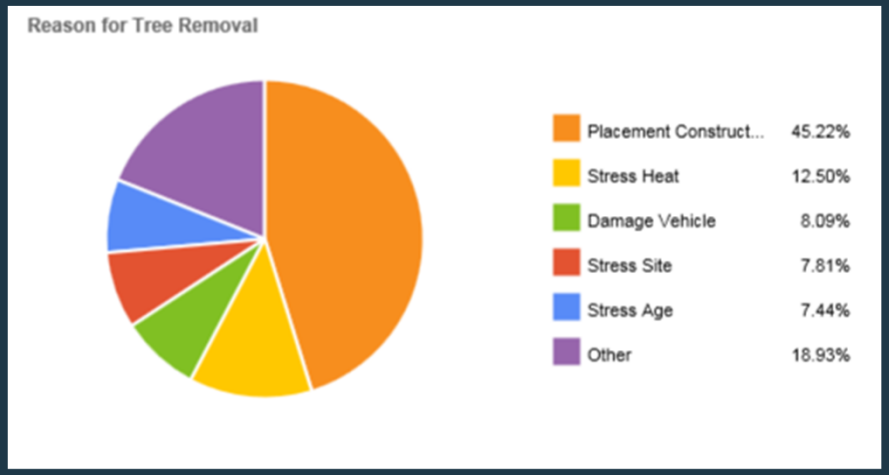
- ✓ Survive seedling stage
- ✓ Establish a root system
- ✓ Grow to capture light for energy
- ✓ Expand canopy to shade out others
- ✓ Reach maturity and reproduce species
  - ✓ Reproduction strategies differ by species

OUR TREE'S LIFE AND GOALS

- ~~Survive seedling stage~~ (nursery)
- Establish a *good* root system (at planting)
- Grow up and above driveways, roads, etc.
- *Not* compete for space
- Live a long life
  - How long depends on the species, but all trees die eventually, especially in urban environments
- Replace successfully

COMMON TREE ISSUES

- Planted too deep
- Girdling roots
- Lack of water
- Too much water
- Pruning wounds
- Soil/site issues
- Lack of sunlight
- Root damage
- Top damage
- Insects/disease



MORE INFO

- Tree Biology Video
- Characteristics and Growth of Trees
- Urban Forestry Video
- Wood Database