Welcome to Arboriculture 101

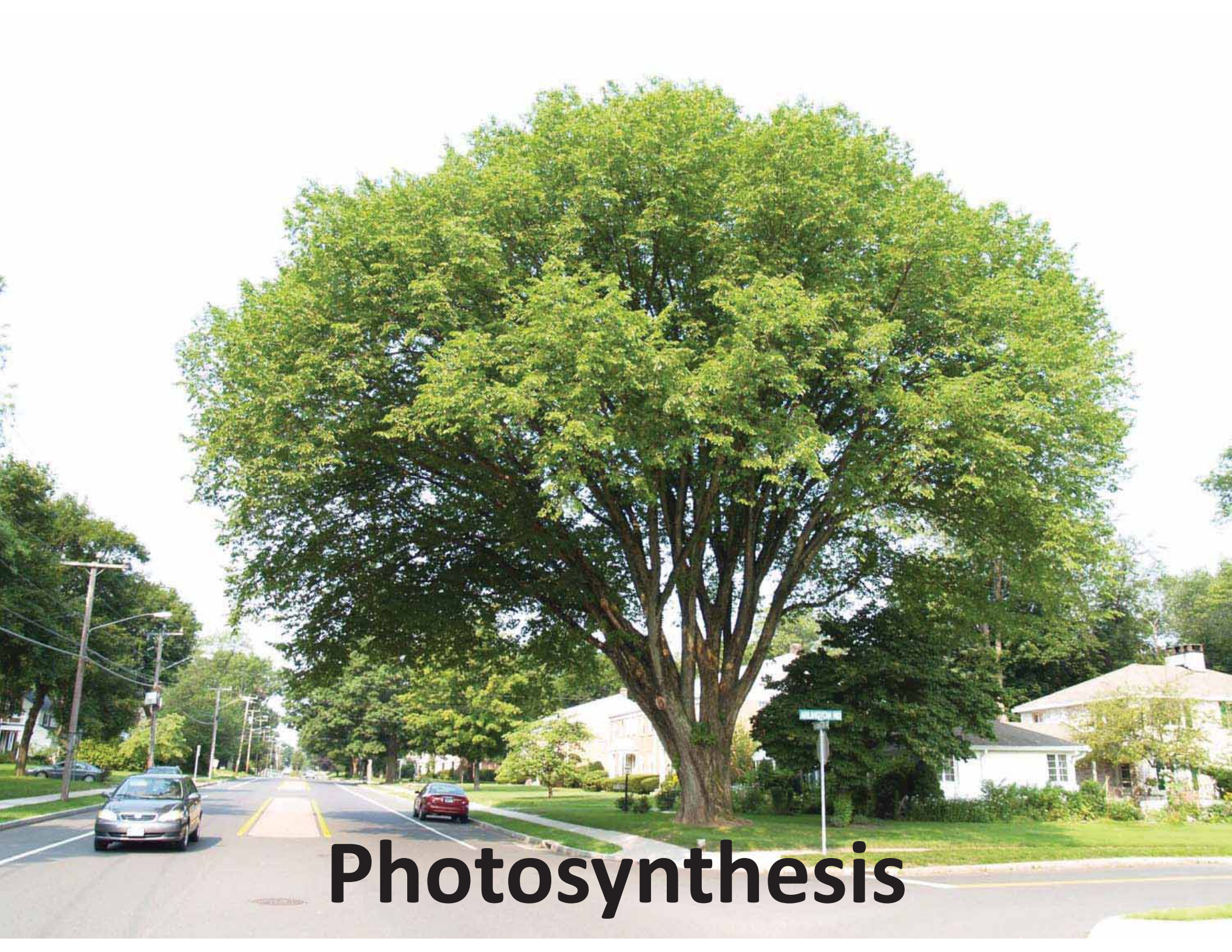
www.ctpa.org/arboriculture101.html

Introduction to Tree Biology

or, how the tree functions as a set of systems

Nine Systems

- Photosynthesis
- Hydrologic
- Structural
- Growth
- Response
- CODIT
- Reproductive
- Chronological
- Death and Shedding



Photosynthesis

Photosynthesis

Carbon Dioxide + Water → Oxygen + Sugar

energy in = sunlight

Photosynthesis

Carbon Dioxide + Water ➔ Oxygen + Sugar

(6) CO_2+ (6) H_2O ➔ (6) O_2 + $C_6H_{12}O_6$

energy from sunlight is now stored in the sugar

Respiration

Oxygen + Sugar ➔ Carbon Dioxide + Water

energy out = metabolism

Sugars are the Building Blocks

Plants will use sugars to make:

Starches, Proteins, Fats, Oils,…

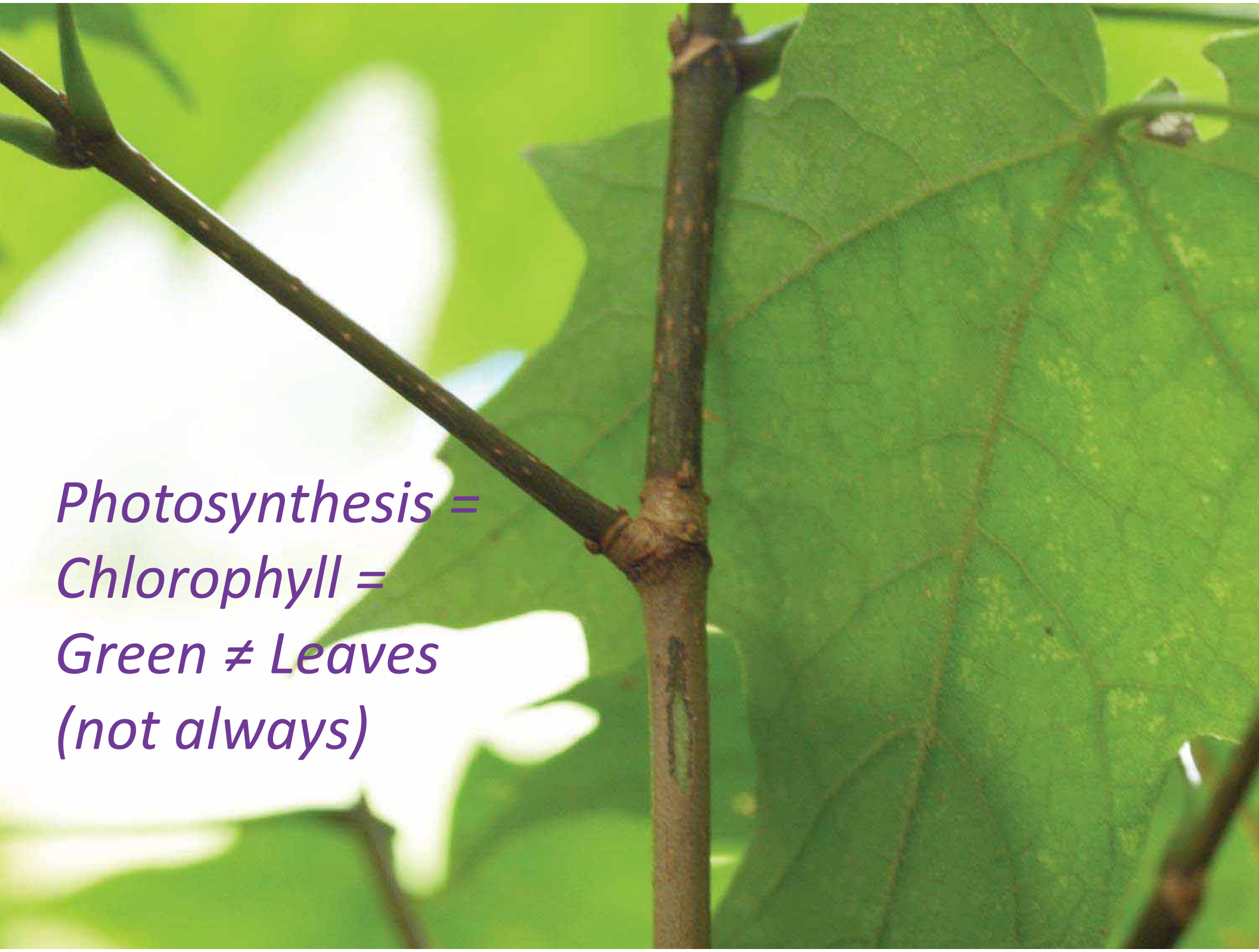
Which then become Cellulose, Lignins, Wood,

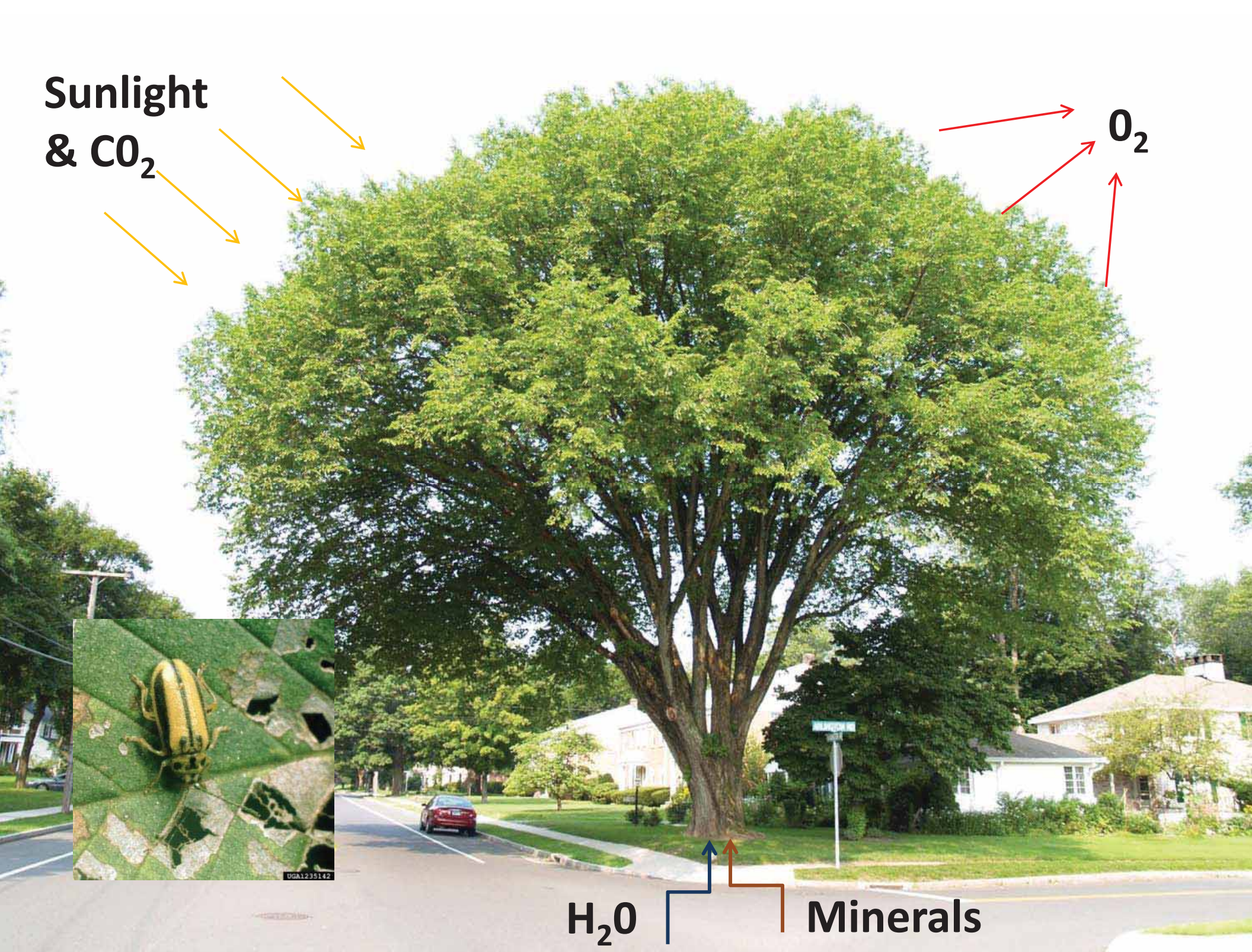
Which then become Bark, Leaves,…

and so on….

From simple sugars to ever more complex compounds….

All of which sounds good to the rest of us who are alive on this planet…


Photosynthesis =
Chlorophyll =
Green ≠ Leaves
(not always)


Sunlight
& CO_2
O_2
H_2O
Minerals

Hydrologic (Circulatory)


Transpiration

Parts of the trunk of a tree.

Bark

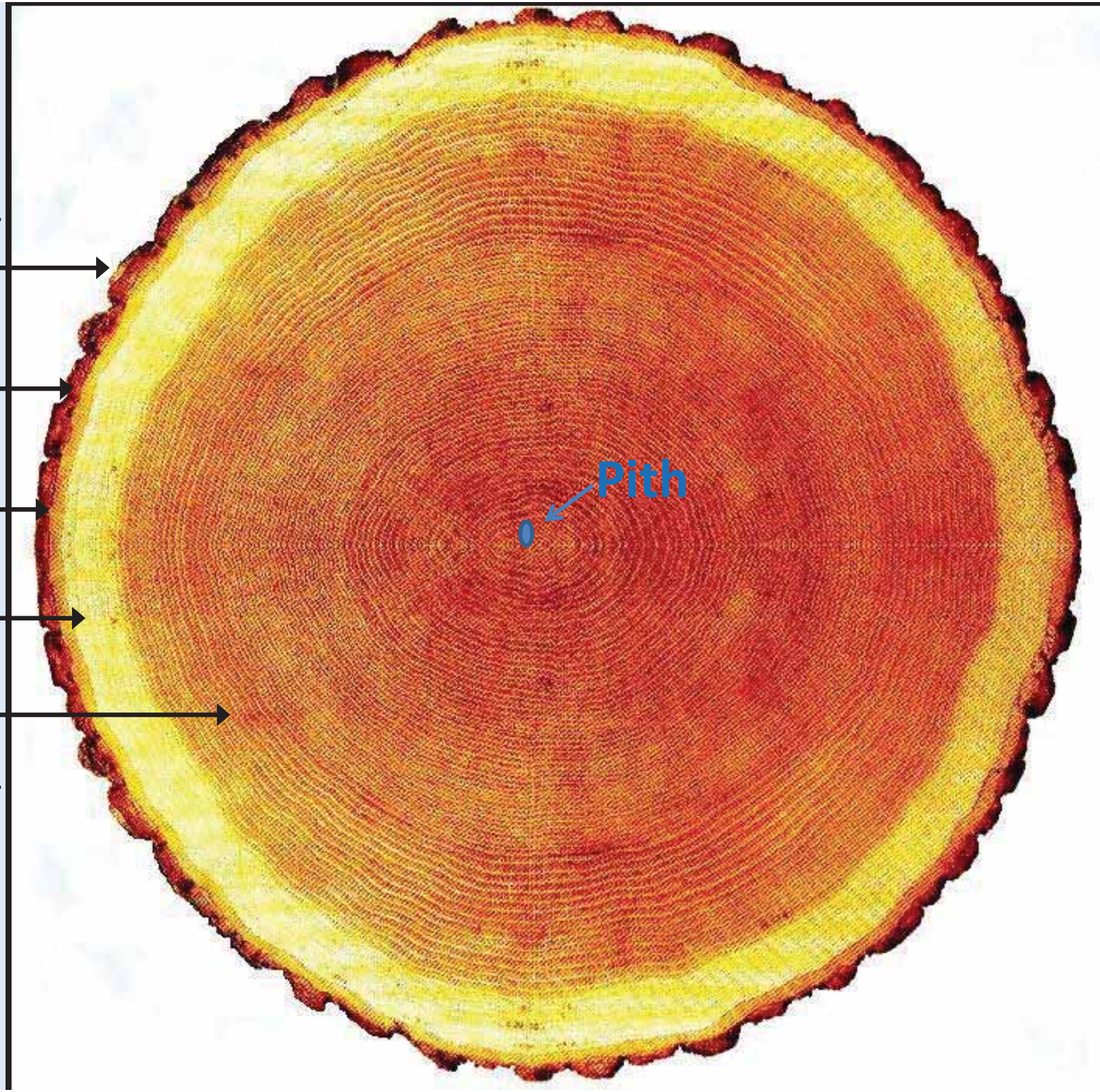
Inner Bark

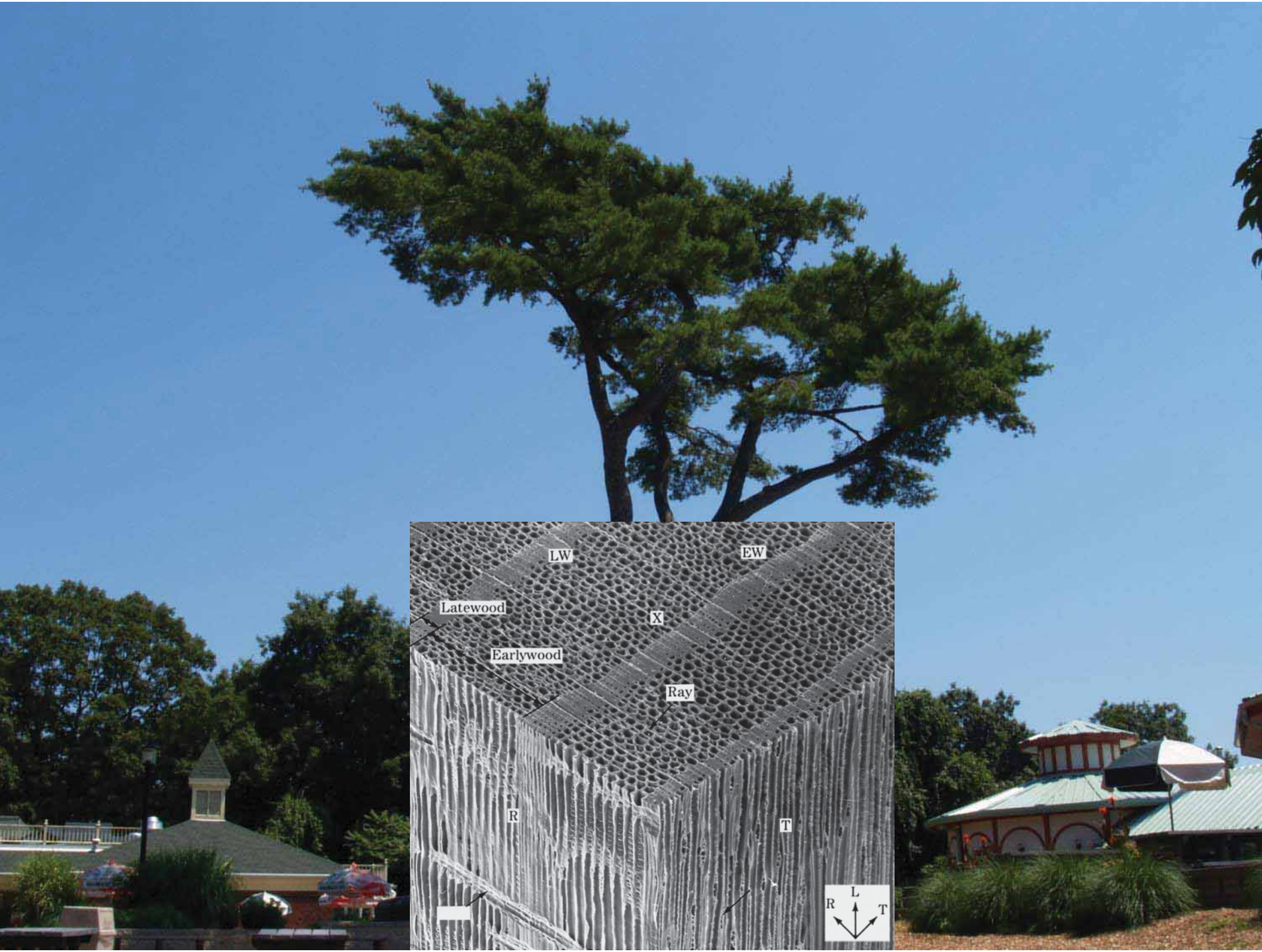
Cambium

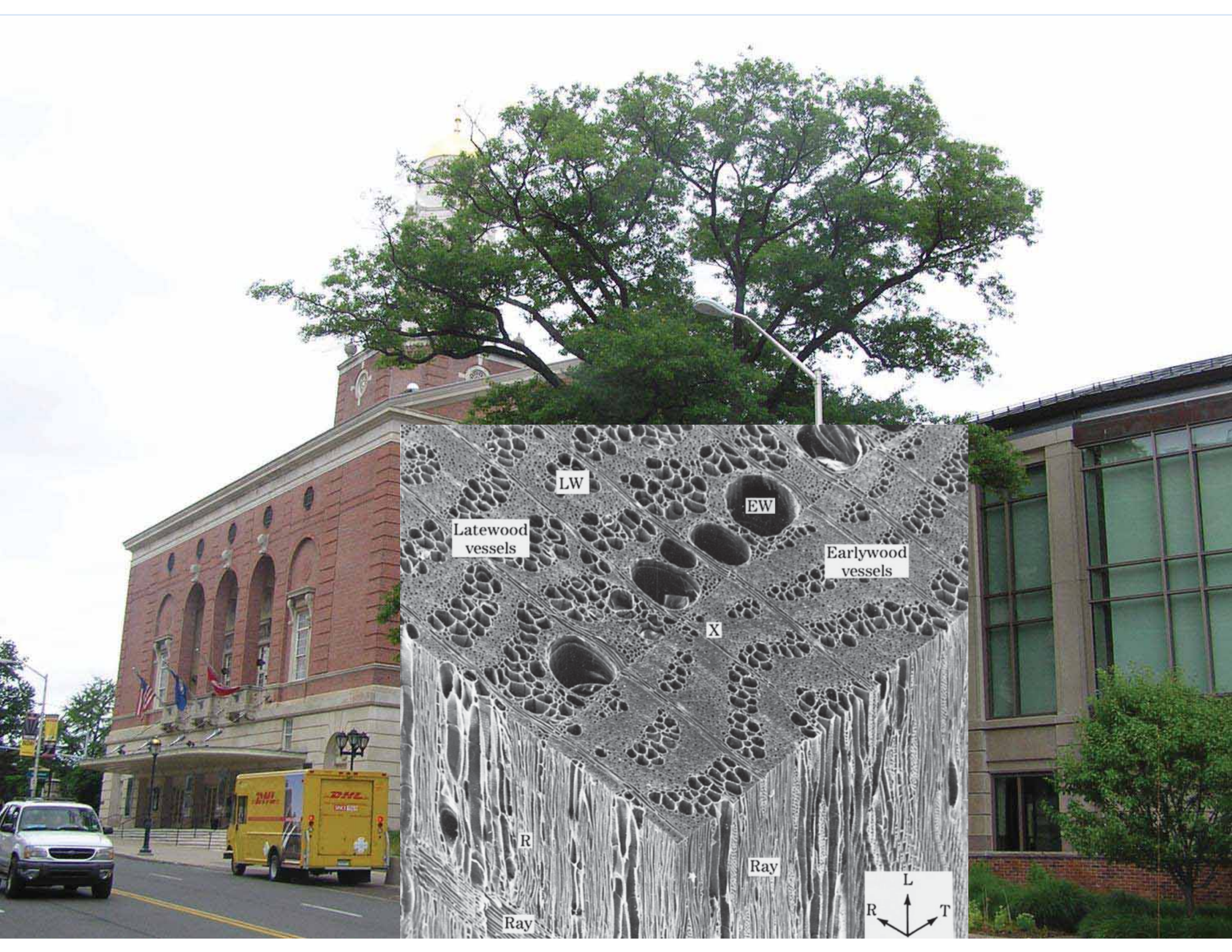
Sapwood

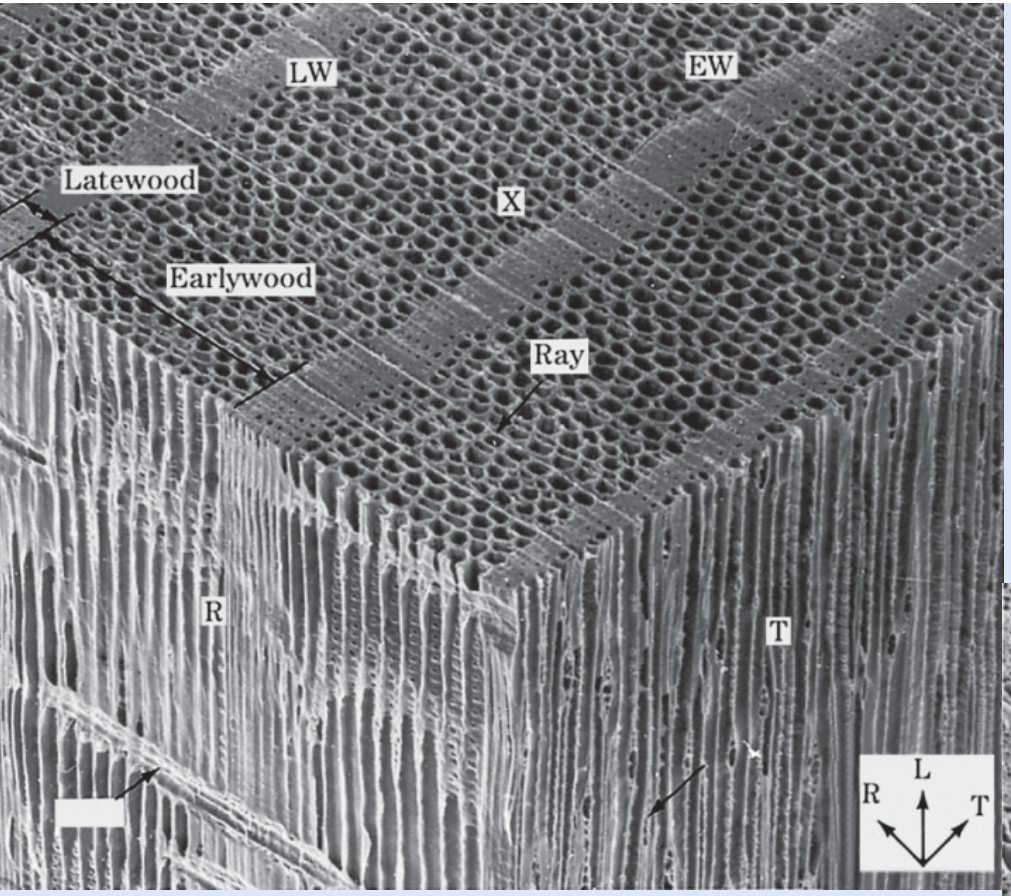
Heartwood

Inner bark contains phloem; wood is largely made up of xylem



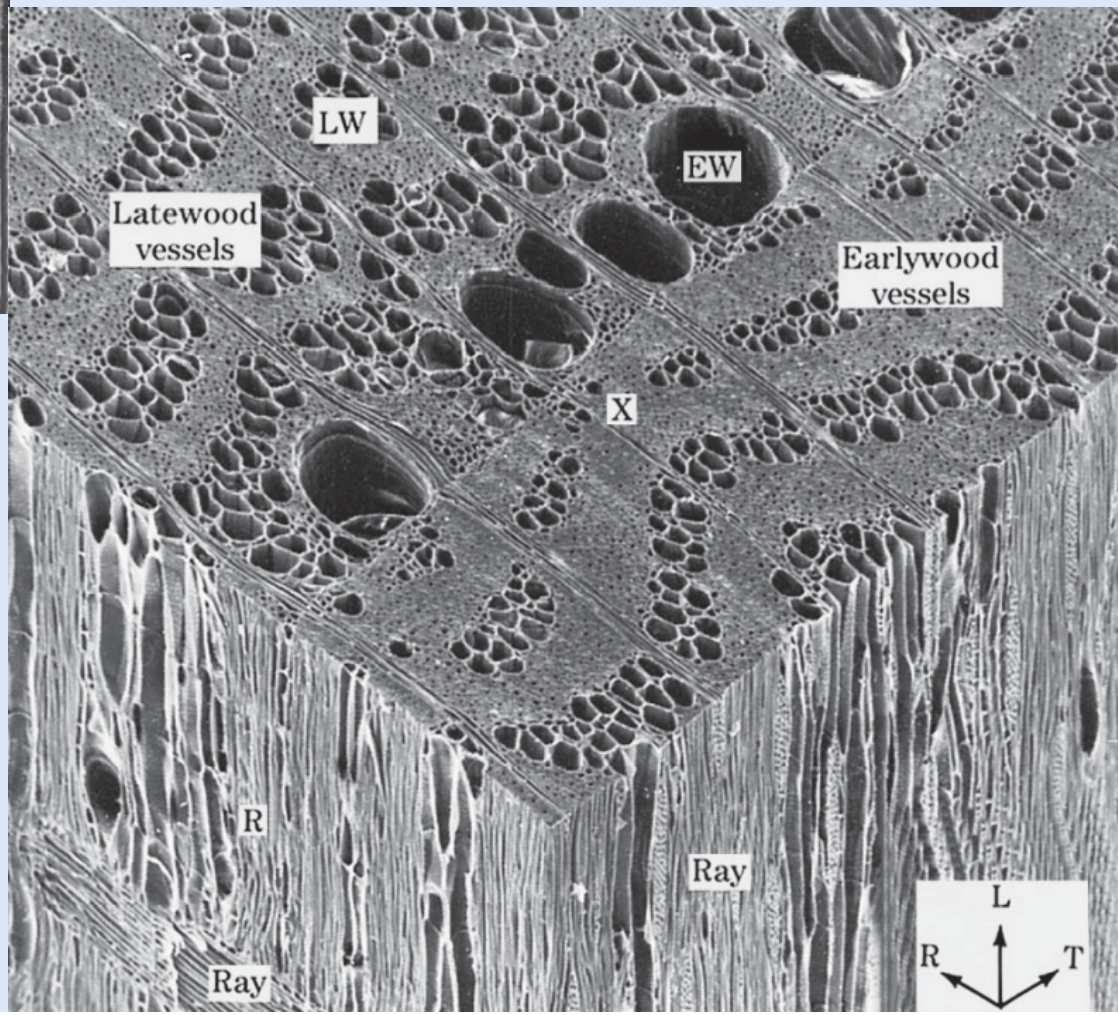

LW
EW
Latewood
X
Earlywood
Ray
R
T
L
R
T

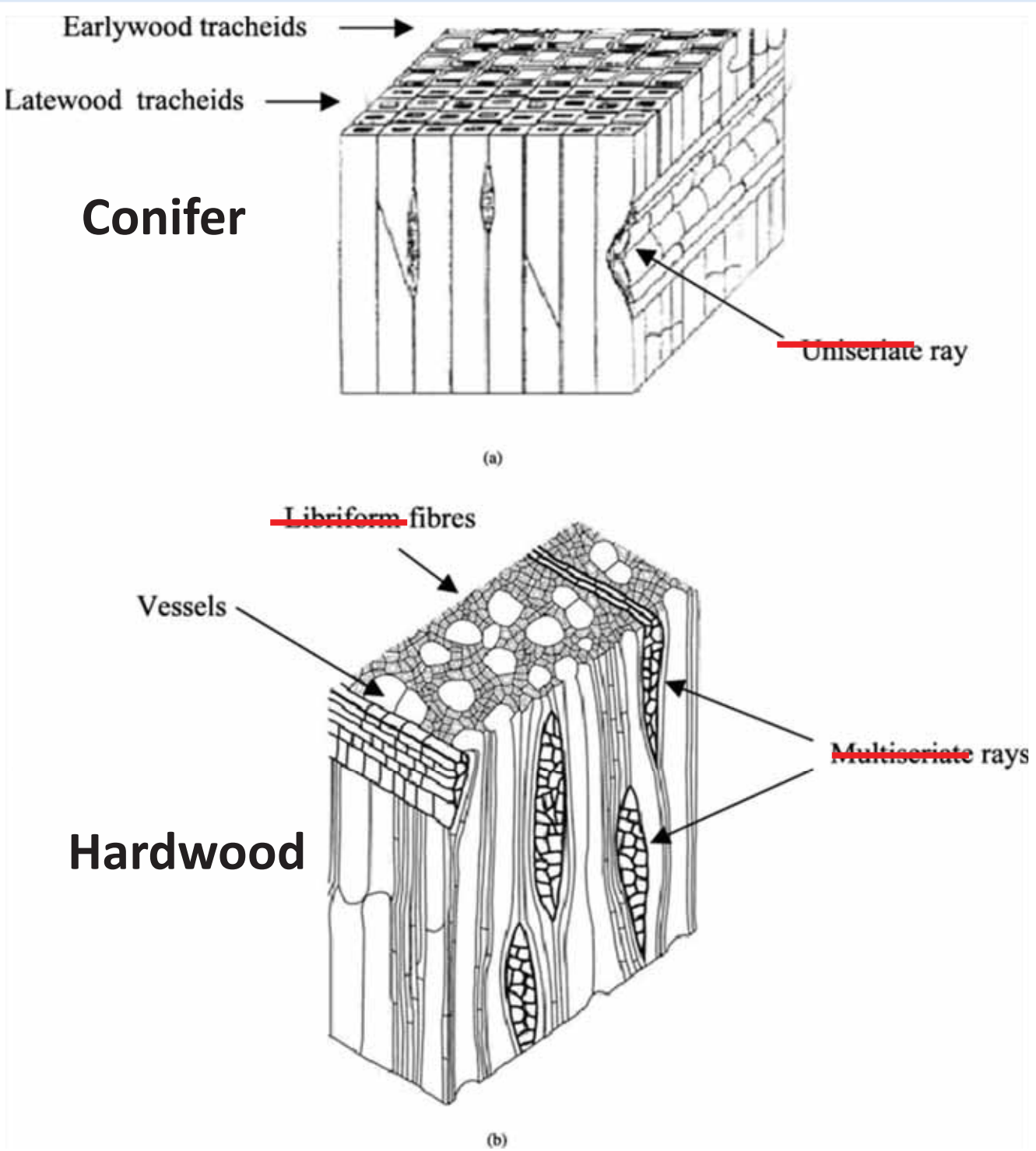

LW
EW
Latewood vessels
Earlywood vessels
X
R
Ray
Ray
L
R
T



← *Conifer (pine)*

Hardwood (red oak) →




Earlywood tracheids
Latewood tracheids
Conifer
Uniseriate ray
(a)
Libriform fibres
Vessels
Multiseriate rays
Hardwood
(b)

Explanatory Notes:

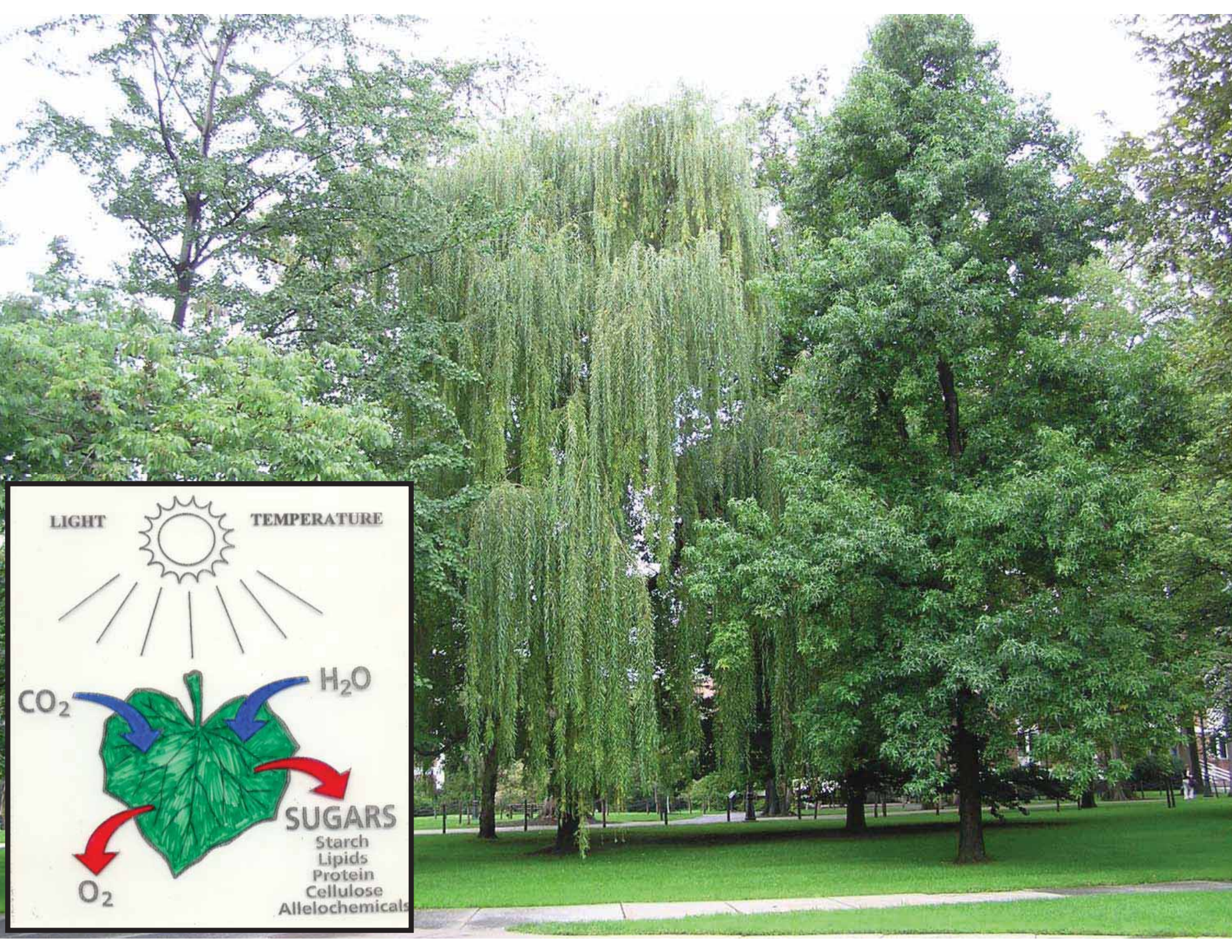
- X = xylem
- Conifers have tracheids
- Hardwoods have fibers and vessels
- Early Wood equals Spring Wood
- Late Wood equals Summer Wood
- Tracheids, fibers and vessels run lengthwise (up and down)
- Rays run across (vertical)

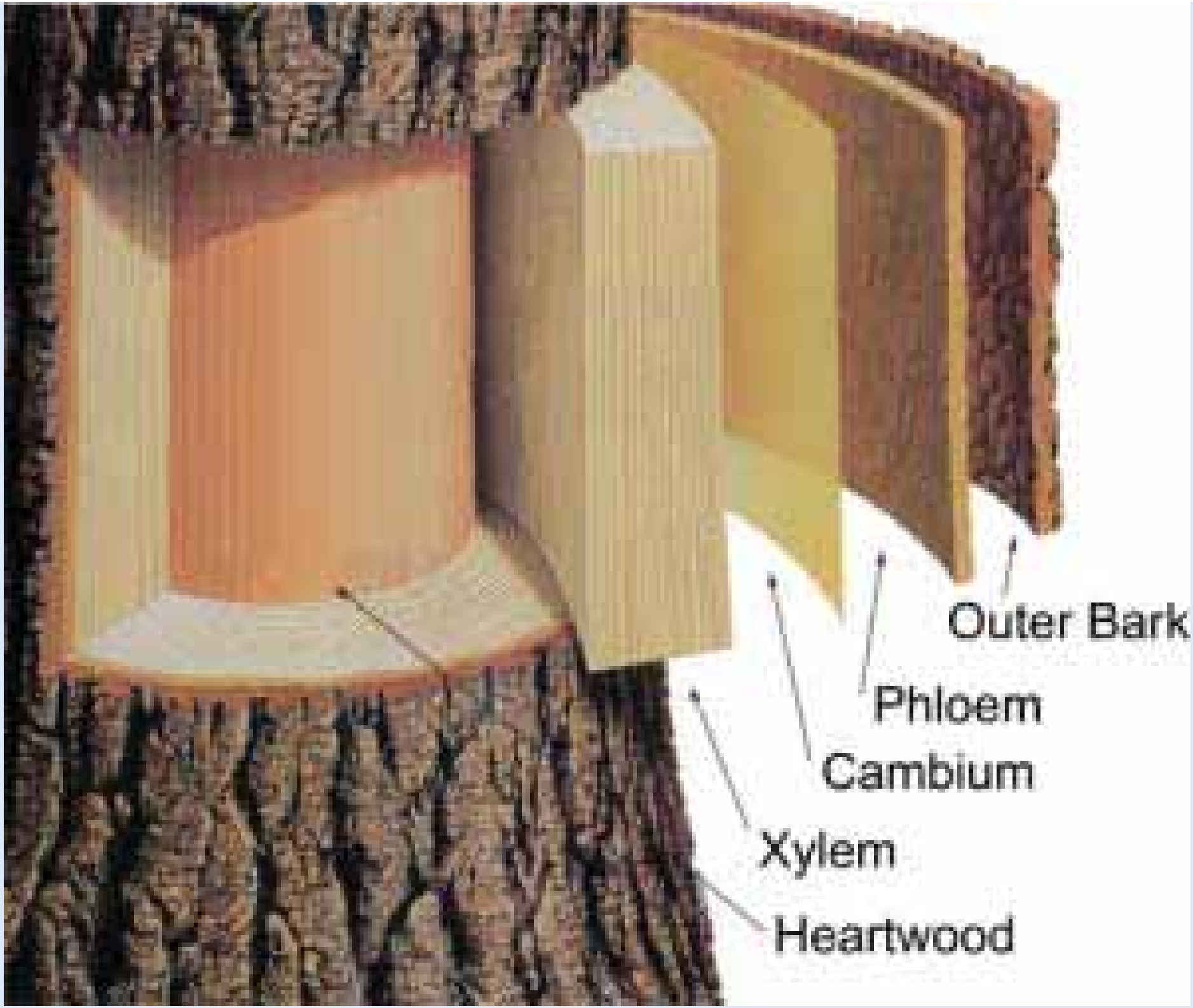
Douglas fir

White ash

Bark side

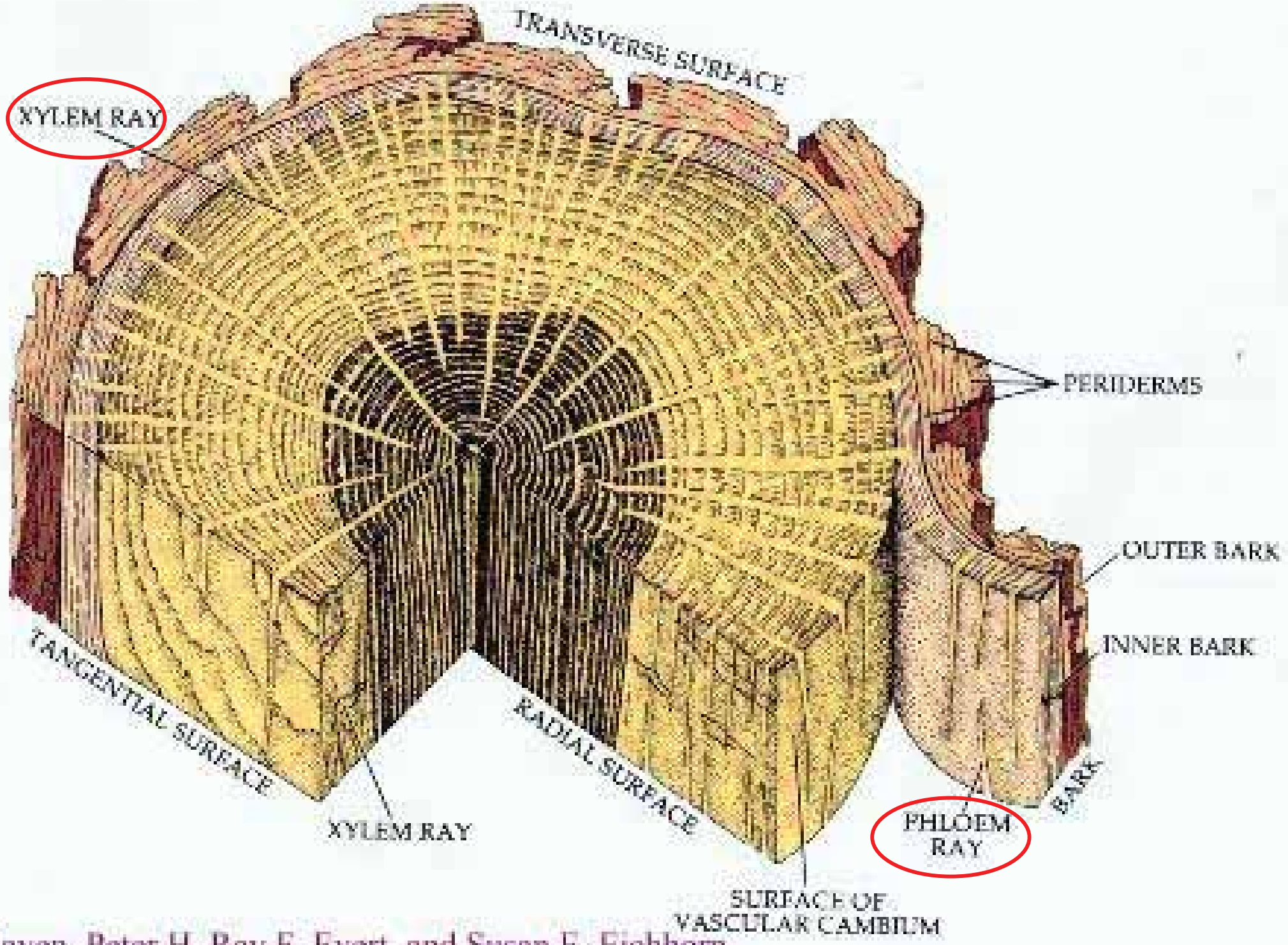
Pith side


LIGHT
TEMPERATURE
CO_2
H_2O
O_2
SUGARS
Starch
Lipids
Protein
Cellulose
Allelochemicals


Outer Bark
Phloem
Cambium
Xylem
Heartwood

Important Notes – on bark:

- Outer bark provides the inner tree with protection from temperature changes, fire, dessication, insect and disease attack.
- Outer bark is made from the crushed remnants of inner bark and cells generated by the cork cambium that gives each species of tree its characteristic look.
- Inner bark is where the phloem tissue is housed.
- Phloem tissue is how the sugars produced in the leaves and elsewhere are moved throughout the tree.
- Unlike individual xylem cells, individual phloem cells are alive, which means that they are much better able to direct where these sugars go.
- Inner bark has ray cells – these ray cells are connected to the ray cells in the wood (or xylem).
- Both xylem cells (wood) and phloem cells (inner bark) are produced by the vascular cambium layer, which is found just beneath the bark.



Raven, Peter H, Ray F. Evert, and Susan E. Eichhorn.

Structural

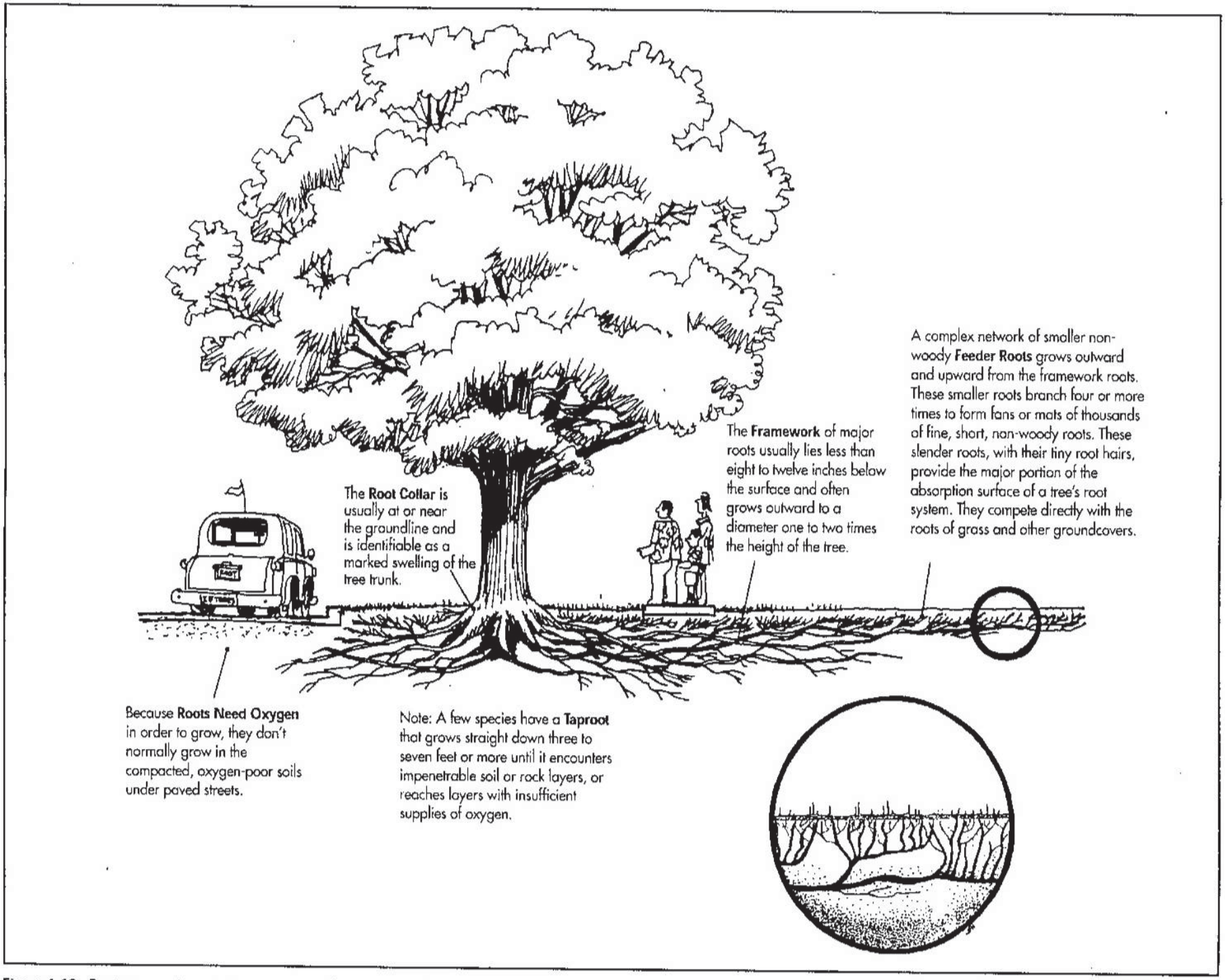
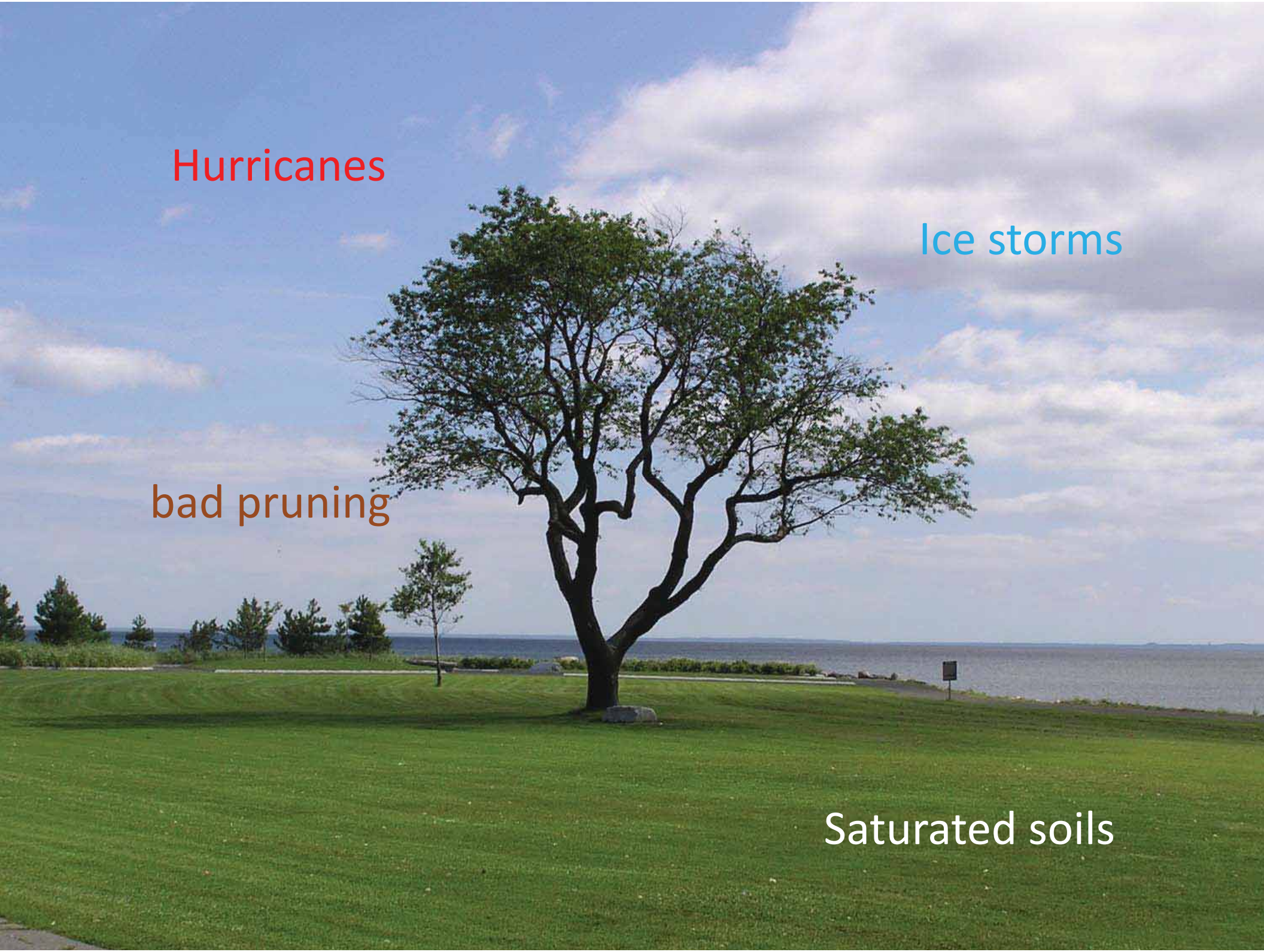
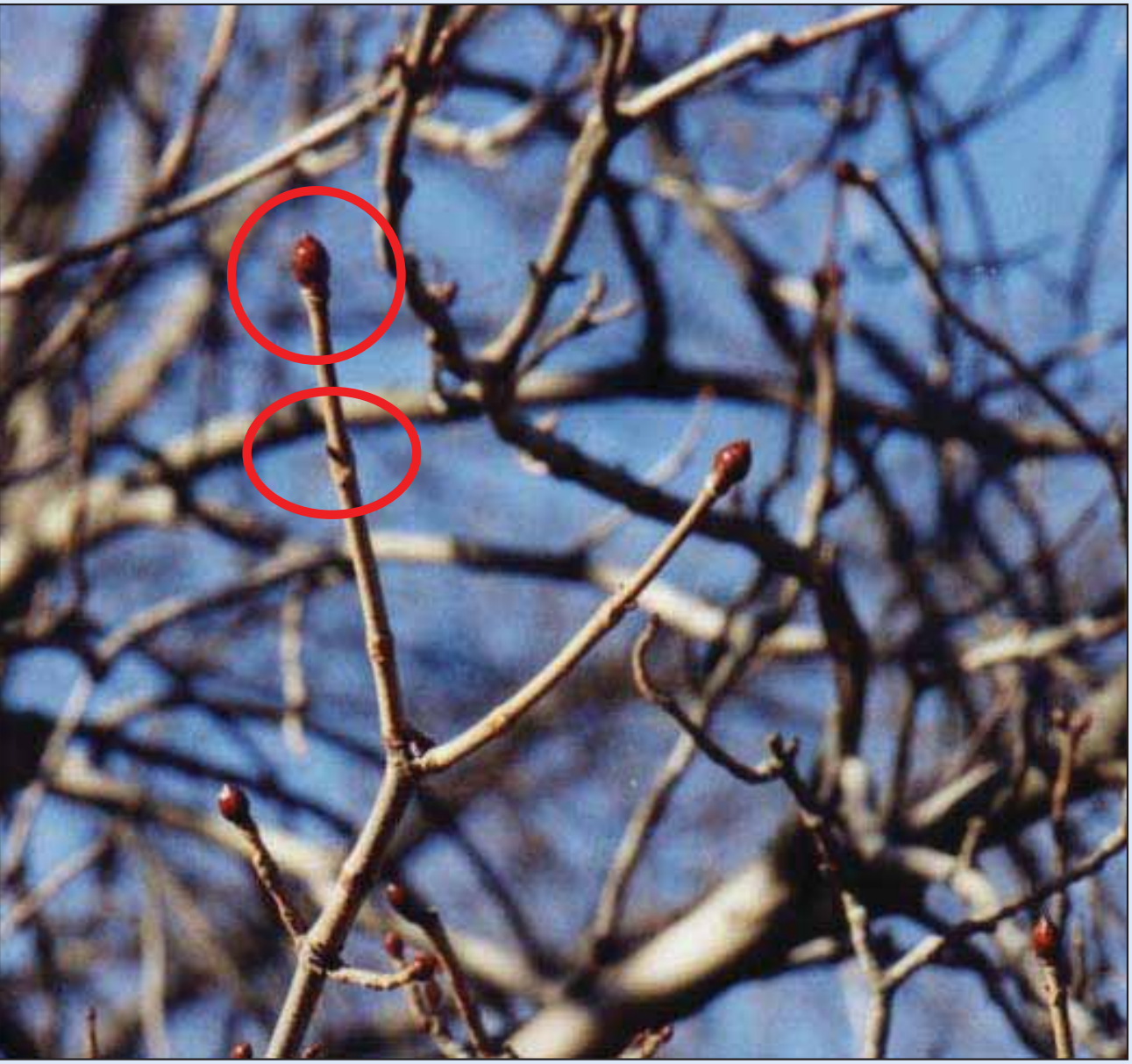


Figure 1.12 Roots grow where water, oxygen, and space are available.

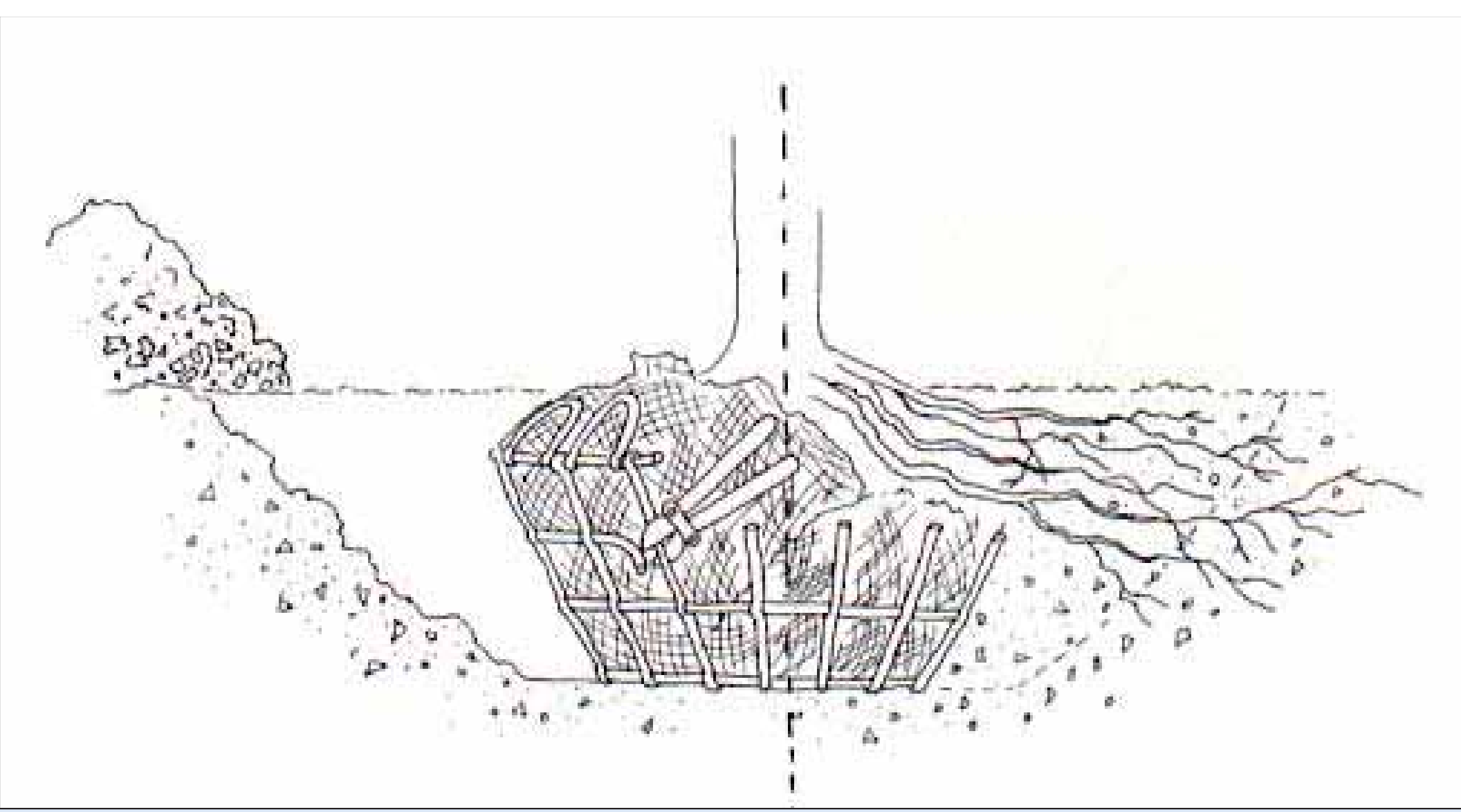

1/2
MILE


Hurricanes
Ice storms
bad pruning
Saturated soils

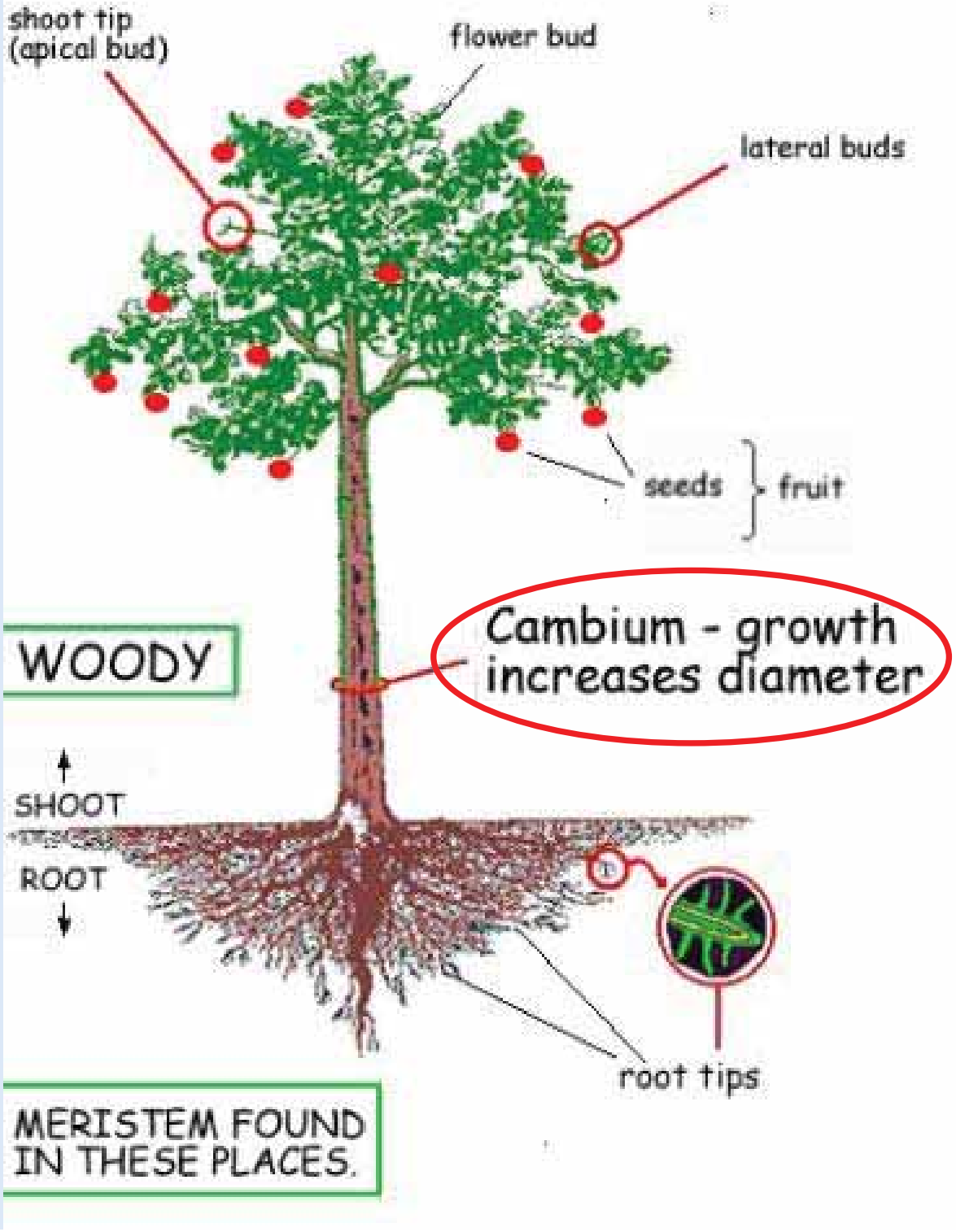
Growth

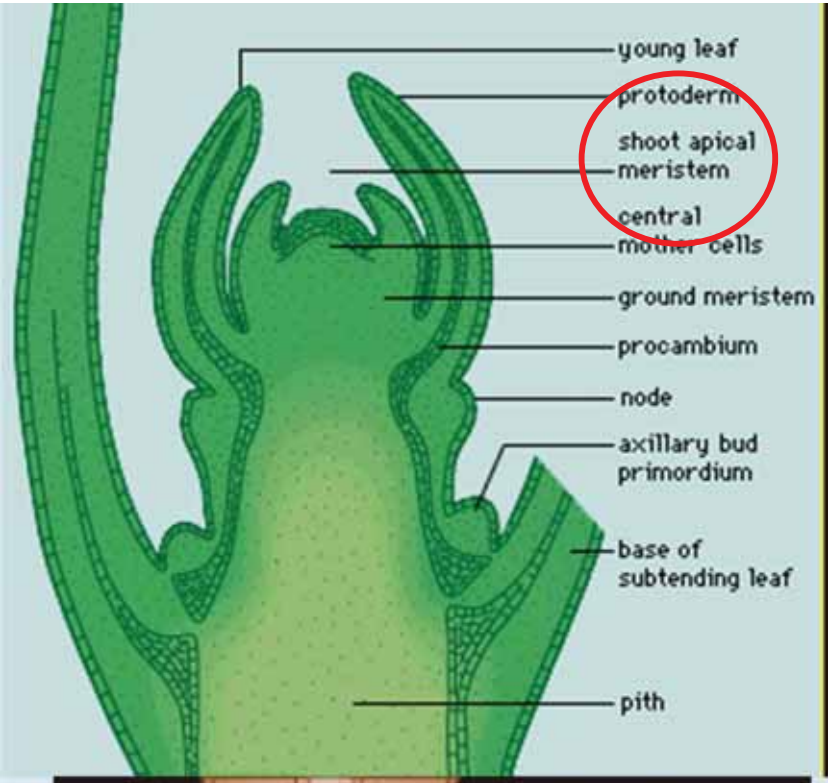


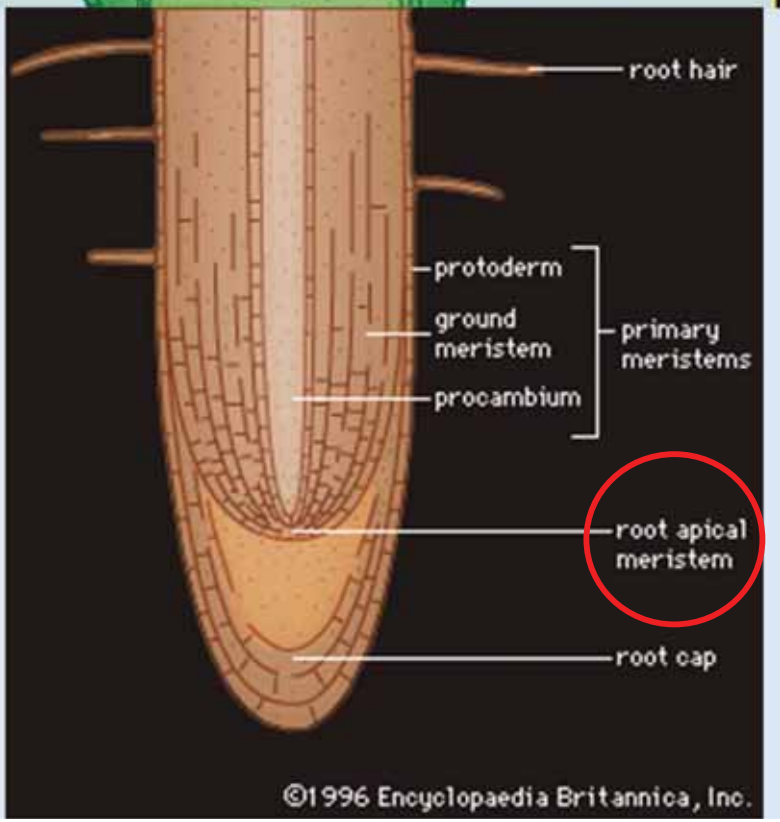
The above ground parts of the tree grow in length from the buds at the tips of the branches and besides the base of the leaves.



Tree roots grow from the tips, in the top 18 inches or so of the soil. When planting a tree, it is important to remove the burlap and wire from the root ball from the upper 18 inches of the root ball, after the root ball has been placed in the hole!


shoot tip
(apical bud)
flower bud
lateral buds
seeds
fruit
WOODY
Cambium - growth
increases diameter
SHOOT
ROOT
root tips
MERISTEM FOUND
IN THESE PLACES.


young leaf
protoderm
shoot apical
meristem
central
mother cells
ground meristem
procambium
node
axillary bud
primordium
base of
subtending leaf
pith


root hair
protoderm
ground
meristem
procambium
primary
meristems
root apical
meristem
root cap
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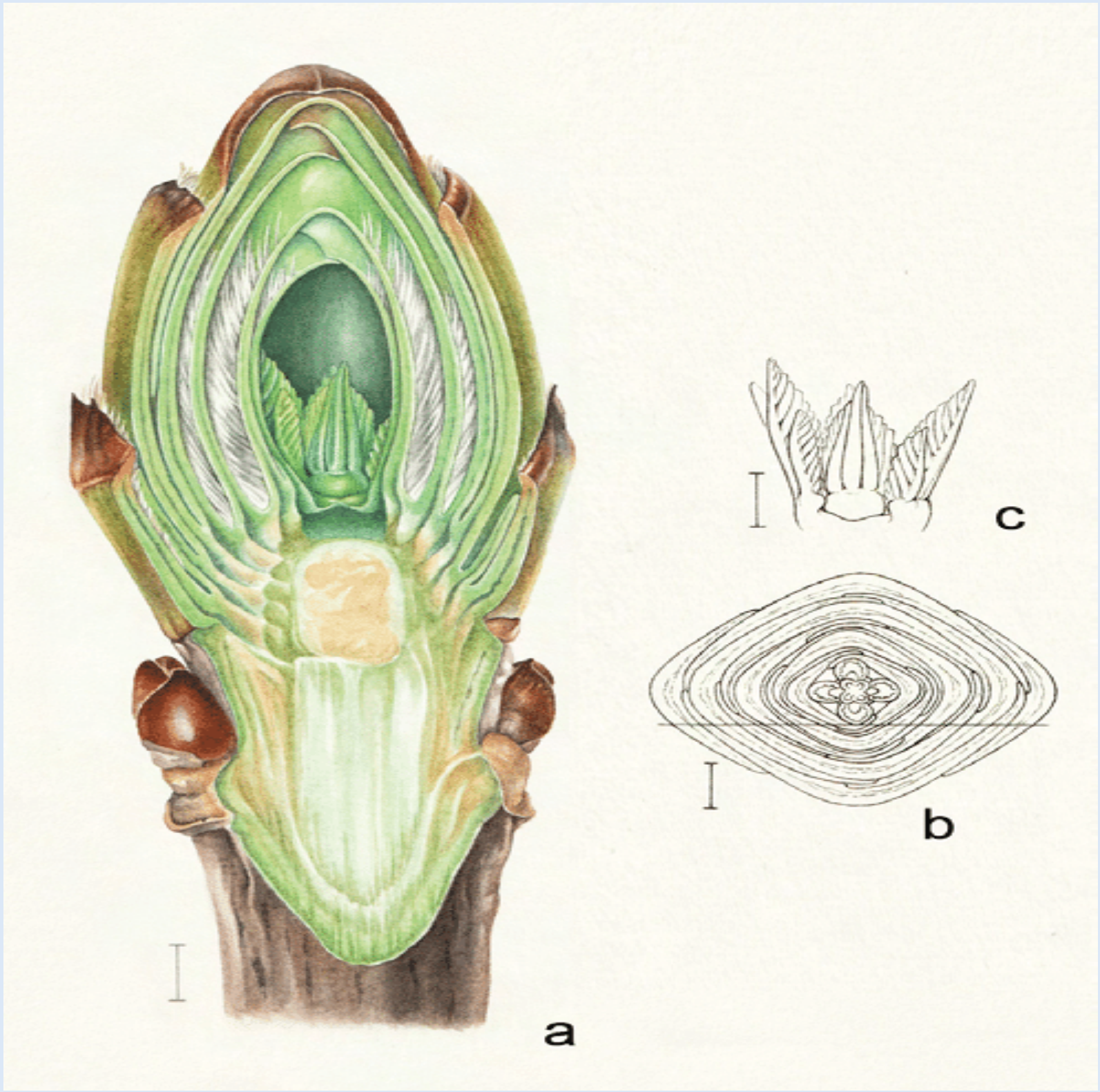
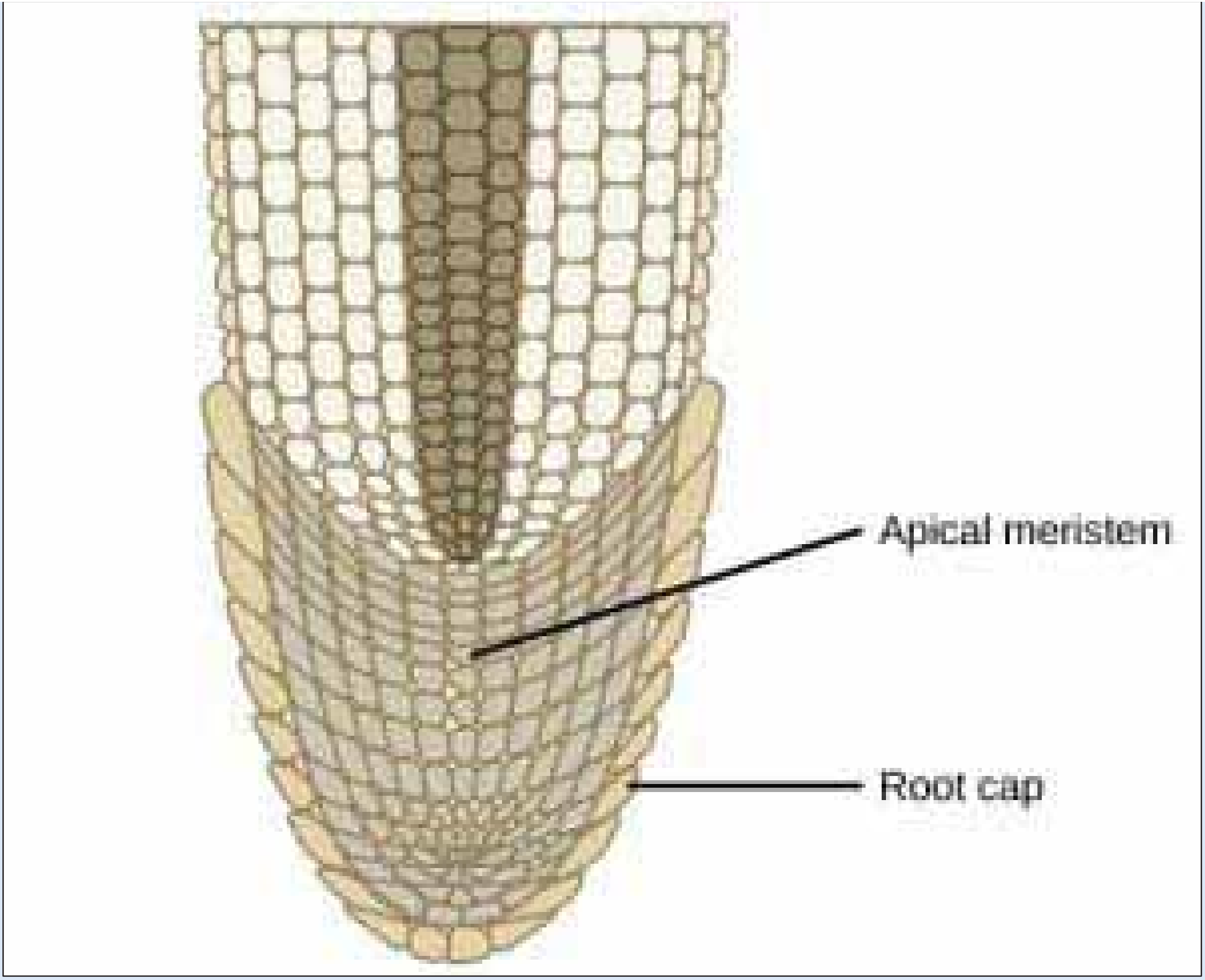
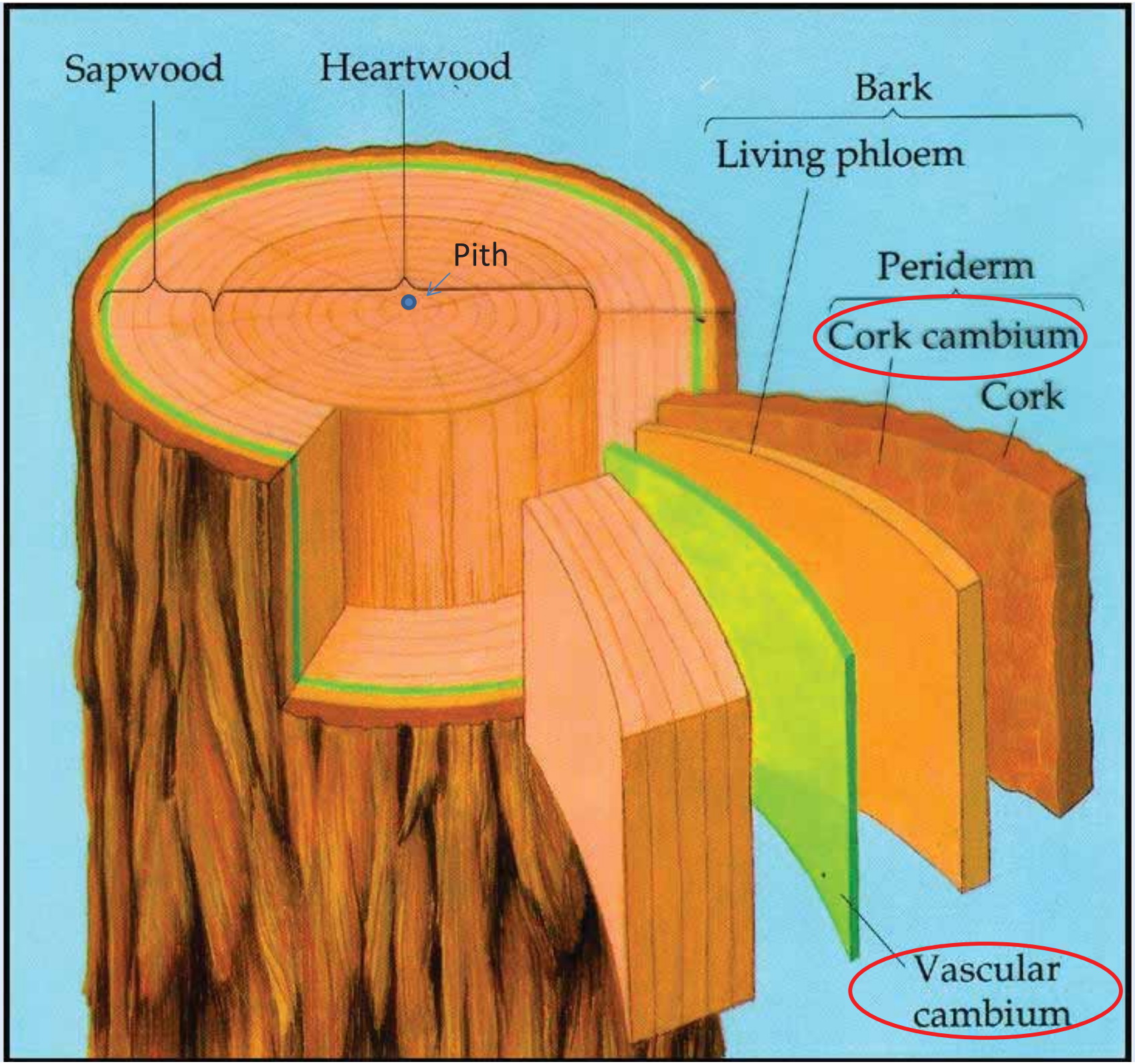
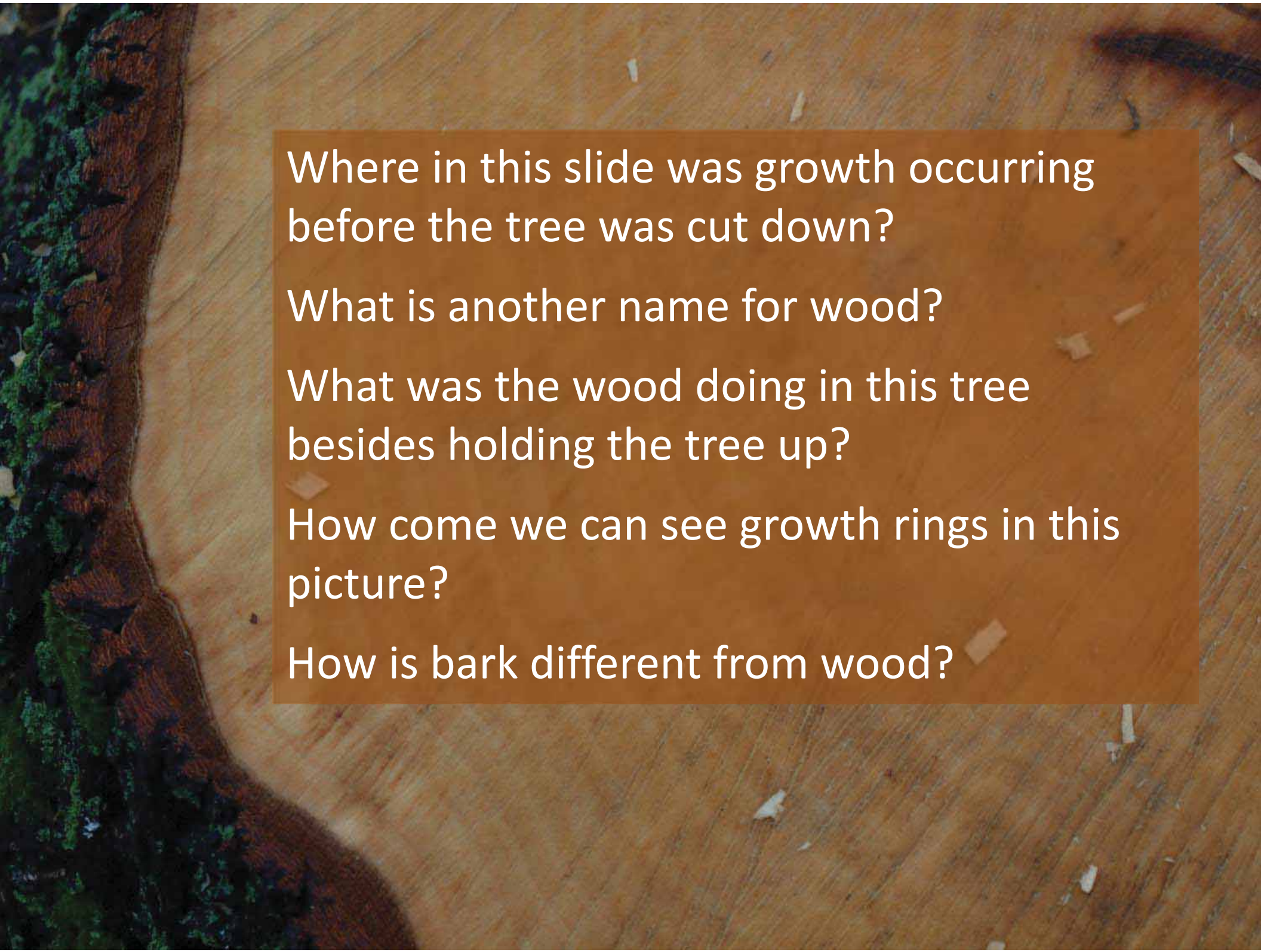

a
b
c


Apical meristem
Root cap

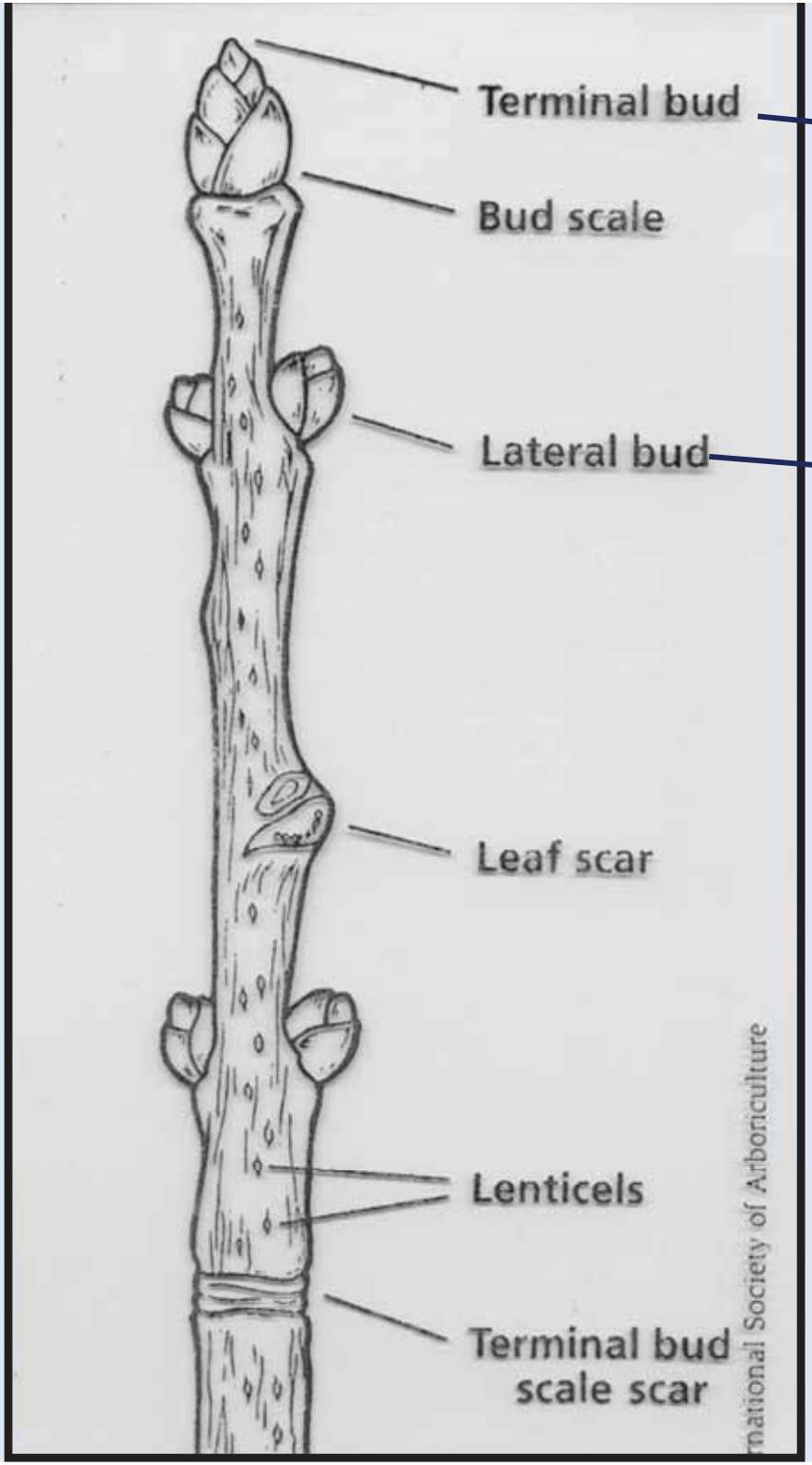
Trees grow in girth by means of the growth layer (vascular cambium) that is located underneath the bark of the tree, including around the trunk and branches and around the roots.

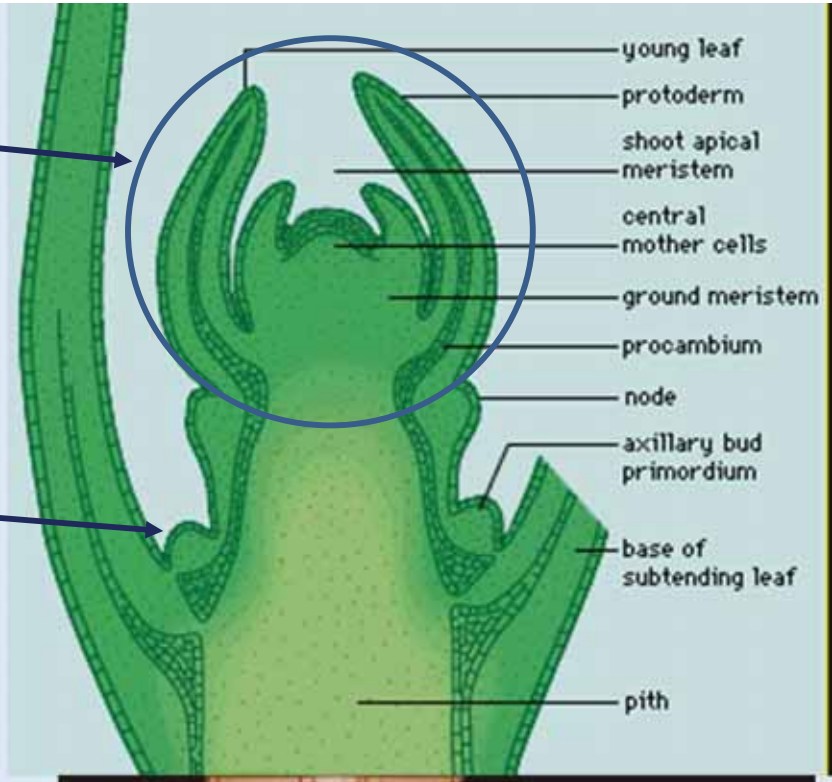

Sapwood
Heartwood
Bark
Living phloem
Pith
Periderm
Cork cambium
Cork
Vascular cambium

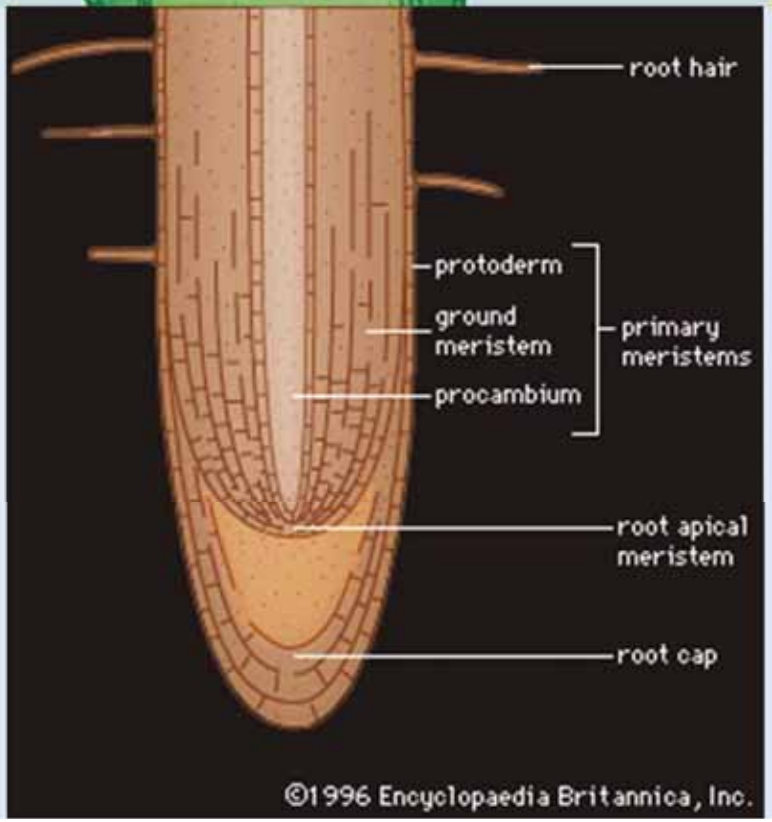

Where in this slide was growth occurring before the tree was cut down?
What is another name for wood?
What was the wood doing in this tree besides holding the tree up?
How come we can see growth rings in this picture?
How is bark different from wood?

Response


7 6
7 5
7 4
IN TERMS OF INCHES AND TENTHS OF INCHES
MADE IN GERMANY


Terminal bud
Bud scale
Lateral bud
Leaf scar
Lenticels
Terminal bud scale scar
rnational Society of Arboriculture


young leaf
protoderm
shoot apical meristem
central mother cells
ground meristem
procambium
node
axillary bud primordium
base of subtending leaf
pith


root hair
protoderm
ground meristem
procambium
primary meristems
root apical meristem
root cap
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excurrent form ↑↑↑

decurrent form ↓↓↓

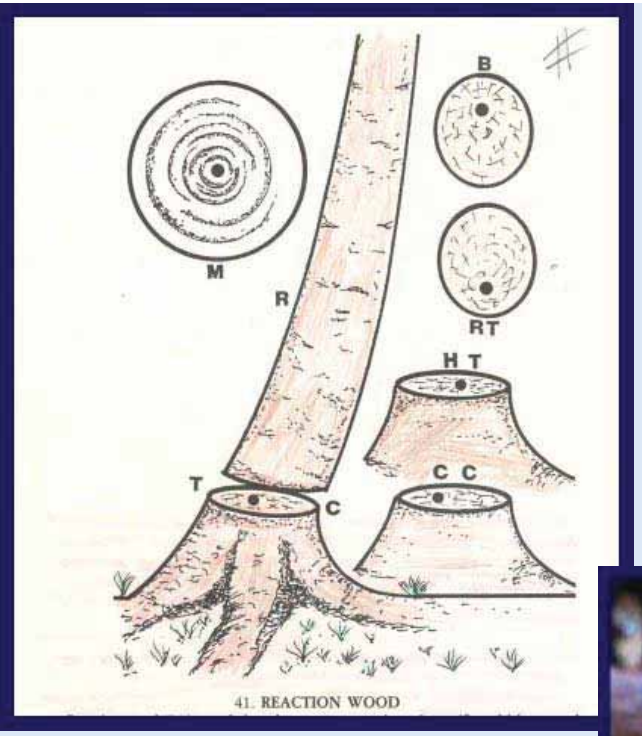

geotropic

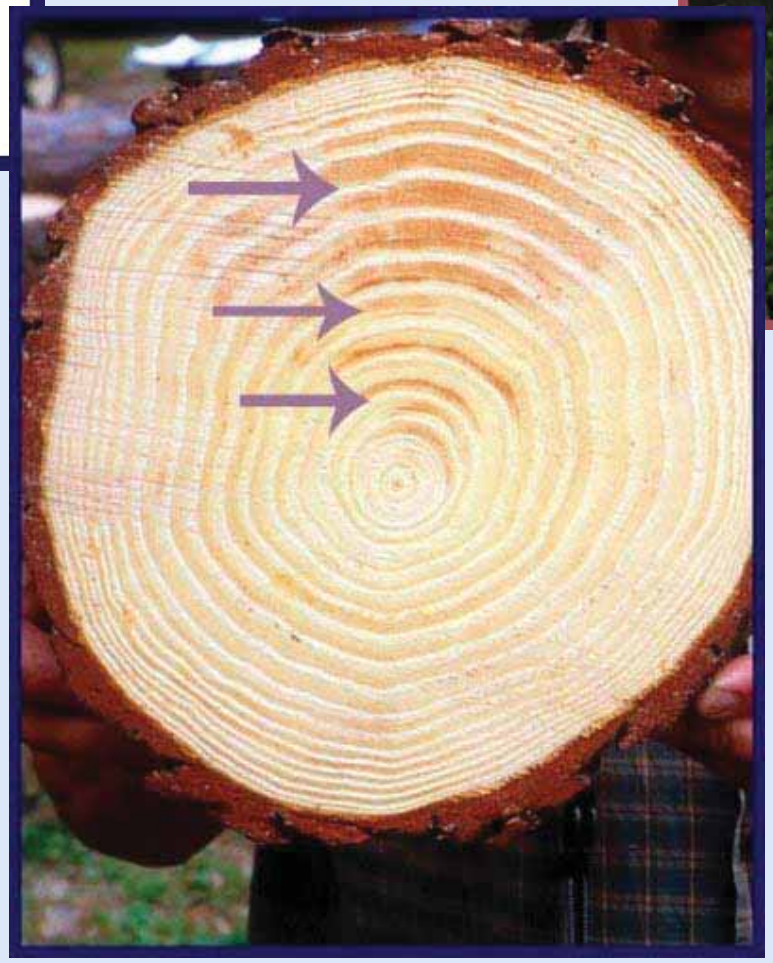

phototropic

Terms

- Excurrent – strong central leader (e.g. pin oak)
- Decurrent – spreading branches (e.g. sugar maple)
- Geotropic – guided by gravity (most conifers)
- Phototropic – guided by access to light (most hardwoods)

(All plants are geotropic, in the sense that roots grow down from the seed and stems grow up)



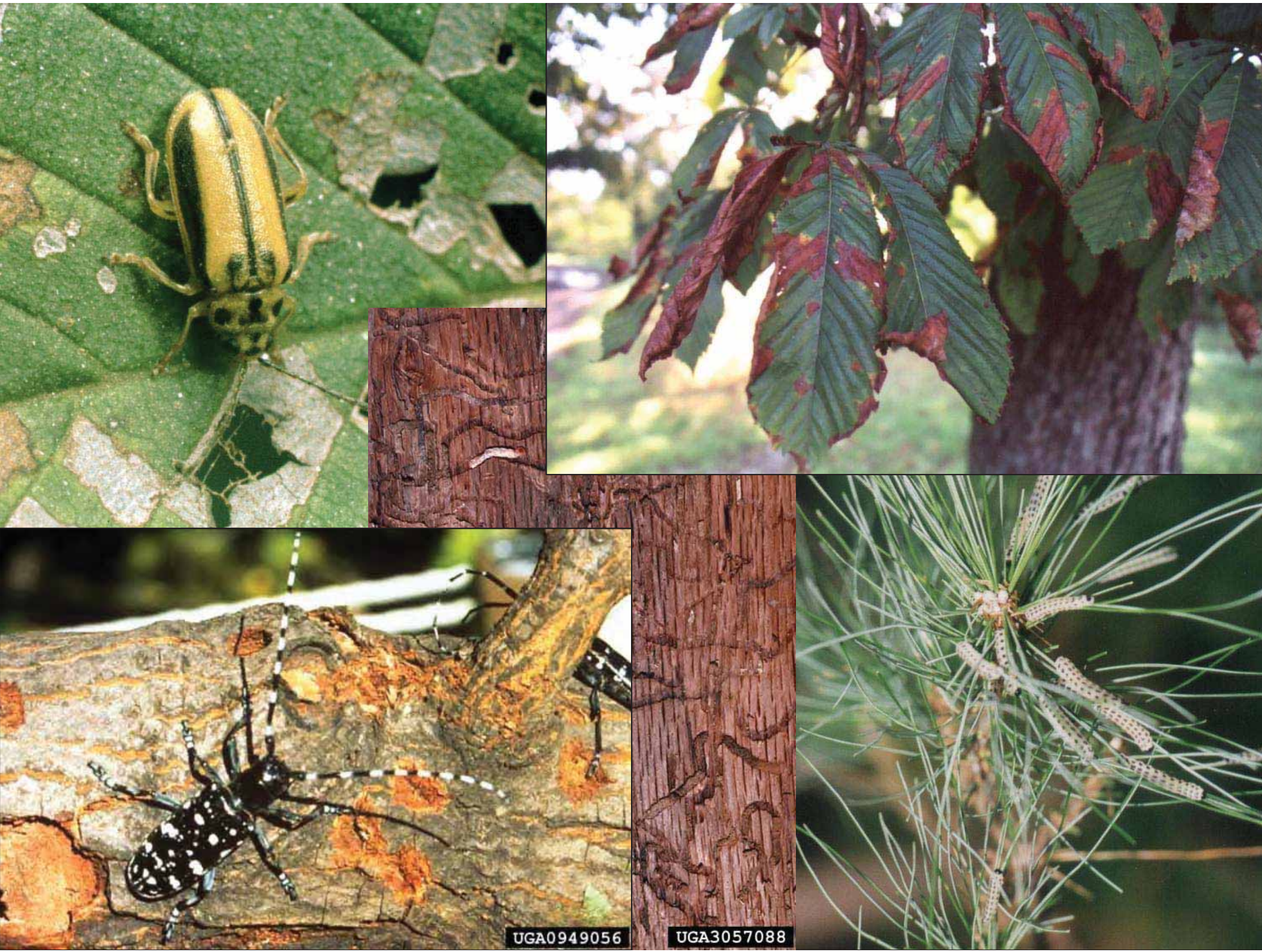


Compression Wood: Conifers

Tension Wood: Hardwoods

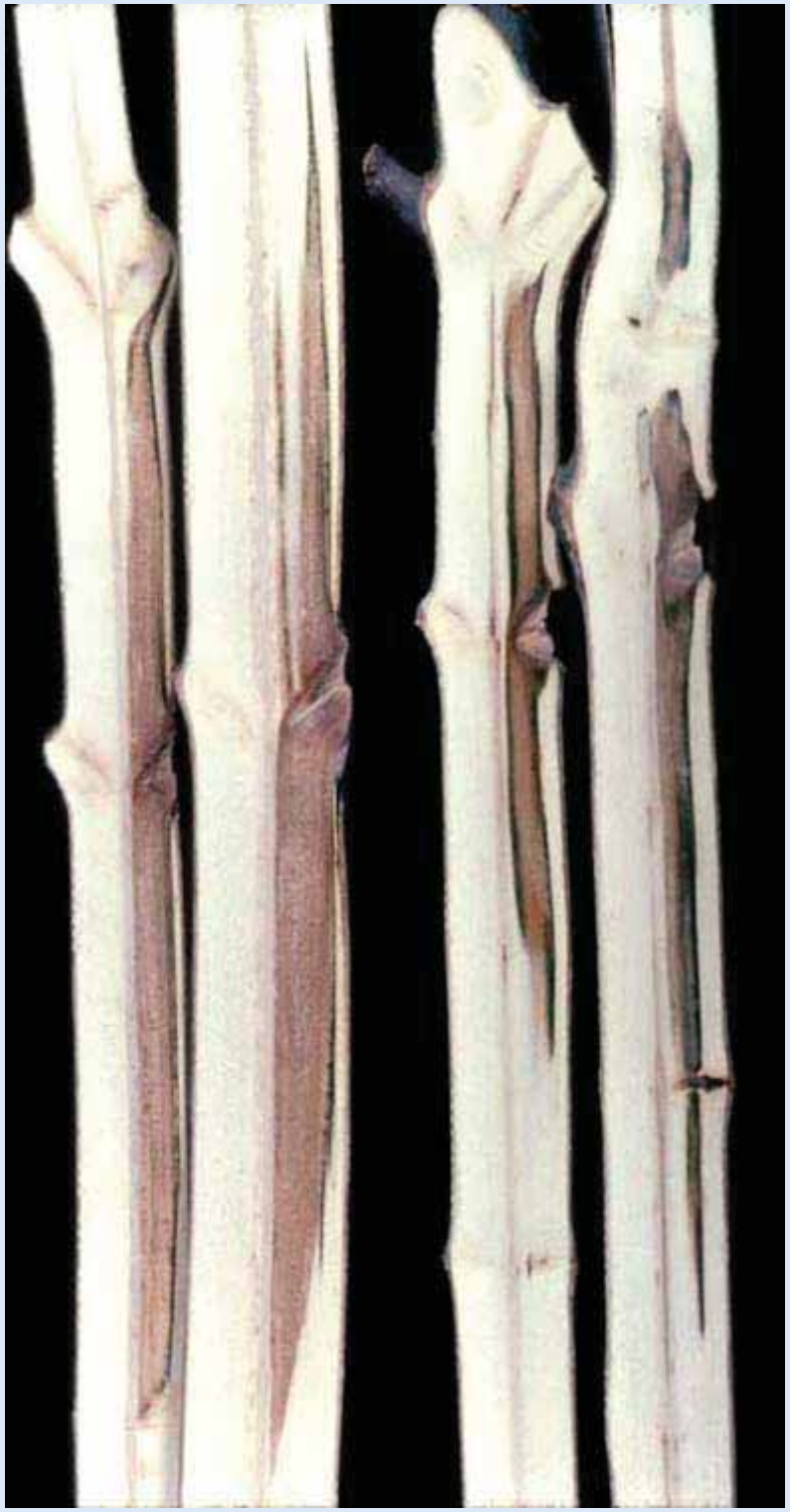

Plant Hormones:
Auxins
Gibberellins
Cytokinins


CHAPMAN


UGA0949056
UGA3057088

CODIT

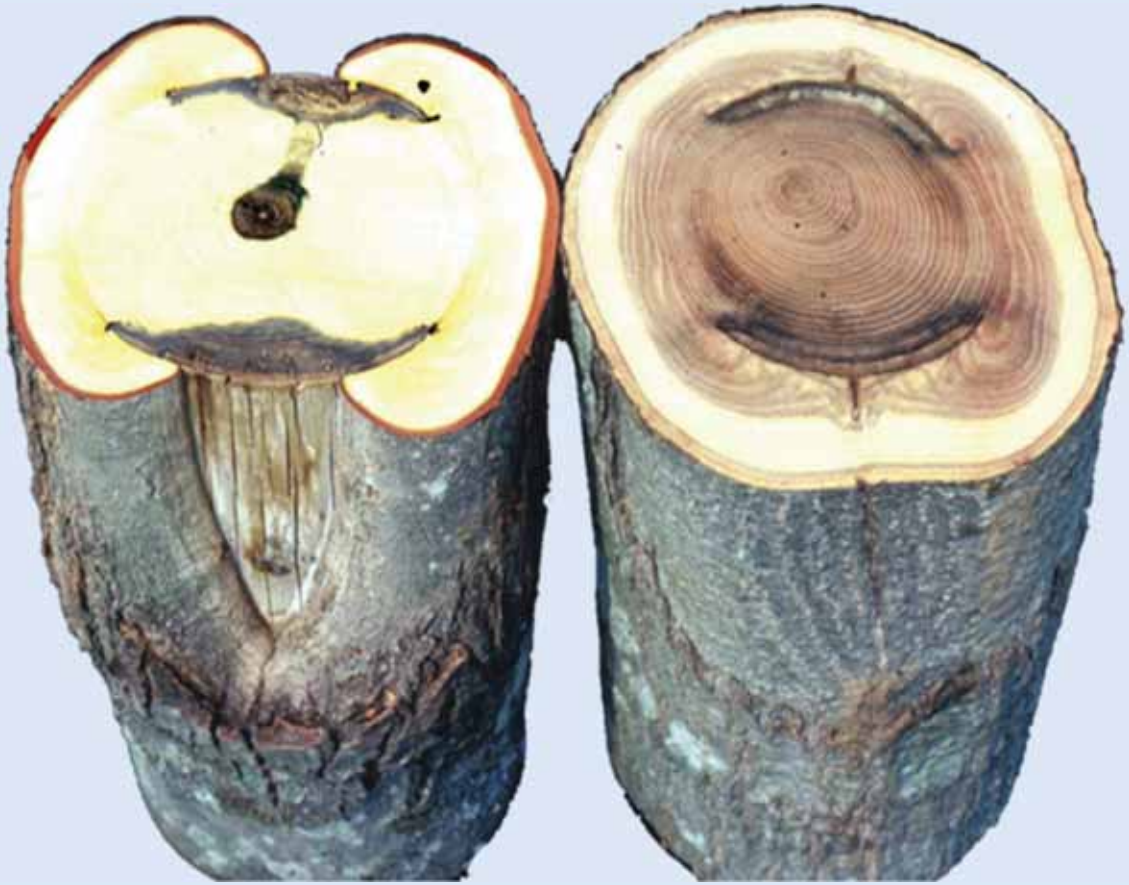
Compartmentalization of Decay in Trees



Compartmentalization

varies from species-to-species

tree-to-tree

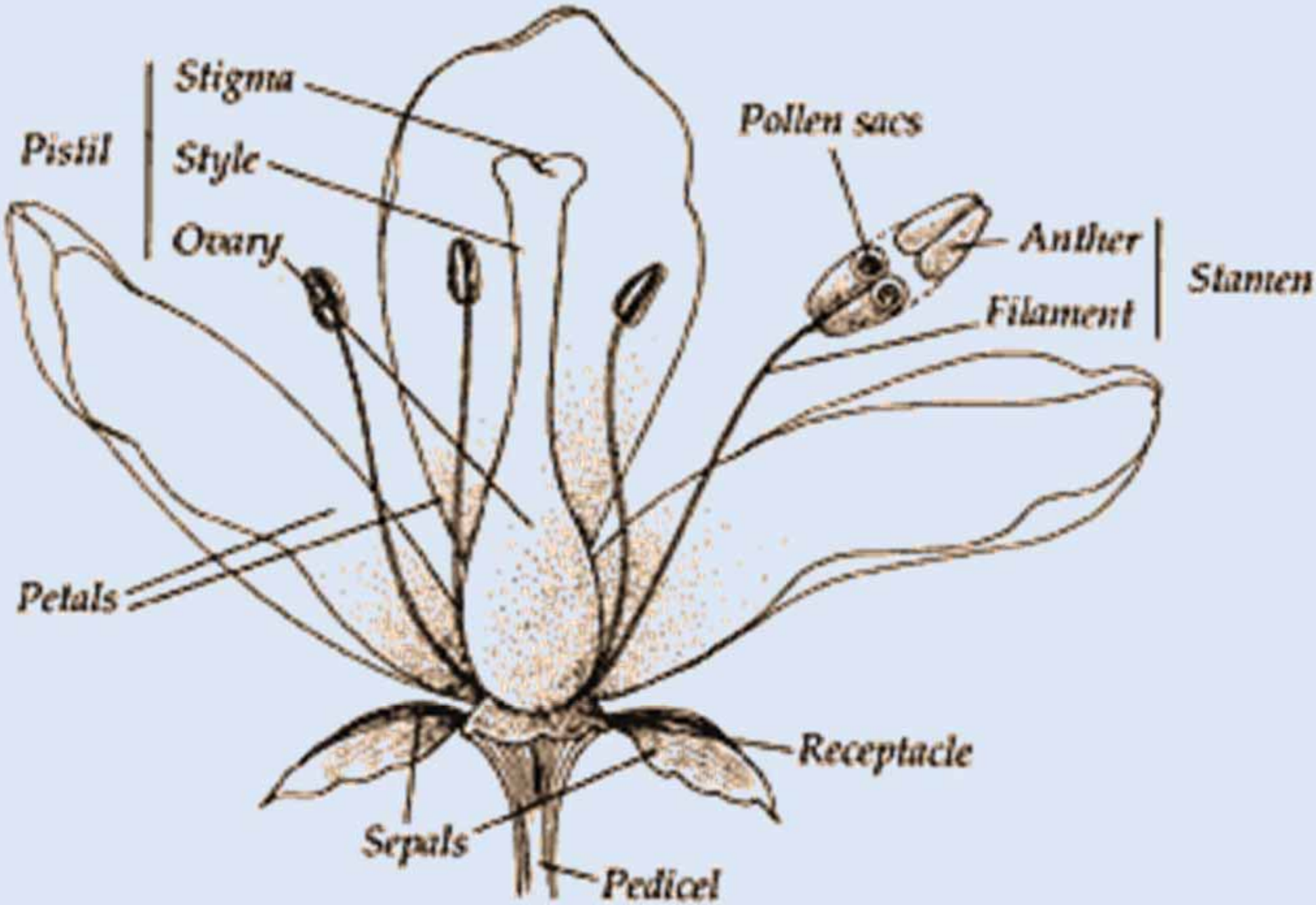


Reproduction

Why you need to know about reproduction in trees

- Floral display (ornamentals especially)
- Fruits and fruiting issues
- Pollen (increasingly a problem in cities!)
- Pollinators – of concern for several reasons
- Asexual reproduction – e.g. suckering

Perfect or two-sexed flower




Red Maples
in spring

Male and Female Trees??

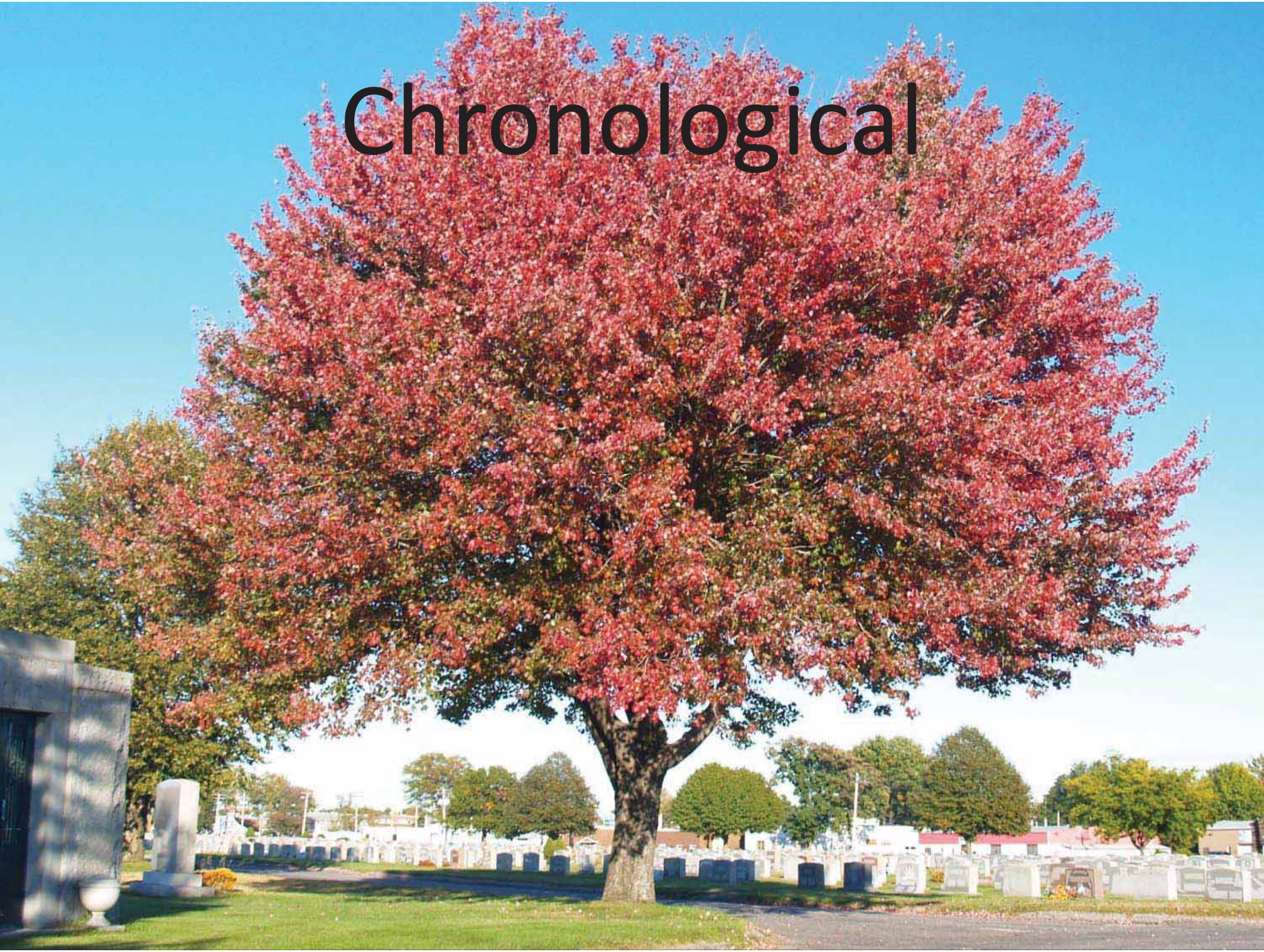
- Monoecious Trees: "one house" – individual male and female flowers on the same tree.
- Dioecious Trees: "two houses" – male and female flowers on different trees.
- Synecious Trees – trees with 'perfect' flowers (the pawpaw (*Asimina triloba*) the tulip poplar (*Liriodendron tulipifera* are examples).

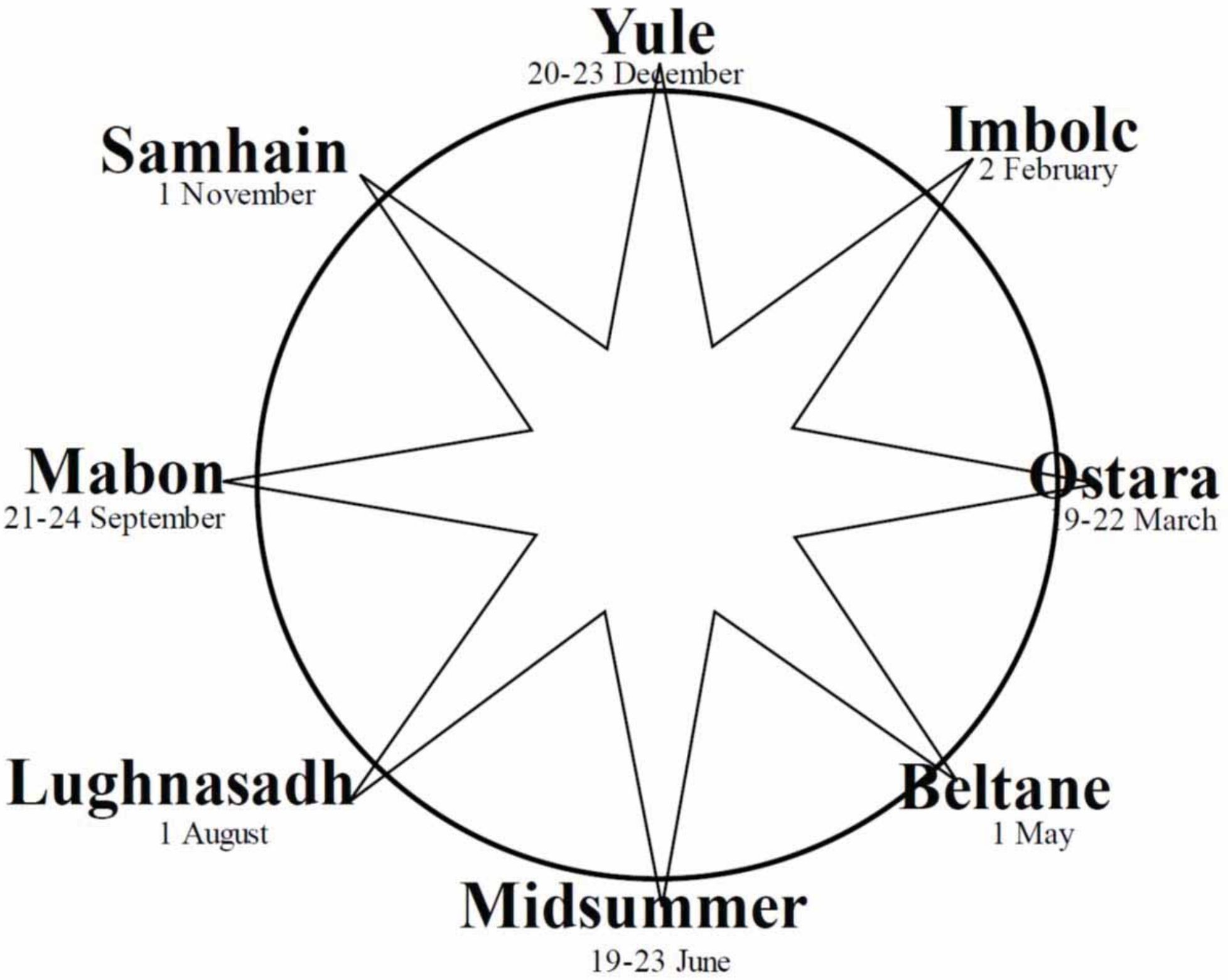

Pistillate (female) flowers
Staminate (male) flowers

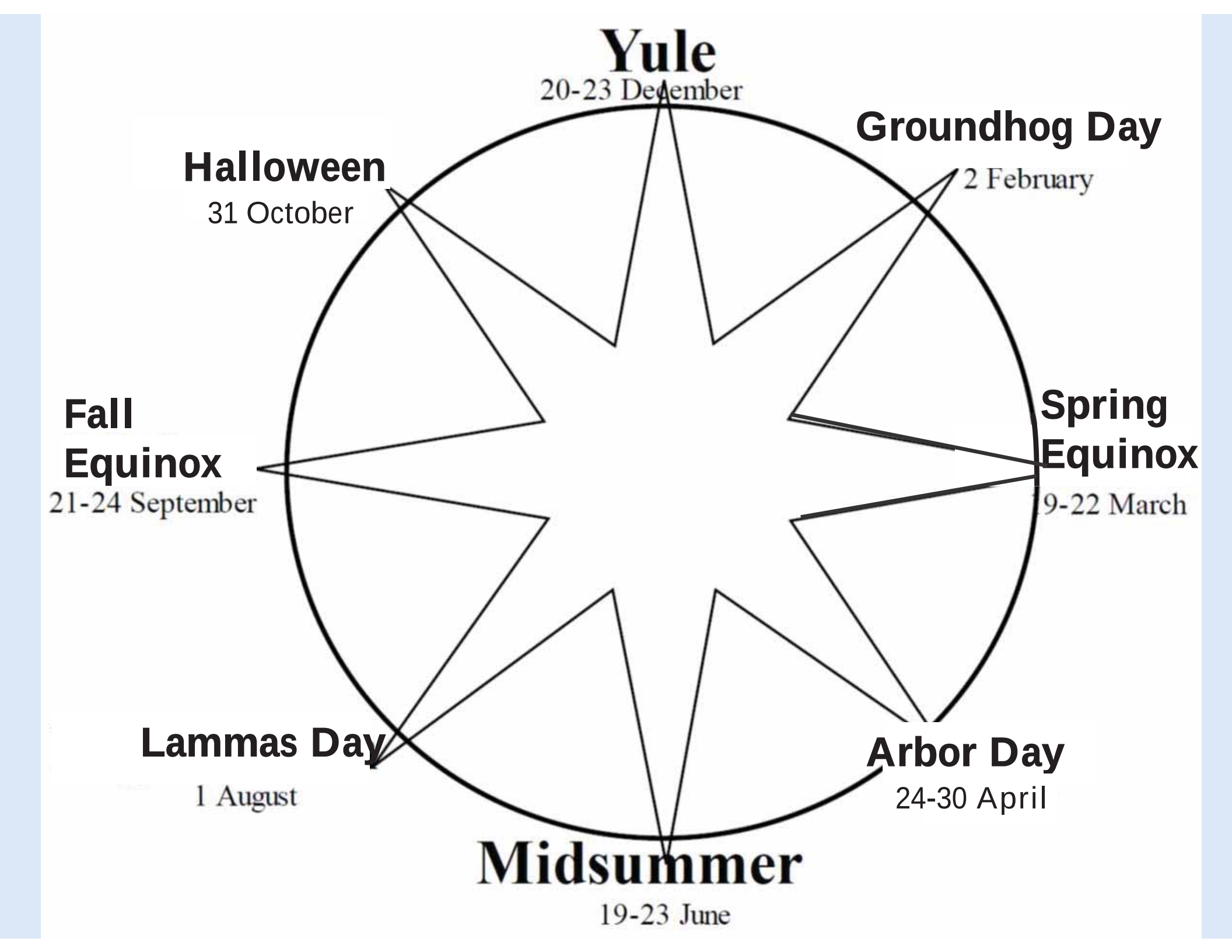

Female flowers


Male flowers

Chronological

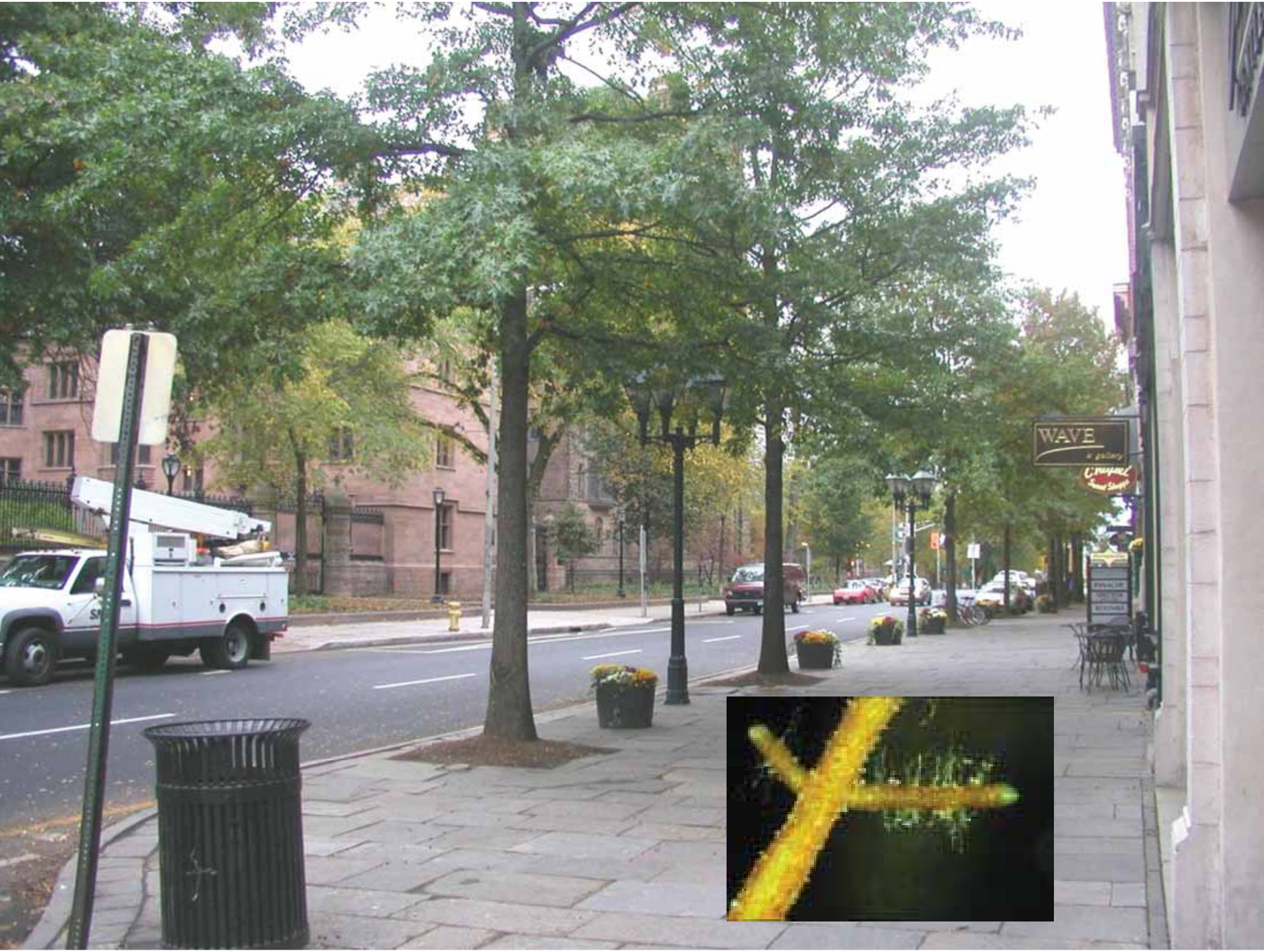


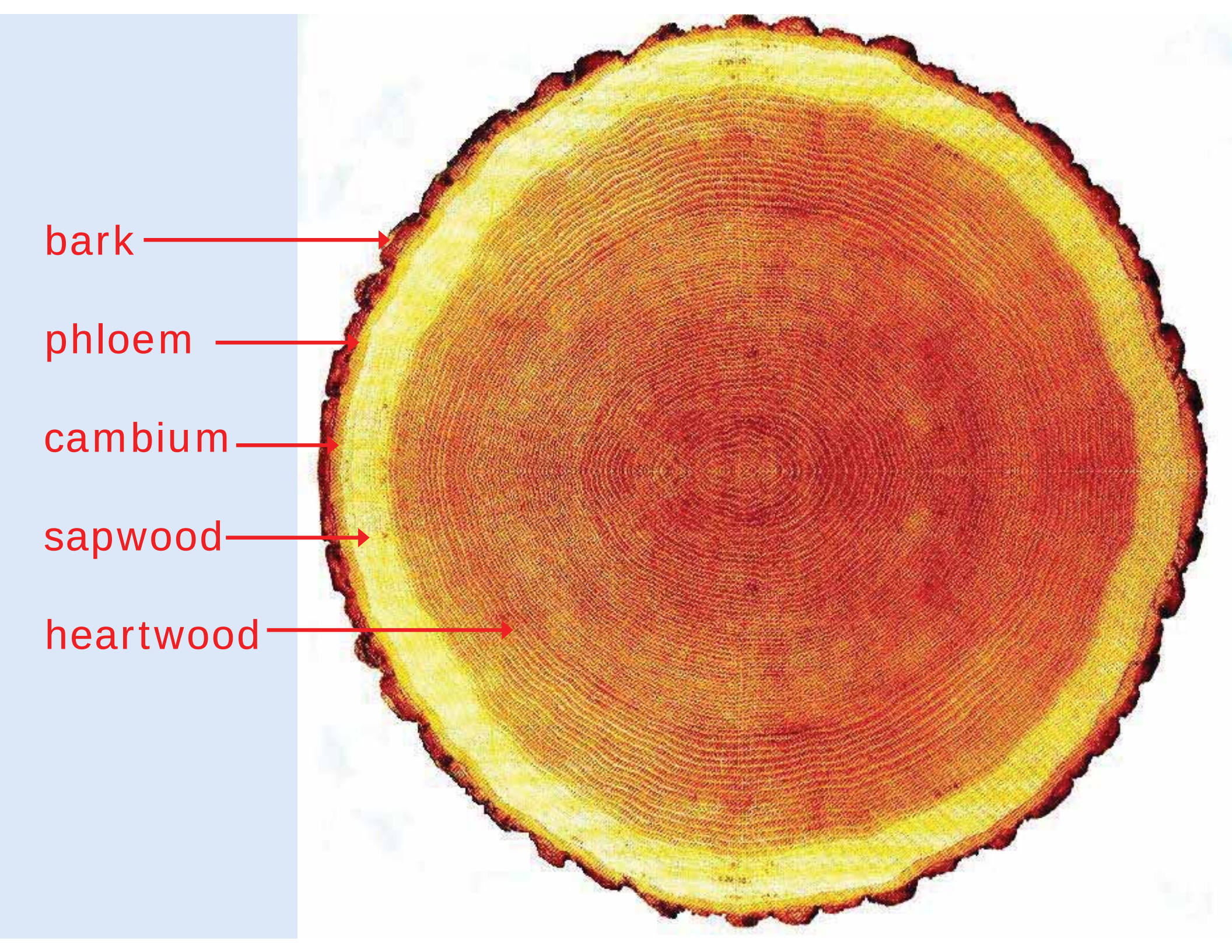

Yule
20-23 December
Imbolc
2 February
Ostara
19-22 March
Beltane
1 May
Midsummer
19-23 June
Lughnasadh
1 August
Mabon
21-24 September
Samhain
1 November


Yule
20-23 December
Groundhog Day
2 February
Halloween
31 October
Fall
Equinox
21-24 September
Spring
Equinox
9-22 March
Lammas Day
1 August
Arbor Day
24-30 April
Midsummer
19-23 June


CAS
OVERFLOW
PARKING

Death & Shedding


WAVE


bark
phloem
cambium
sapwood
heartwood

Summary

Trees are woody, highly competitive, highly organized organisms that photosynthesize, and use the products of photosynthesis to develop a variety of structures and conduct a variety of functions that are necessary to keep it alive.


Questions?