

# Tree Physiology – How a Tree Views the World

*Produced by Peter Kolb MSU Extension Forestry Specialist*



**550 year-old ponderosa pine**



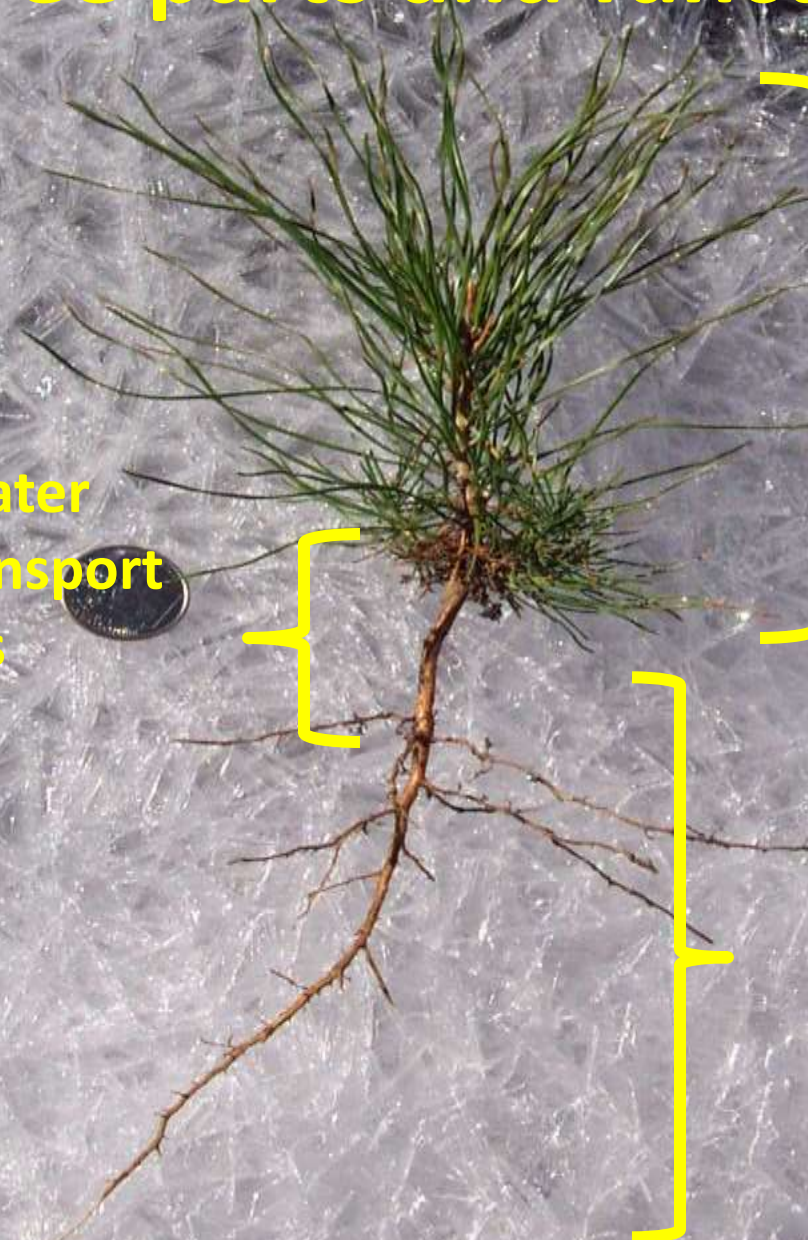
# Tree parts and function

**Stem - where water and nutrient transport occurs as well as energy storage**

**Needles/leaves - where photosynthesis (energy production) occurs**

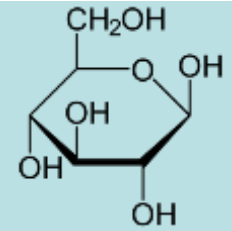
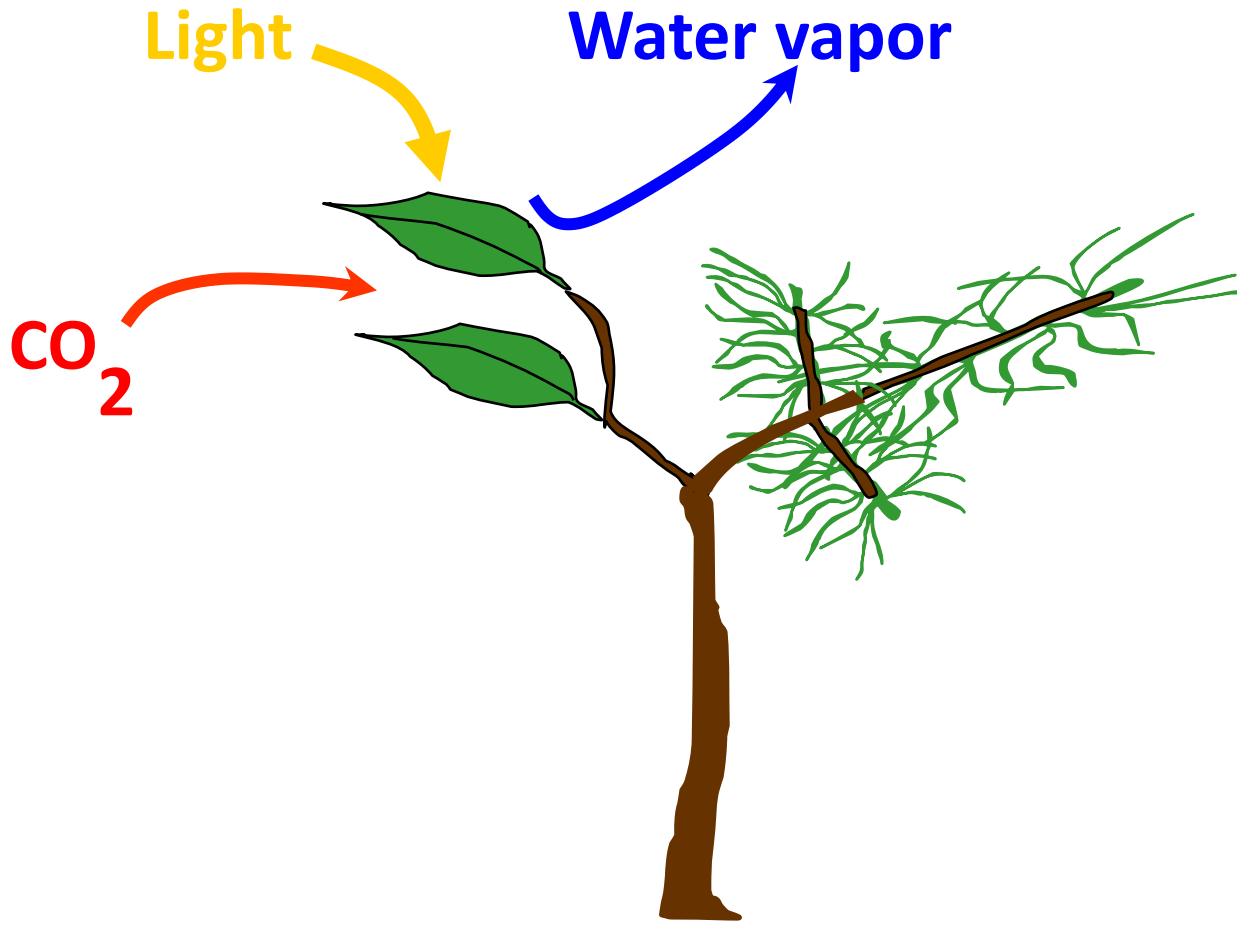
**Root system - water and nutrient absorption, energy storage, hormone production**

**2-year old ponderosa pine seedling**

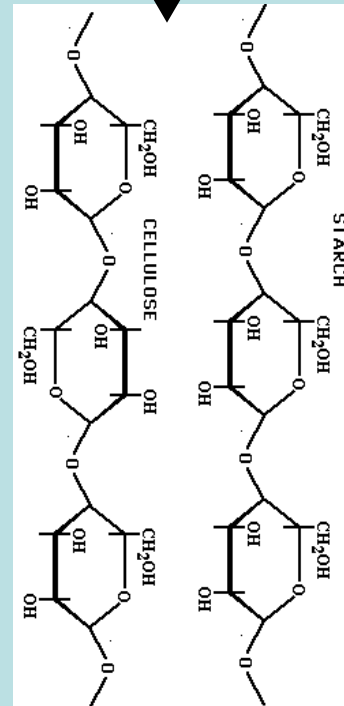


**Broadleaf** – usually deciduous  
(annual leaf drop) and angiosperm  
(conspicuous flowers – seed in ovary)

**Conifer** – usually evergreen (3-7  
year leaf duration) needle shaped  
leaves, inconspicuous flowers and  
cones (covered seeds)

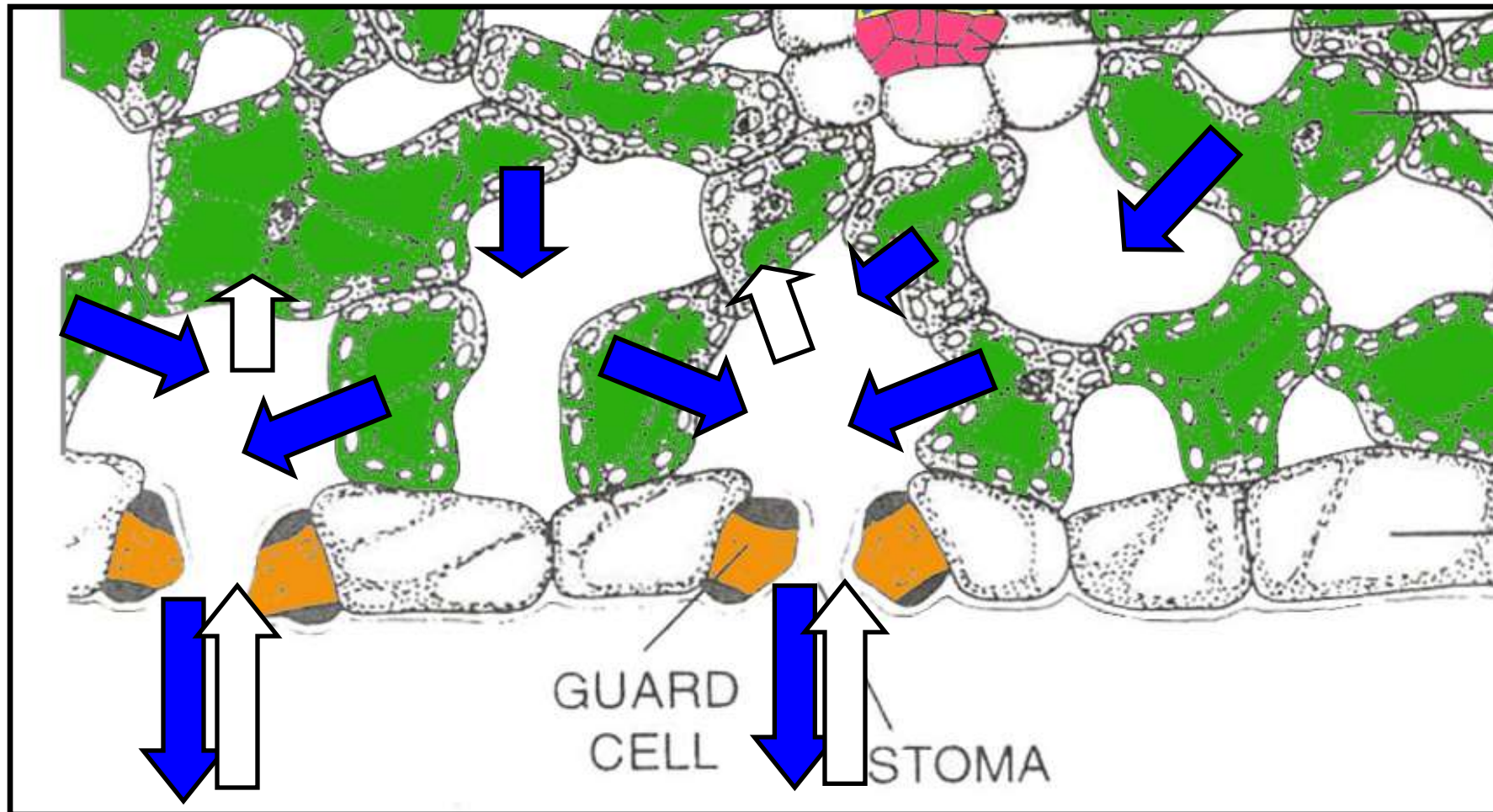


glucose

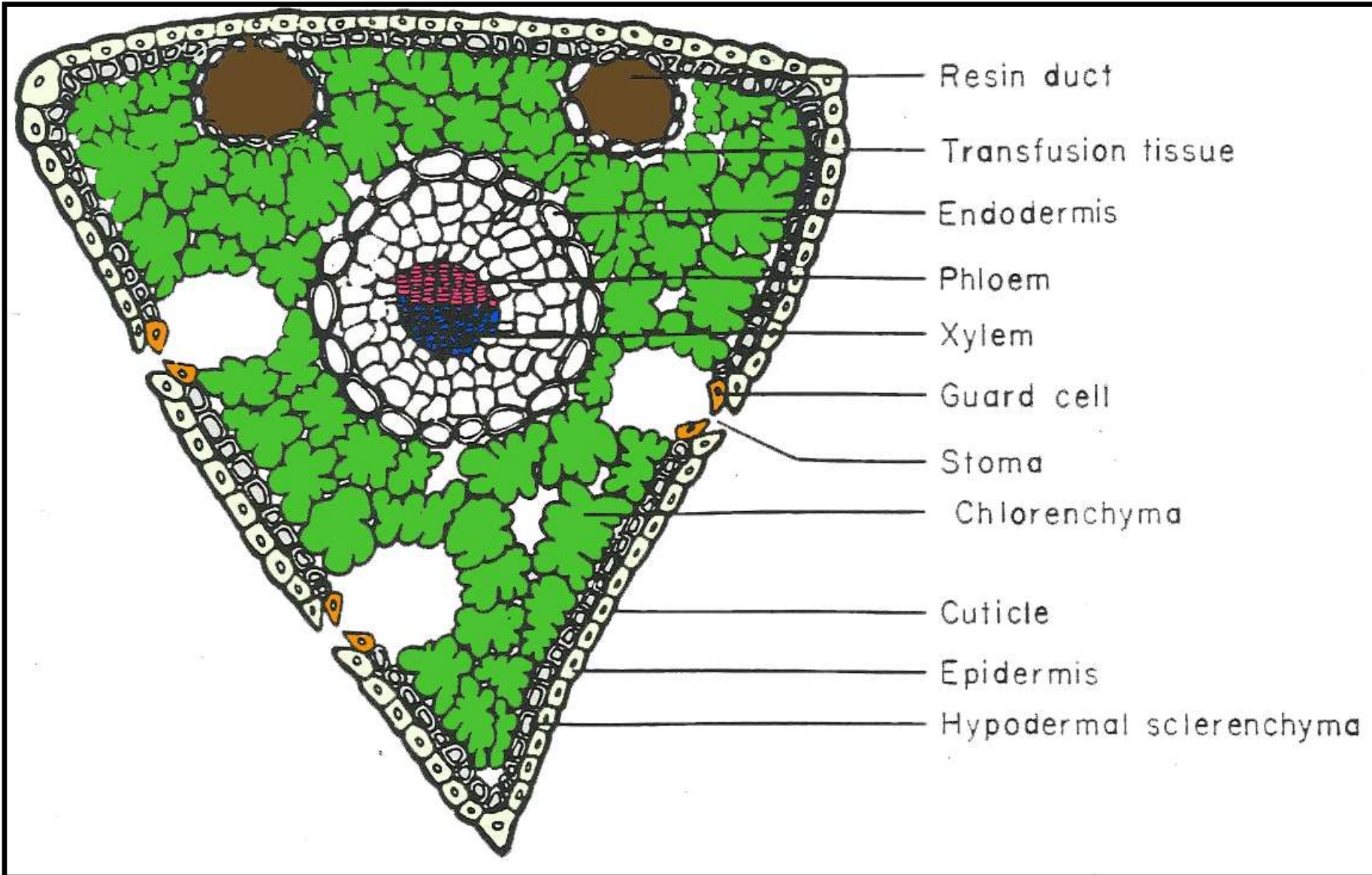




# Water – CO<sub>2</sub> Exchange



# Leaf Components – Gymnosperm (eastern white pine)



# Sun and Shade Leaves - Hemlock

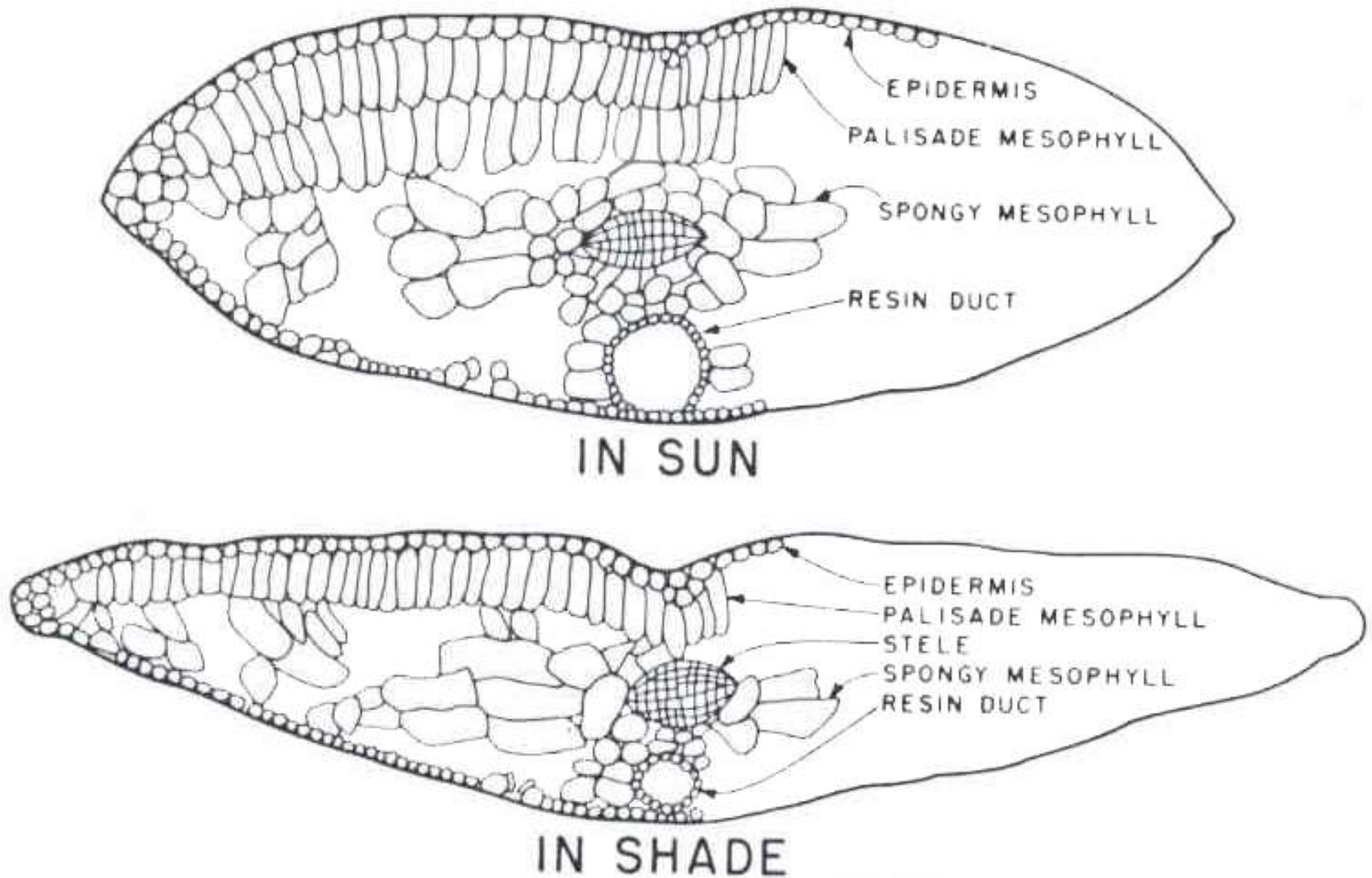


FIGURE 3. Cross sections of typical hemlock needles developed in full sunlight and in the shade of a dense Douglas-fir canopy.











Terminal leader



One year's growth



6<sup>th</sup> year



5<sup>th</sup> year



4<sup>th</sup> year



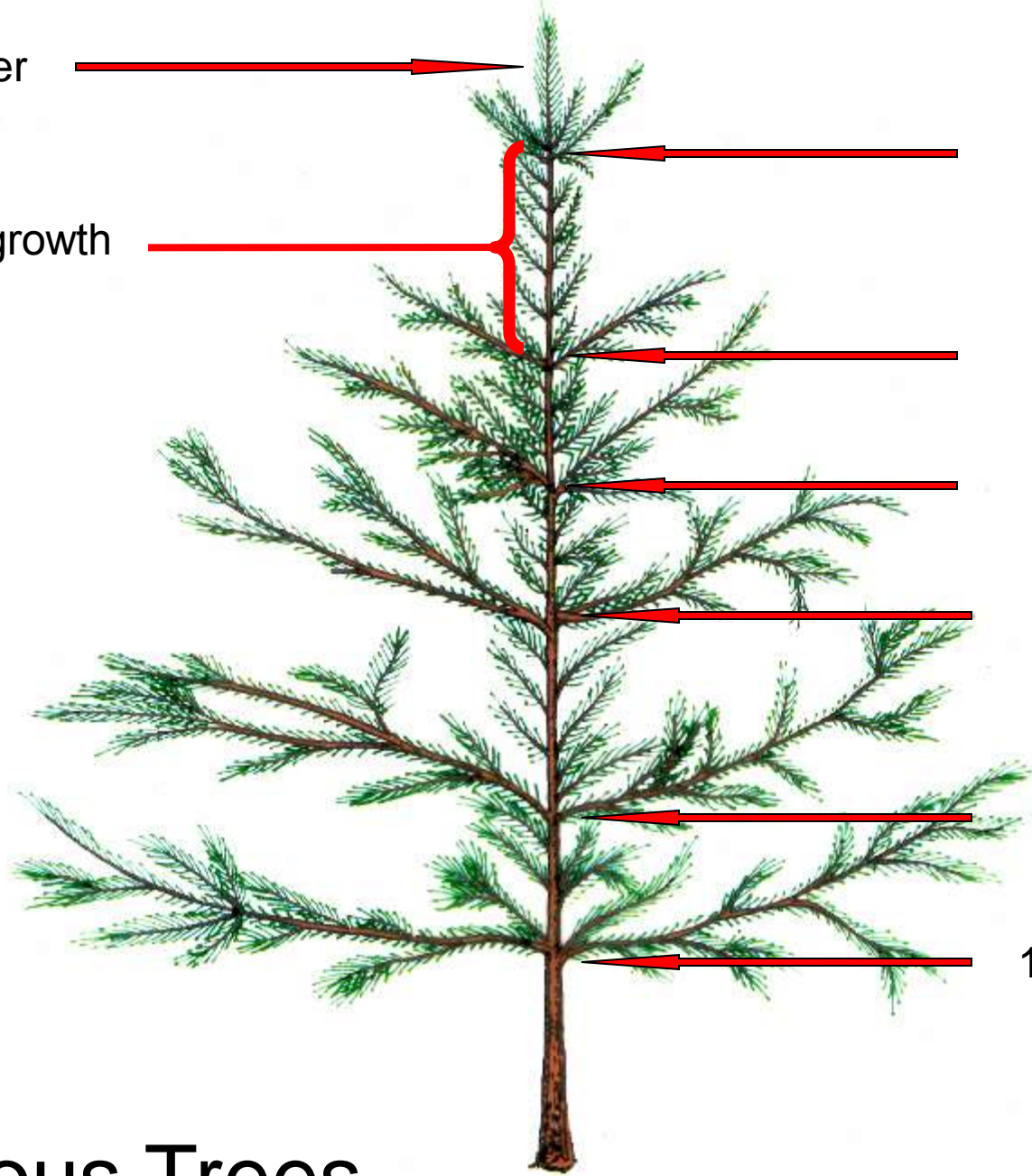
3<sup>rd</sup> year



2<sup>nd</sup> year

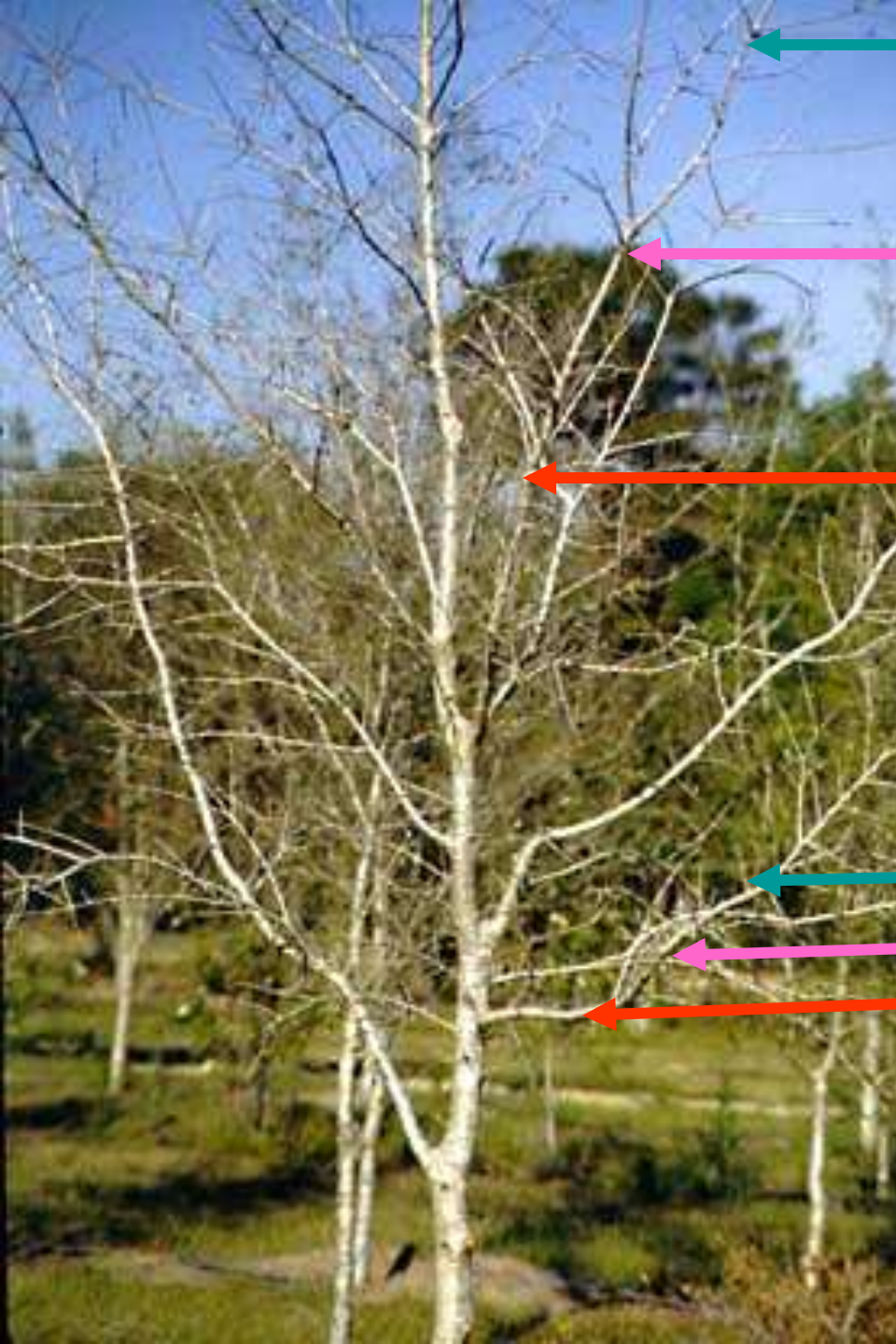


1<sup>st</sup> year



# Coniferous Trees





**Year 7**

**Year 6**

**Year 5**

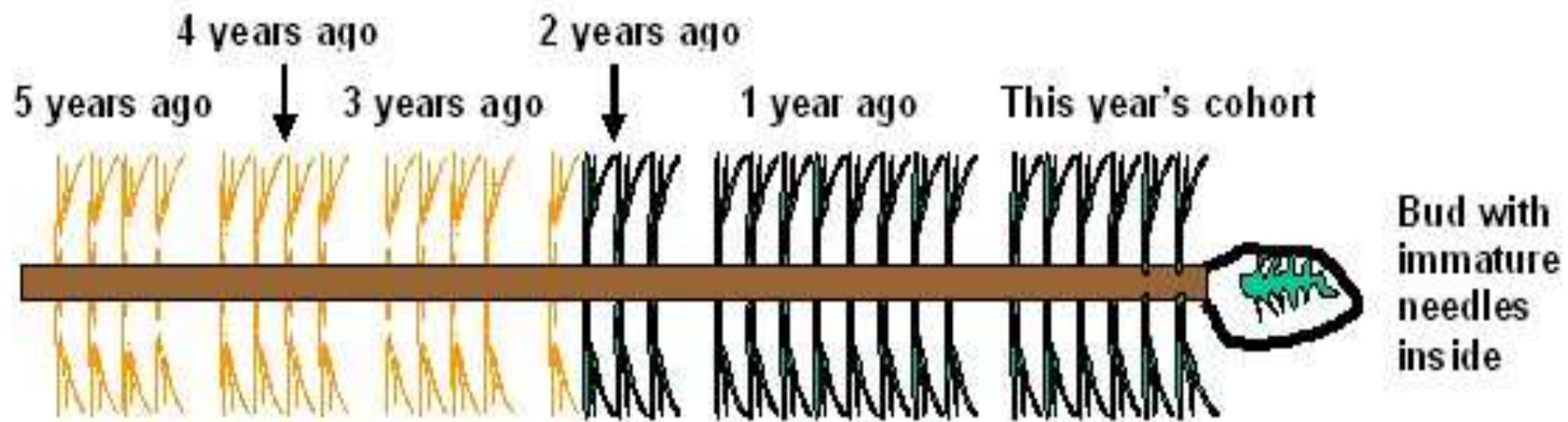
**Year 7**

**Year 6**

**Year 5**

**Deciduous Tree**





Older needles that will be dropped in the fall













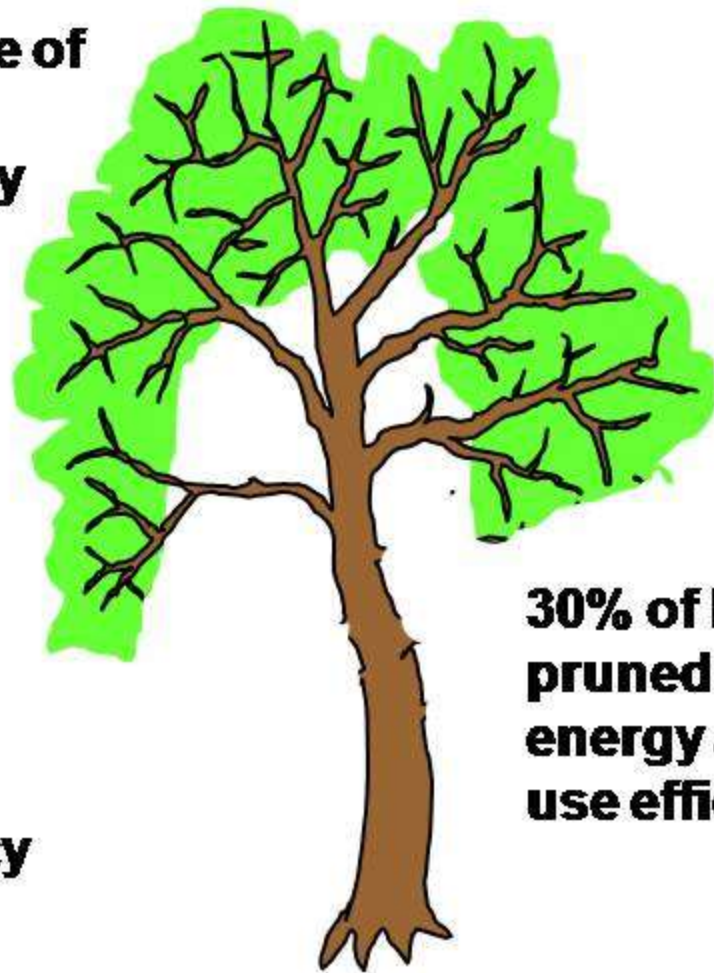






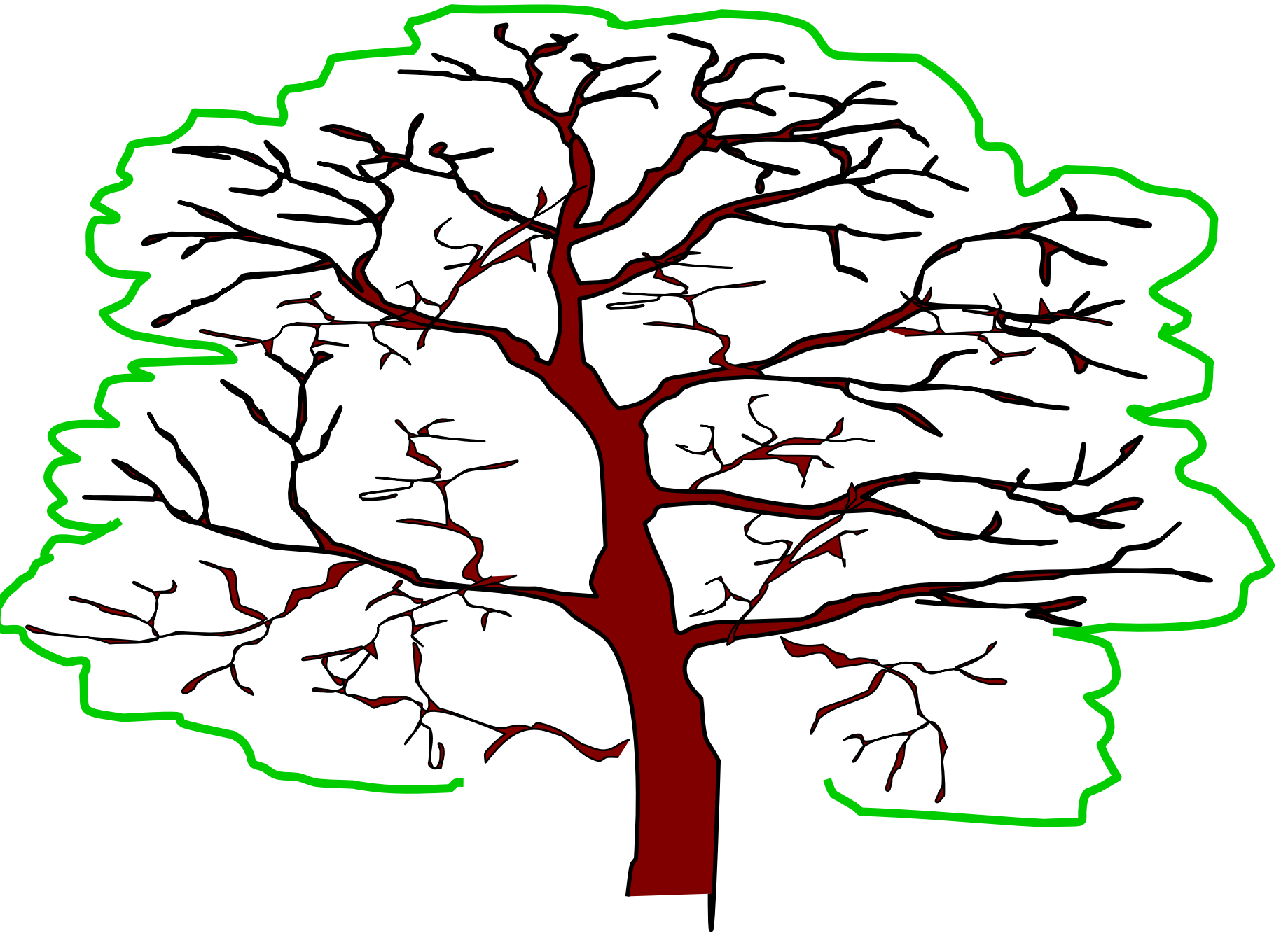
**Leaf zone of  
least efficiency**

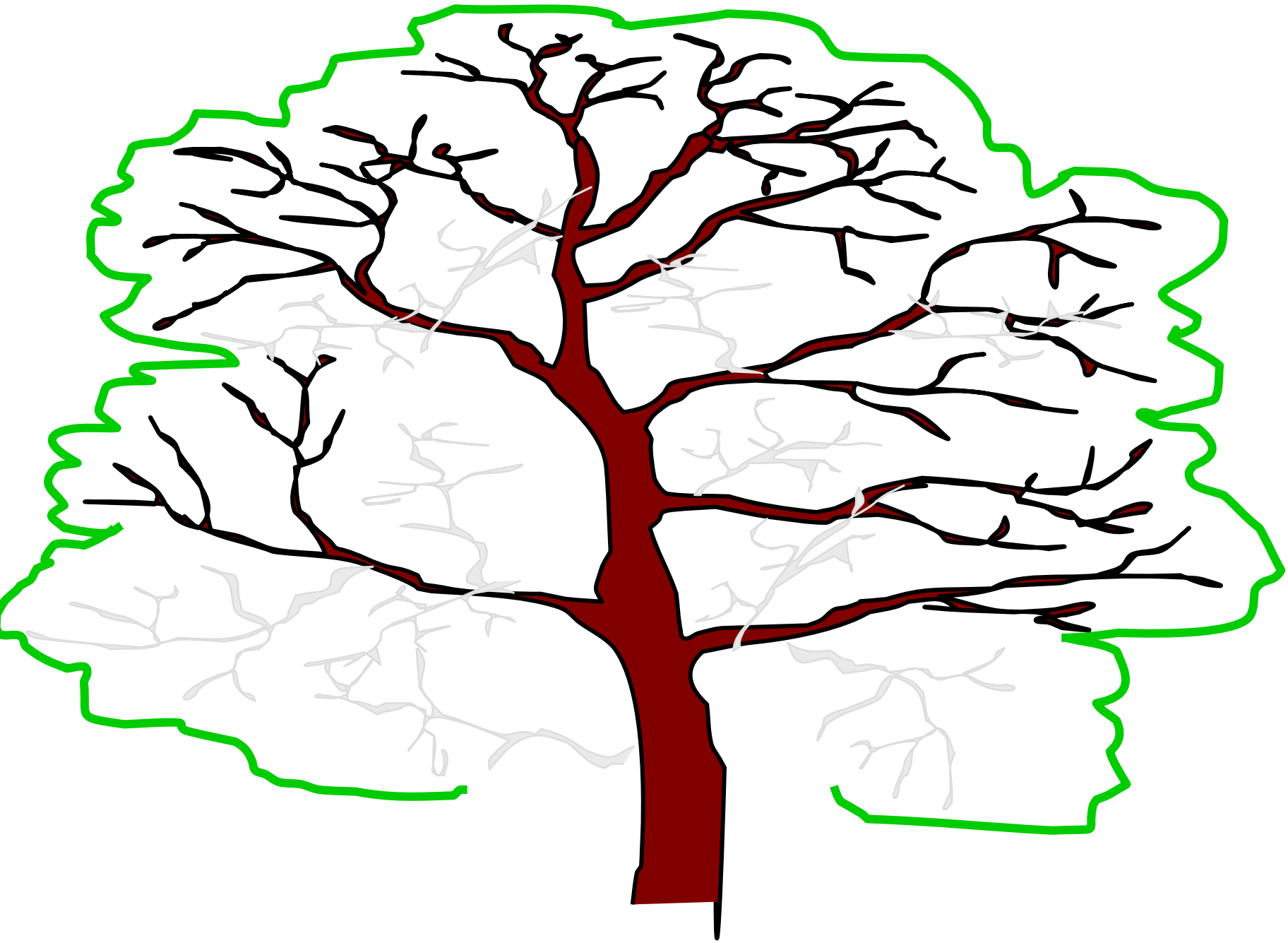
**Leaf zone of  
greatest  
efficiency**



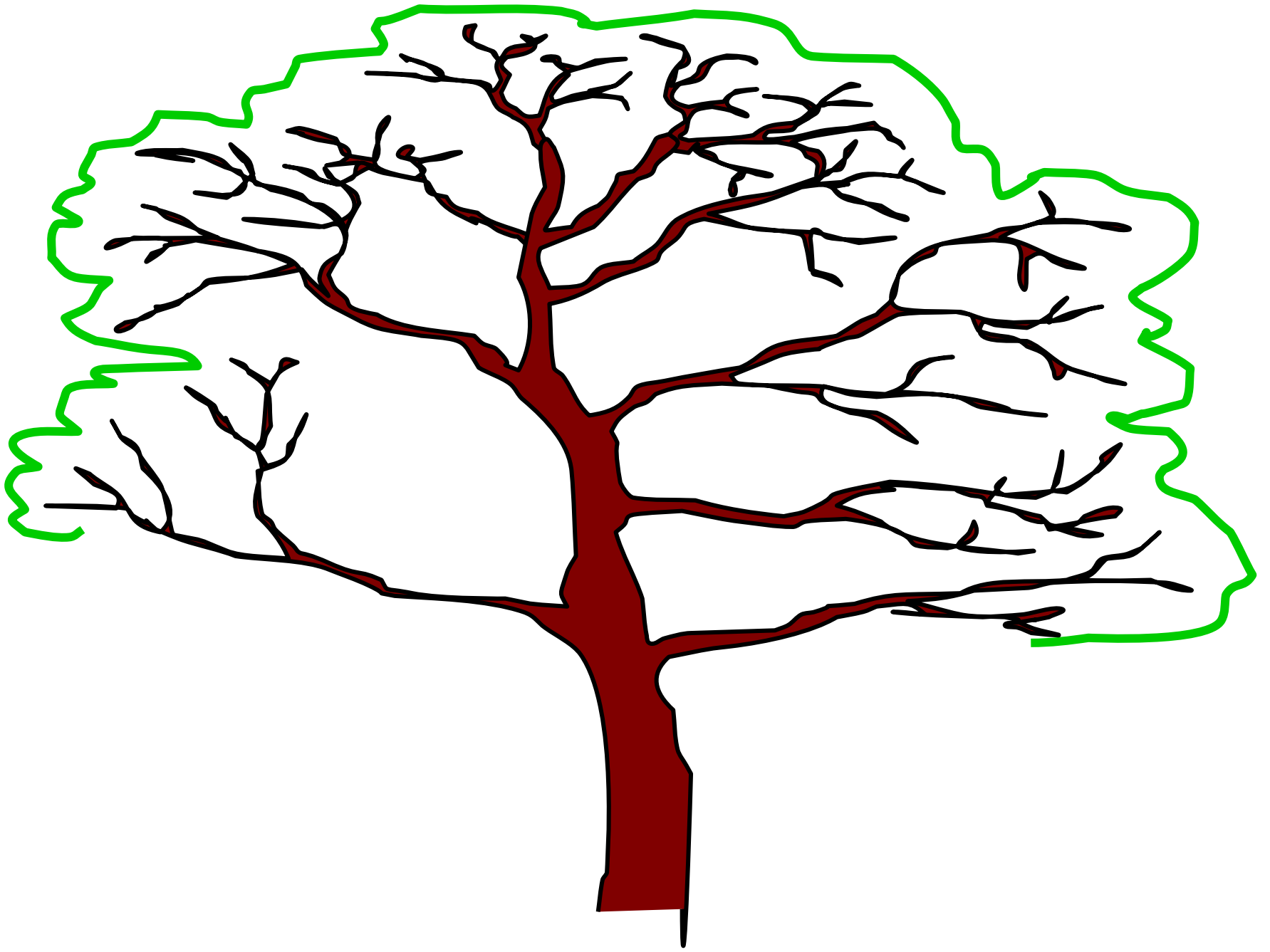
**30% of leaf area  
pruned off for  
energy and water  
use efficiency**

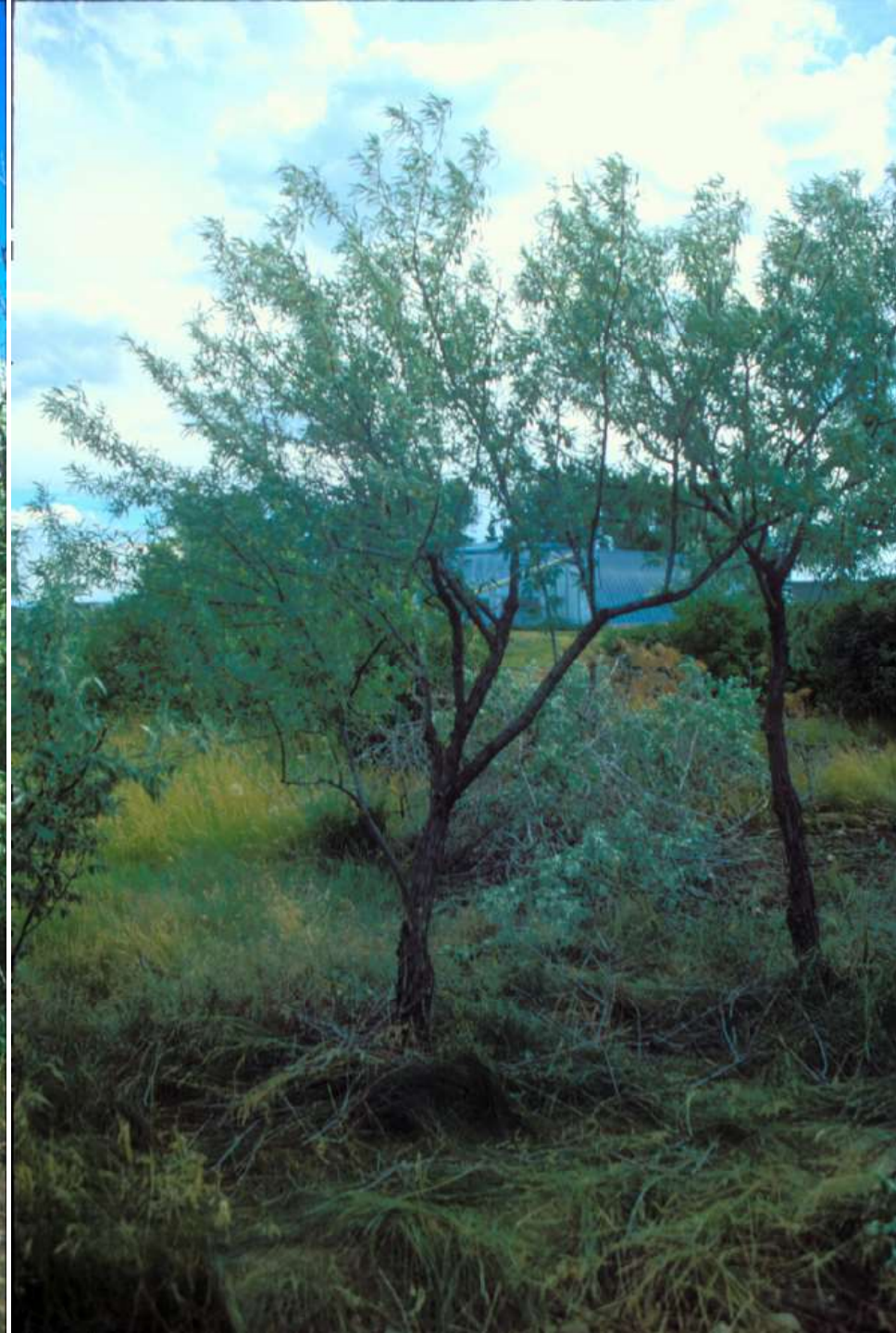




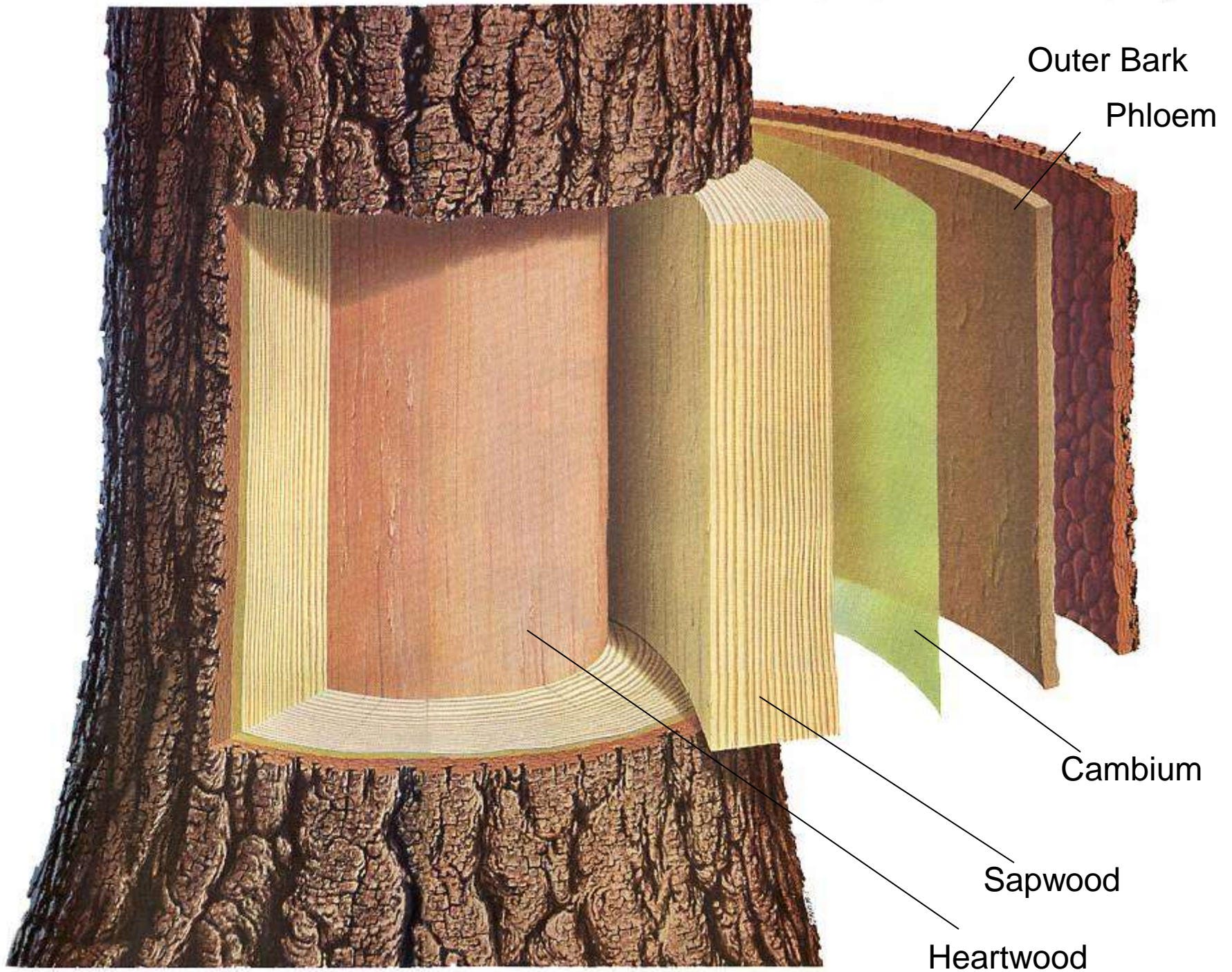














**18 years**

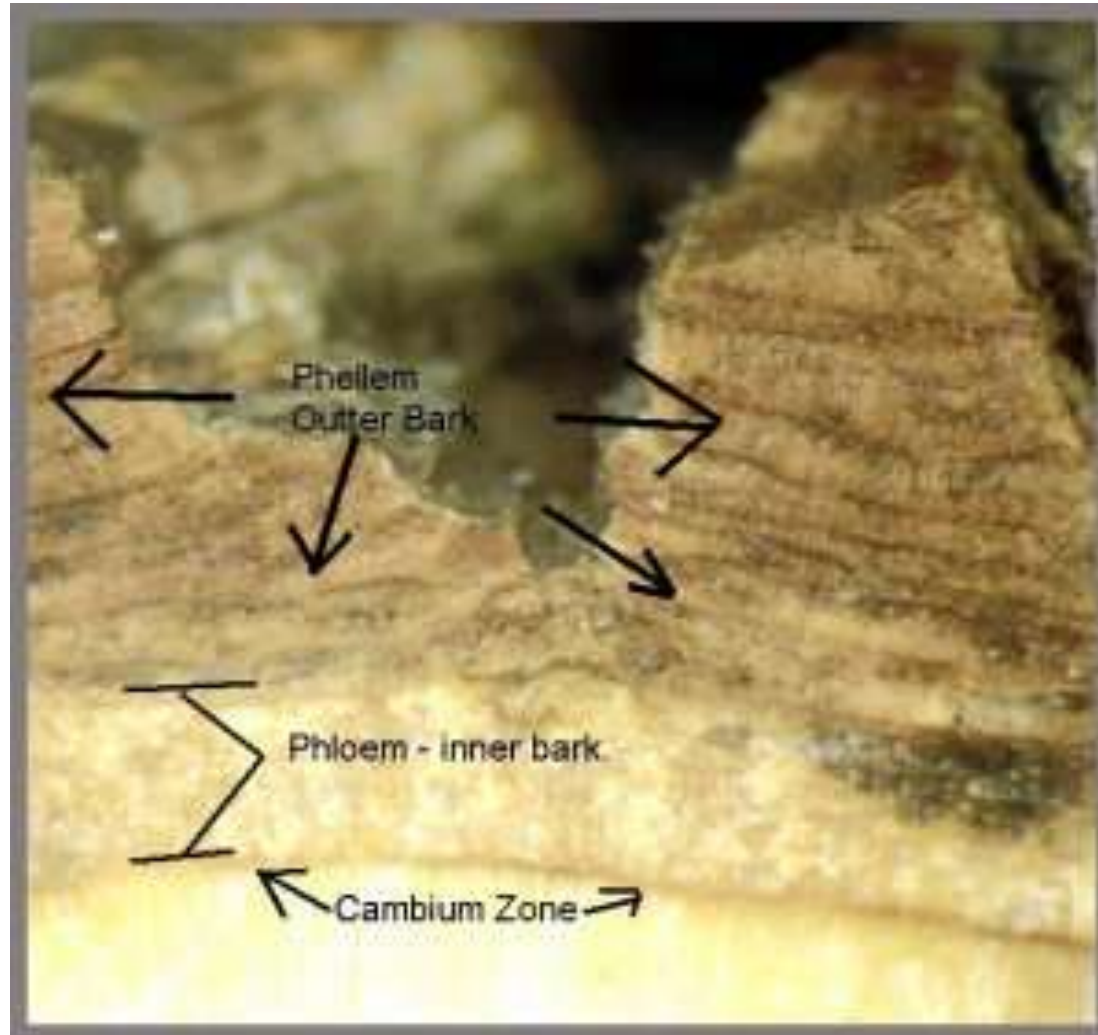
**23 years**

**69 years**

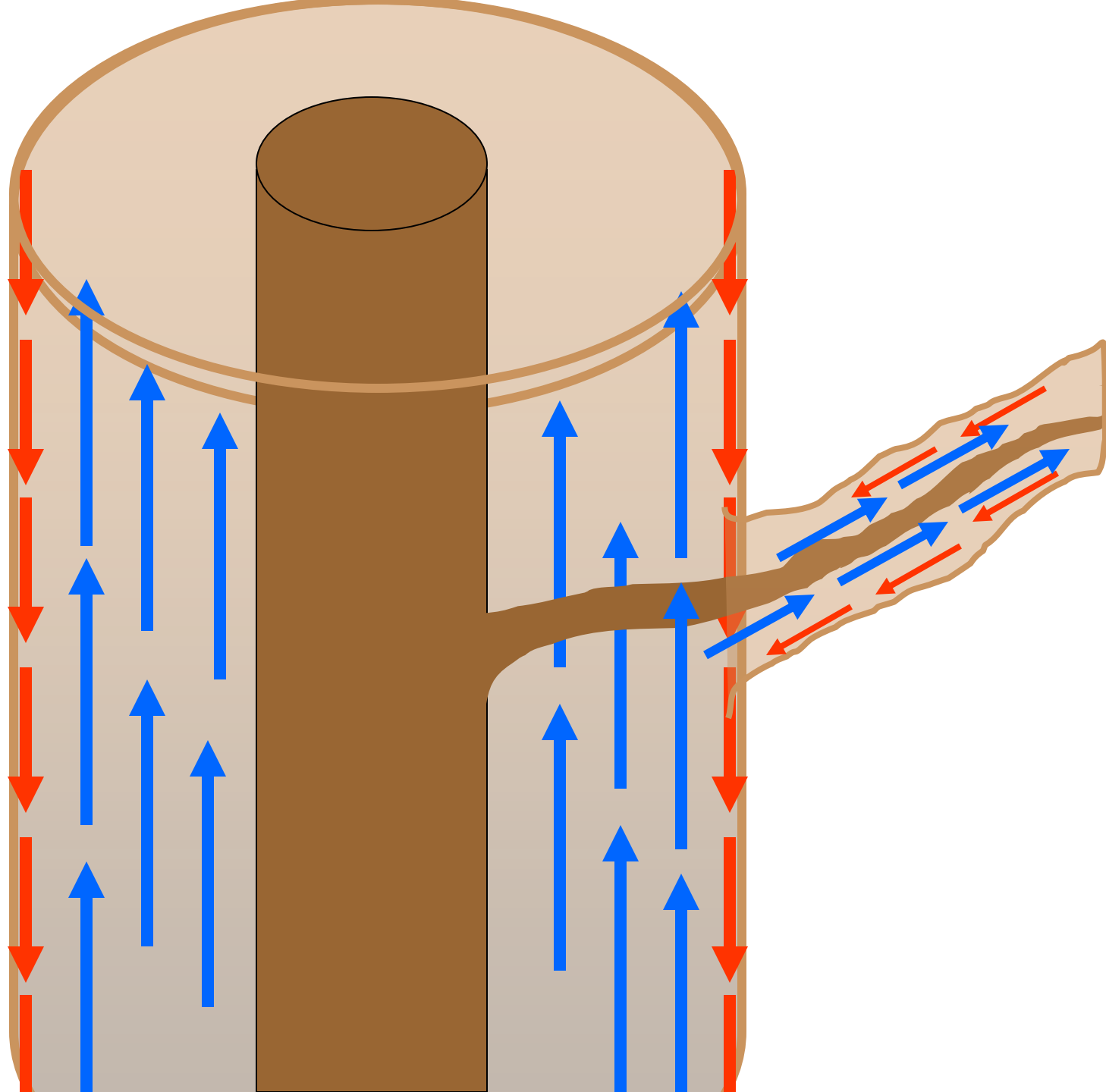




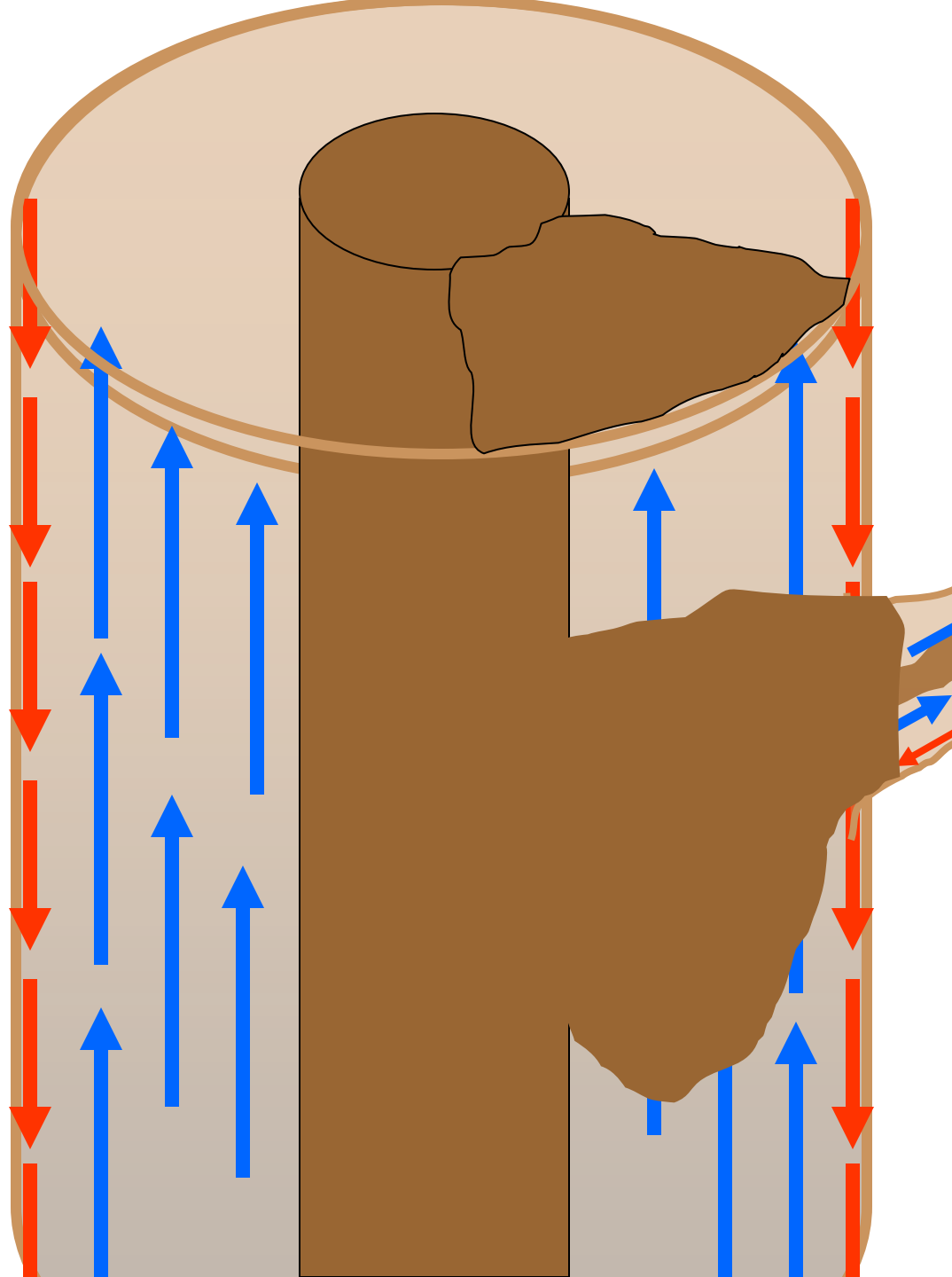
# The Bark

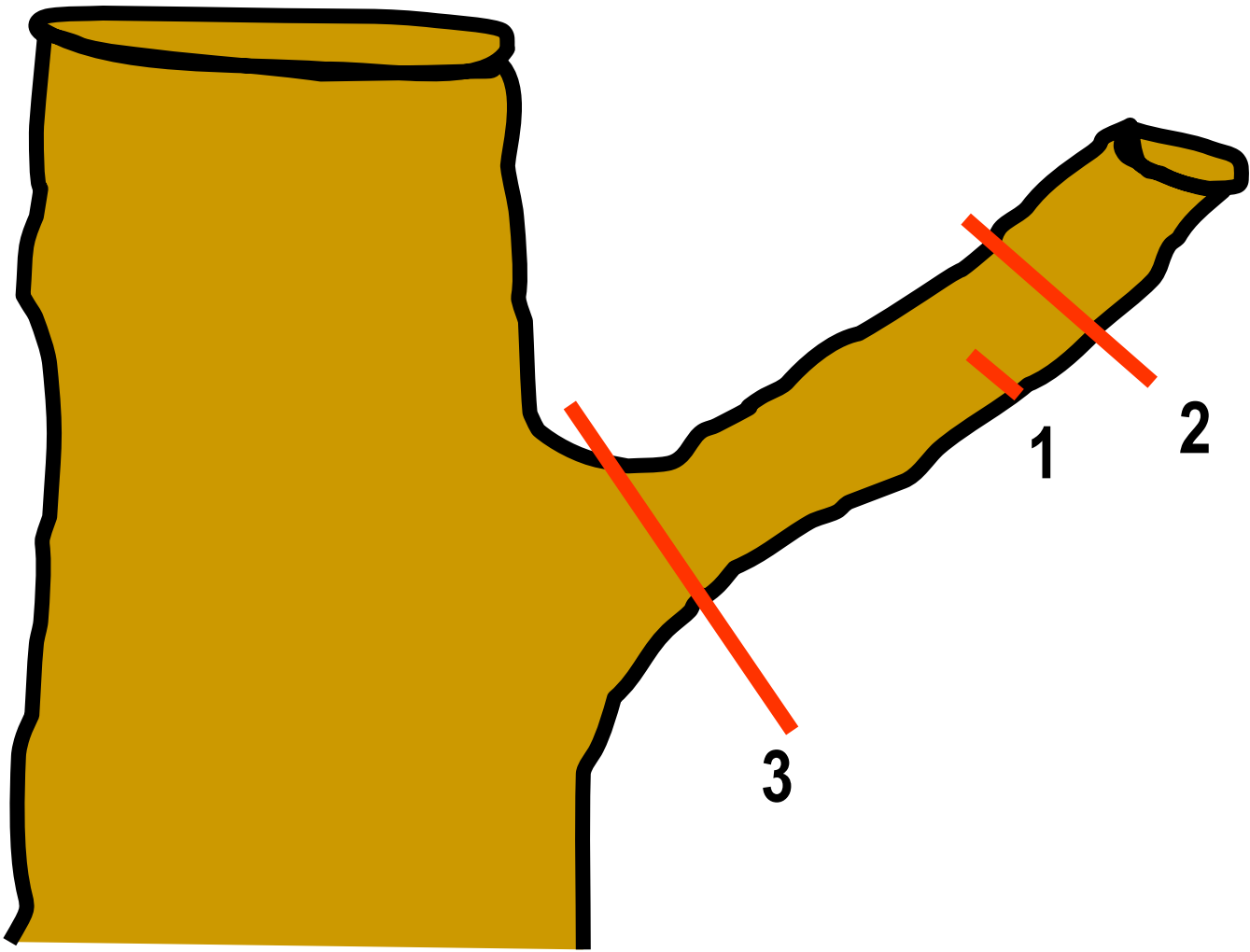


Ratio of  
Phloem : Xylem  
1 : 6









1

2

3





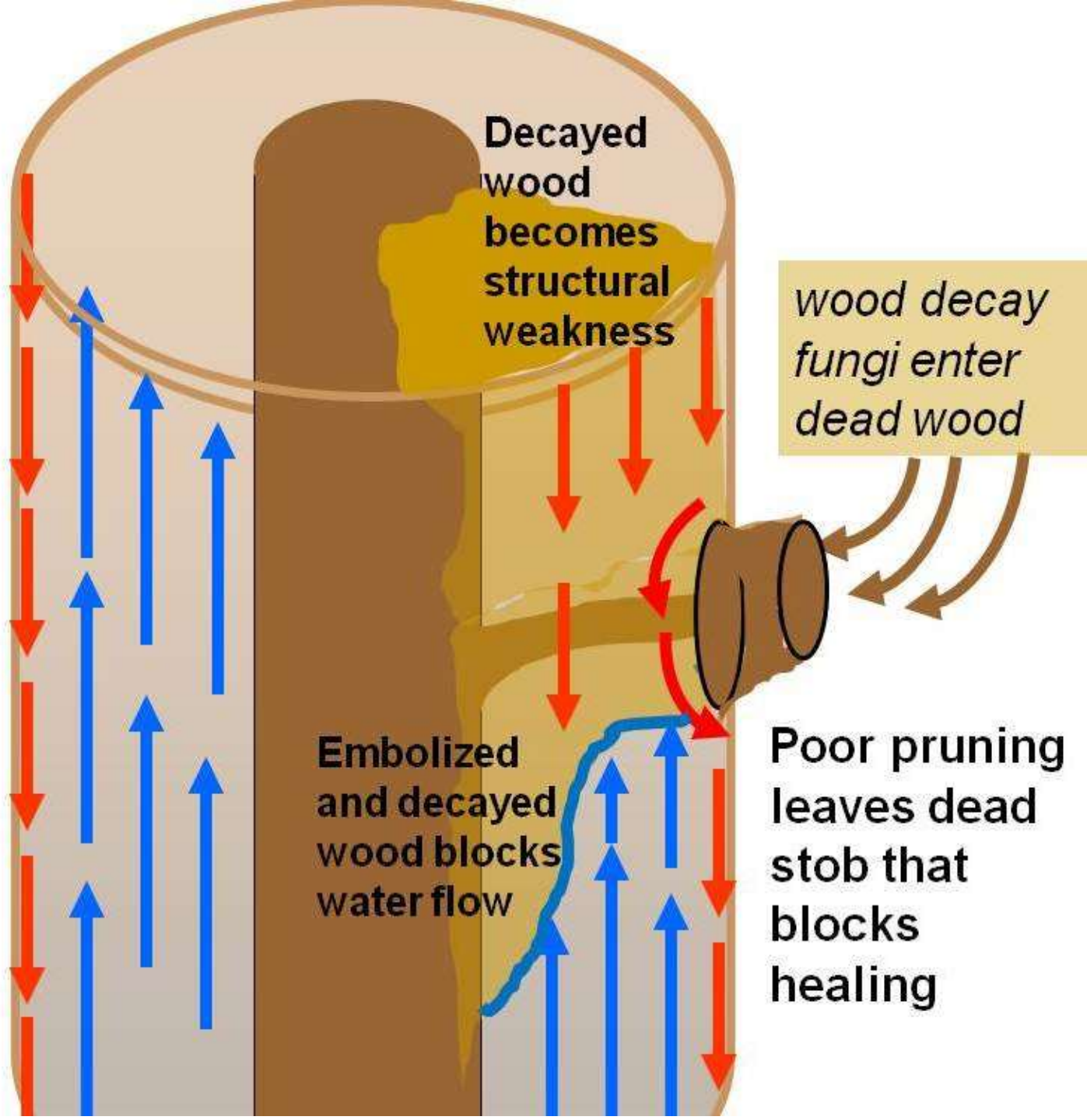


















**Fig. 10.** *Aesculus hippocastaneum* L., two big pruning wounds with far reaching discoloration inside the trunk.

**The Hamburg Tree Pruning System –  
A framework for pruning of individual  
trees**

**Dirk Dujesiefken and Horst Stobbe**  
Institute of Arboriculture, Hamburg,  
Germany

Urban For. Urban Green. 1 (2002): 75–82

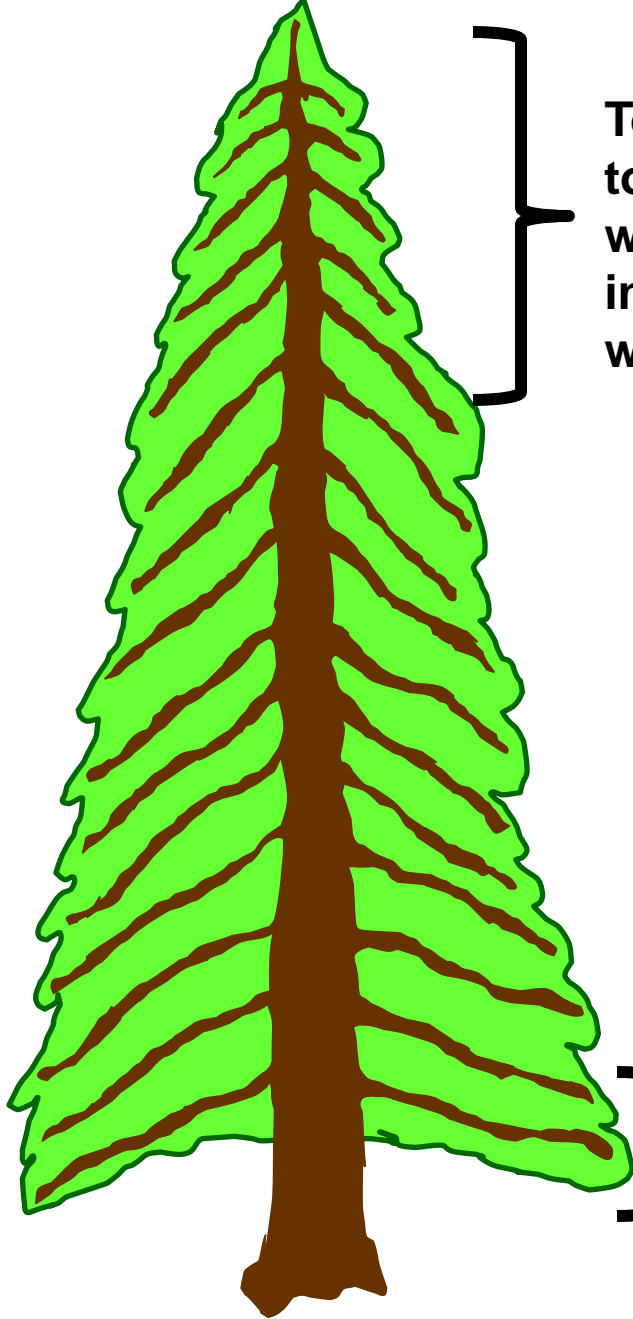








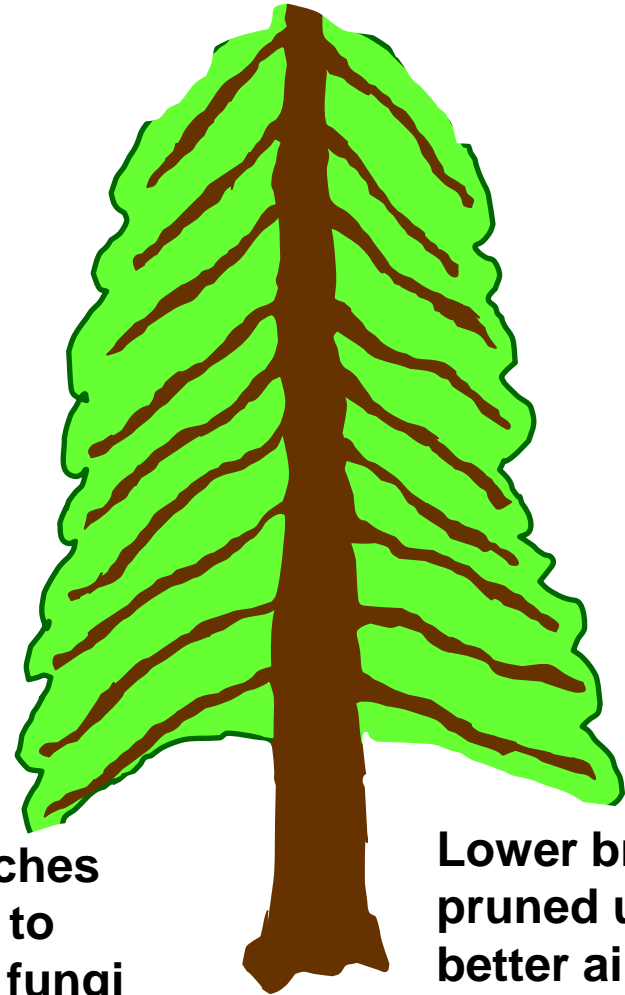




Top exposed  
to greater  
wind  
increasing  
water use



Lower branches  
more prone to  
needle cast fungi



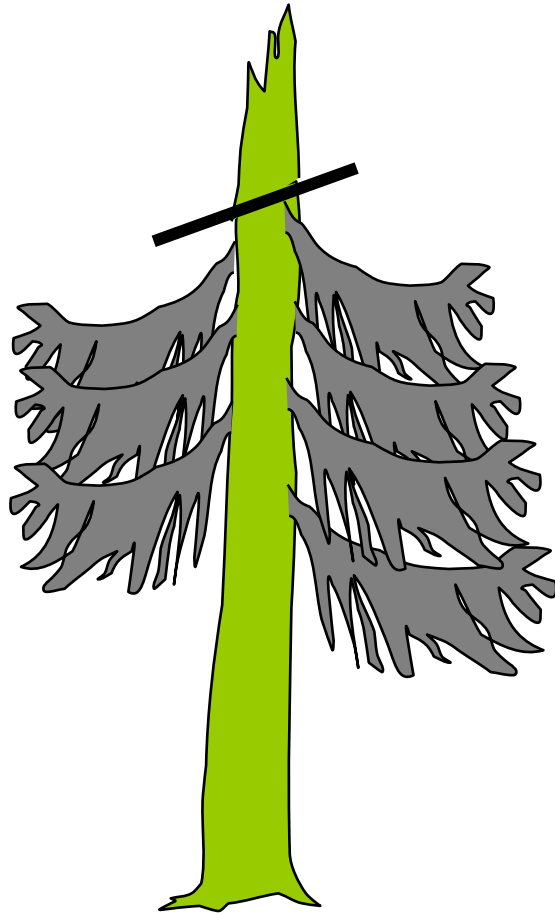
Top pruned down to desired  
height for windbreak effectiveness  
while reducing water needs and  
increasing wind stability

Lower branches  
pruned up for  
better air  
circulation

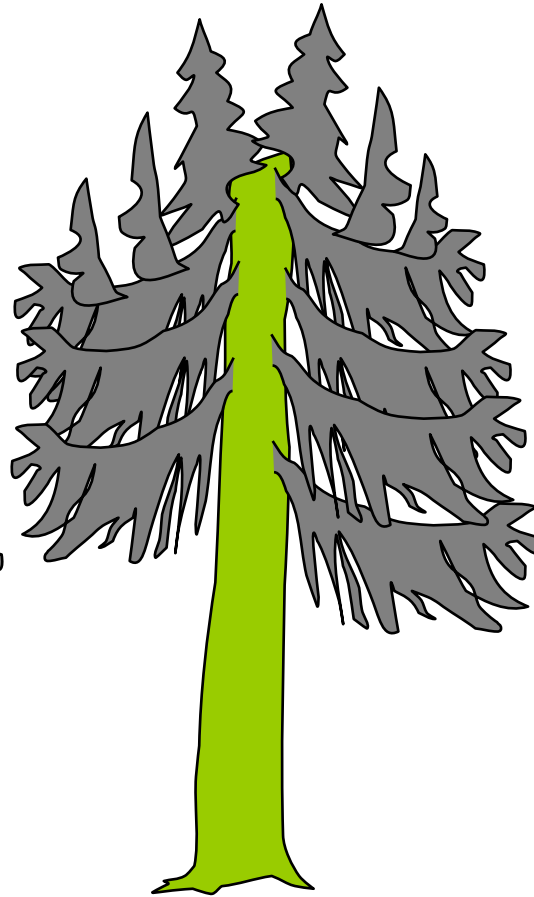




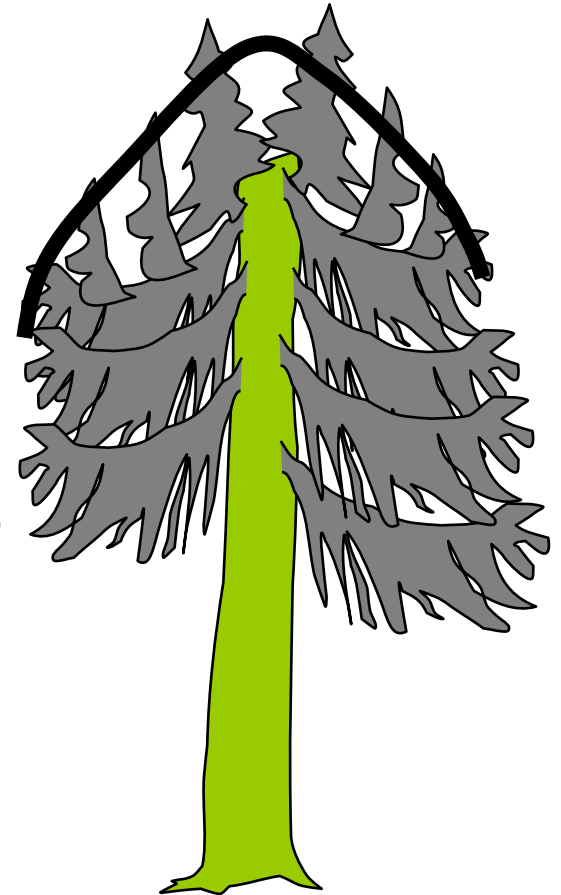
**1<sup>st</sup>** broken top  
is pruned back to  
within 1" of living  
branches.



**2<sup>nd</sup>** after several  
years, new "top"  
may need to be  
shaped



Spruces can be  
shaped into dense  
rounded tops



**Figure 10**









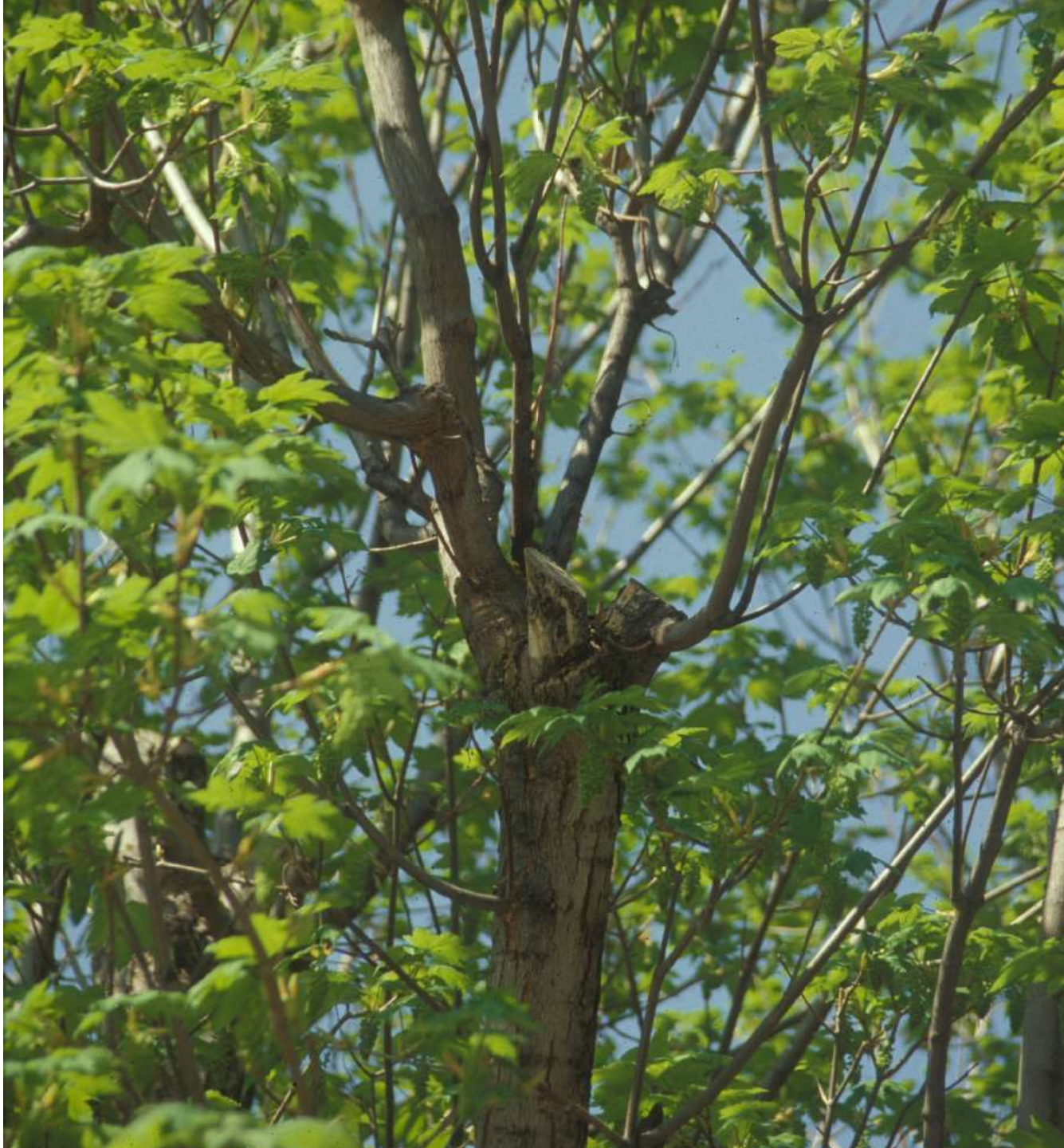












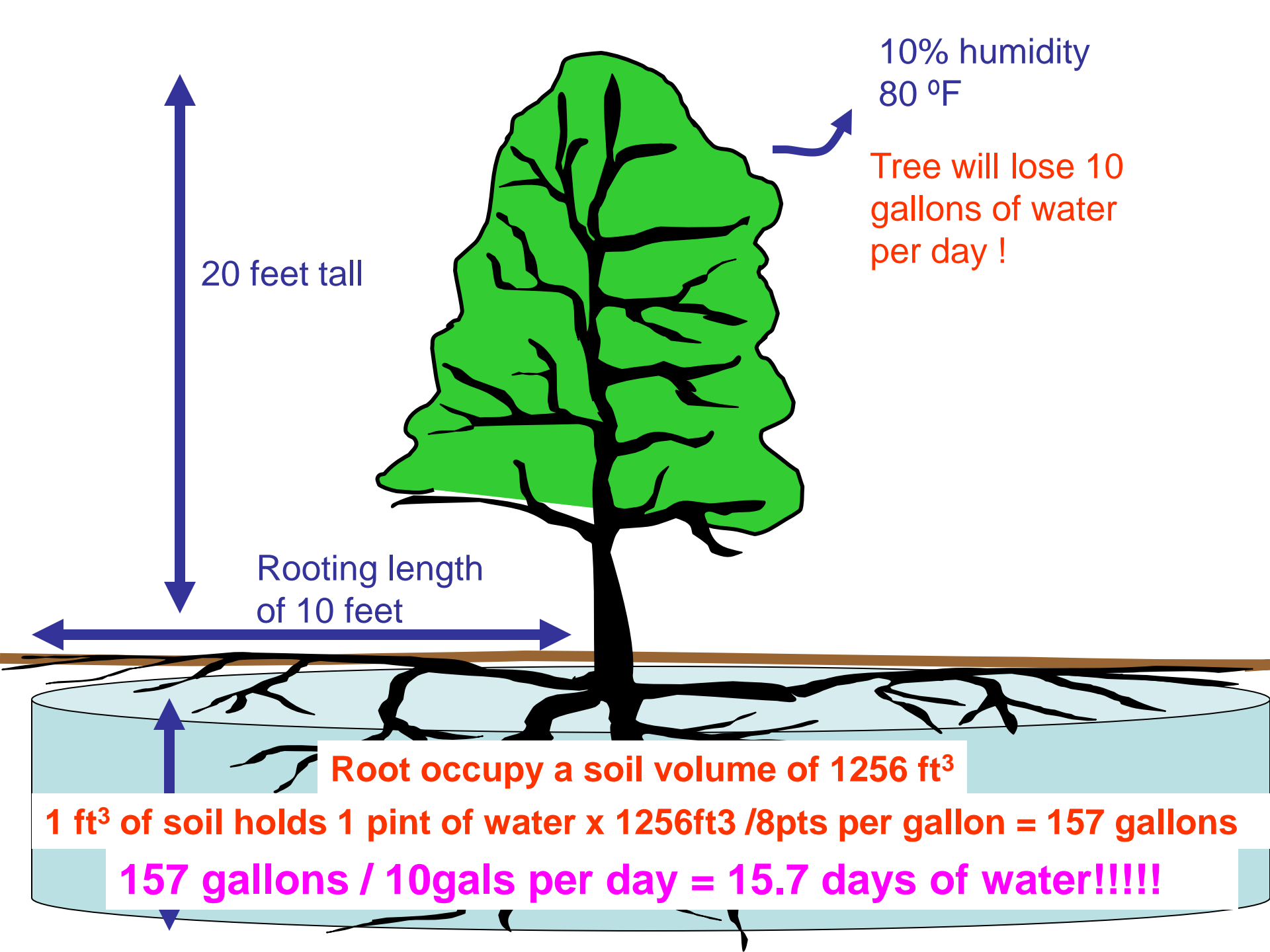






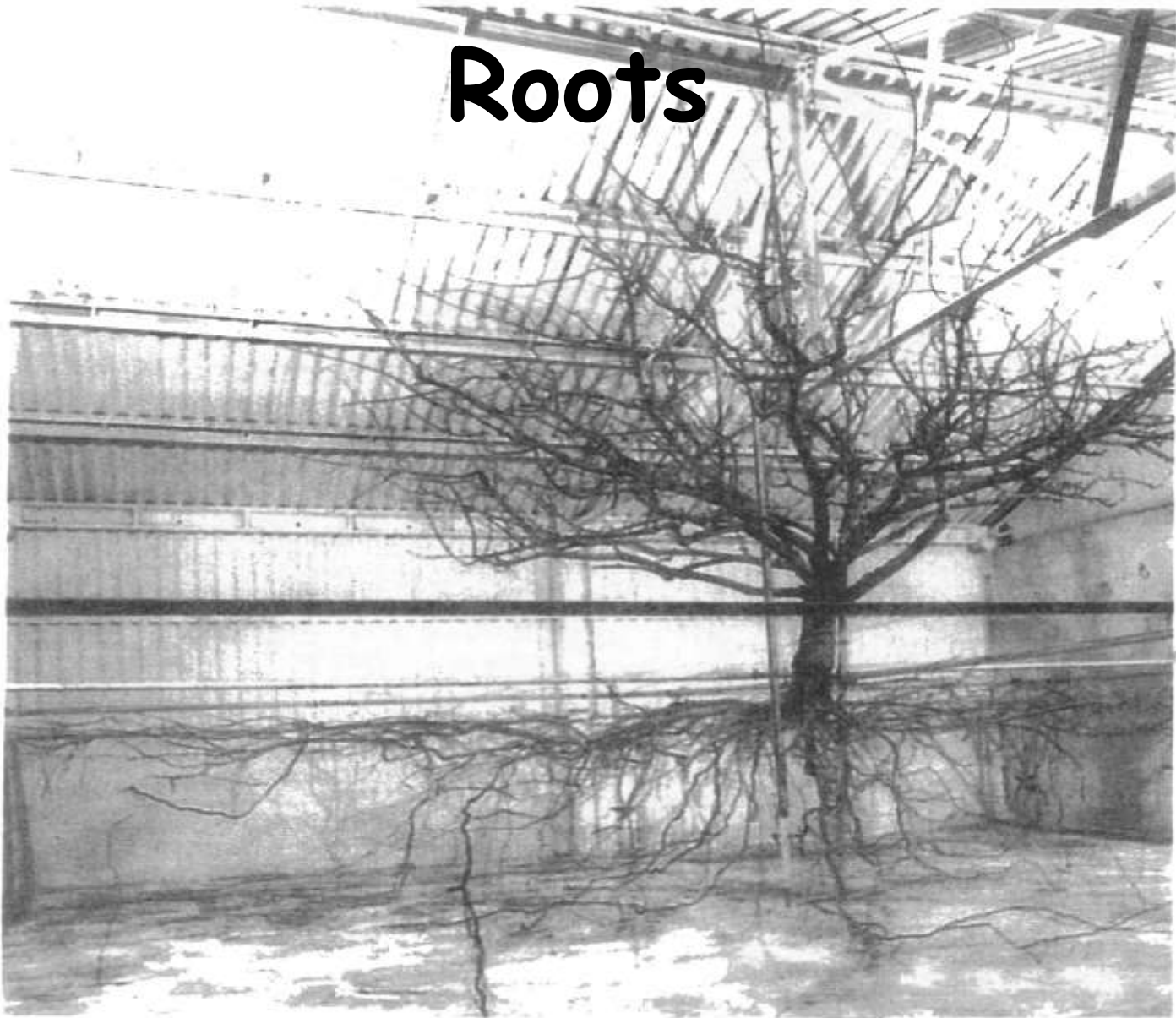




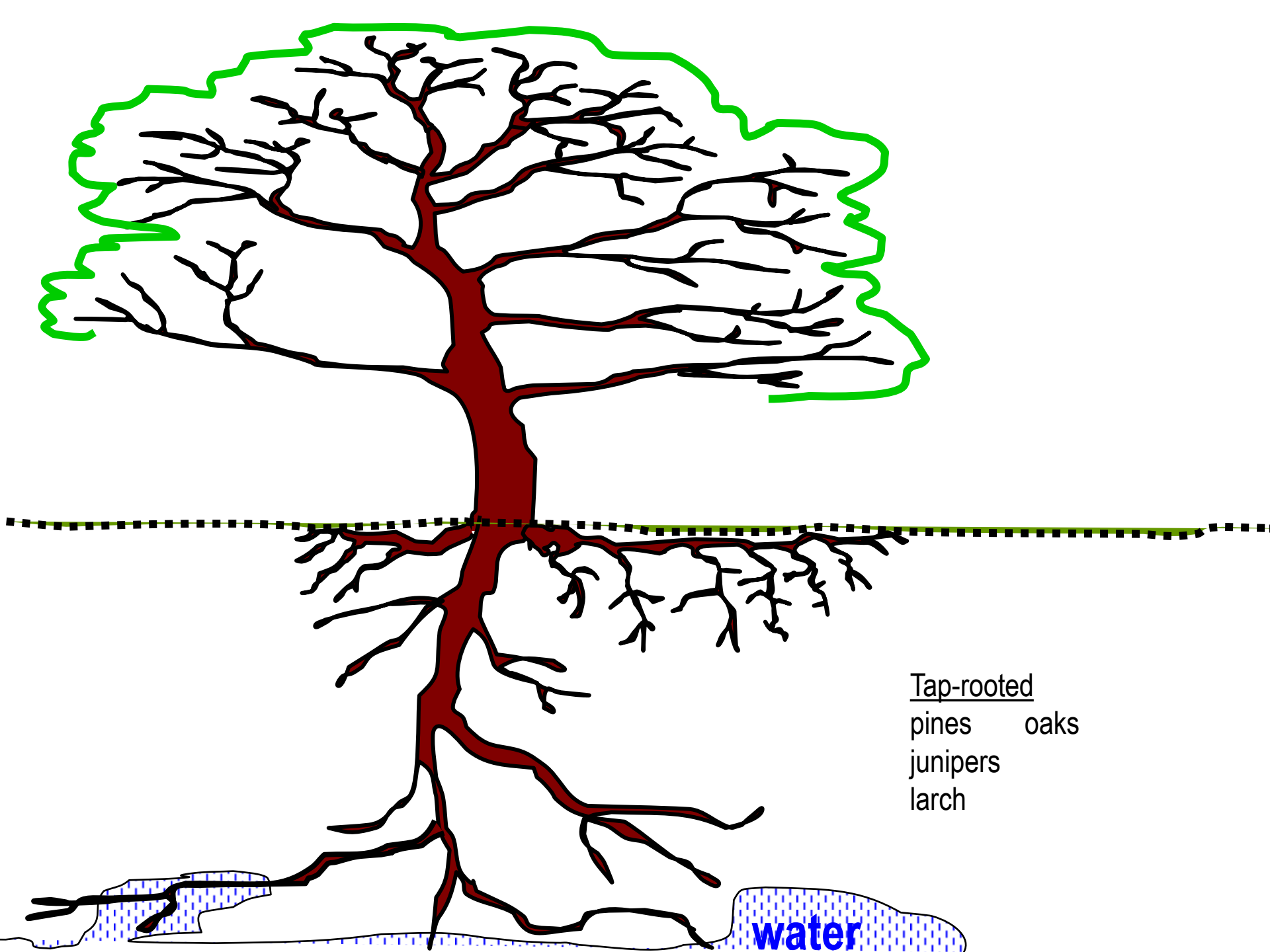




# Roots



**FIGURE 2.25.** Root system of a 16-year-old Cox's Orange Pippin apple rootstock. From Rogers and Head (1969), with permission of Horticultural.



Tap-rooted  
pines      oaks  
junipers  
larch



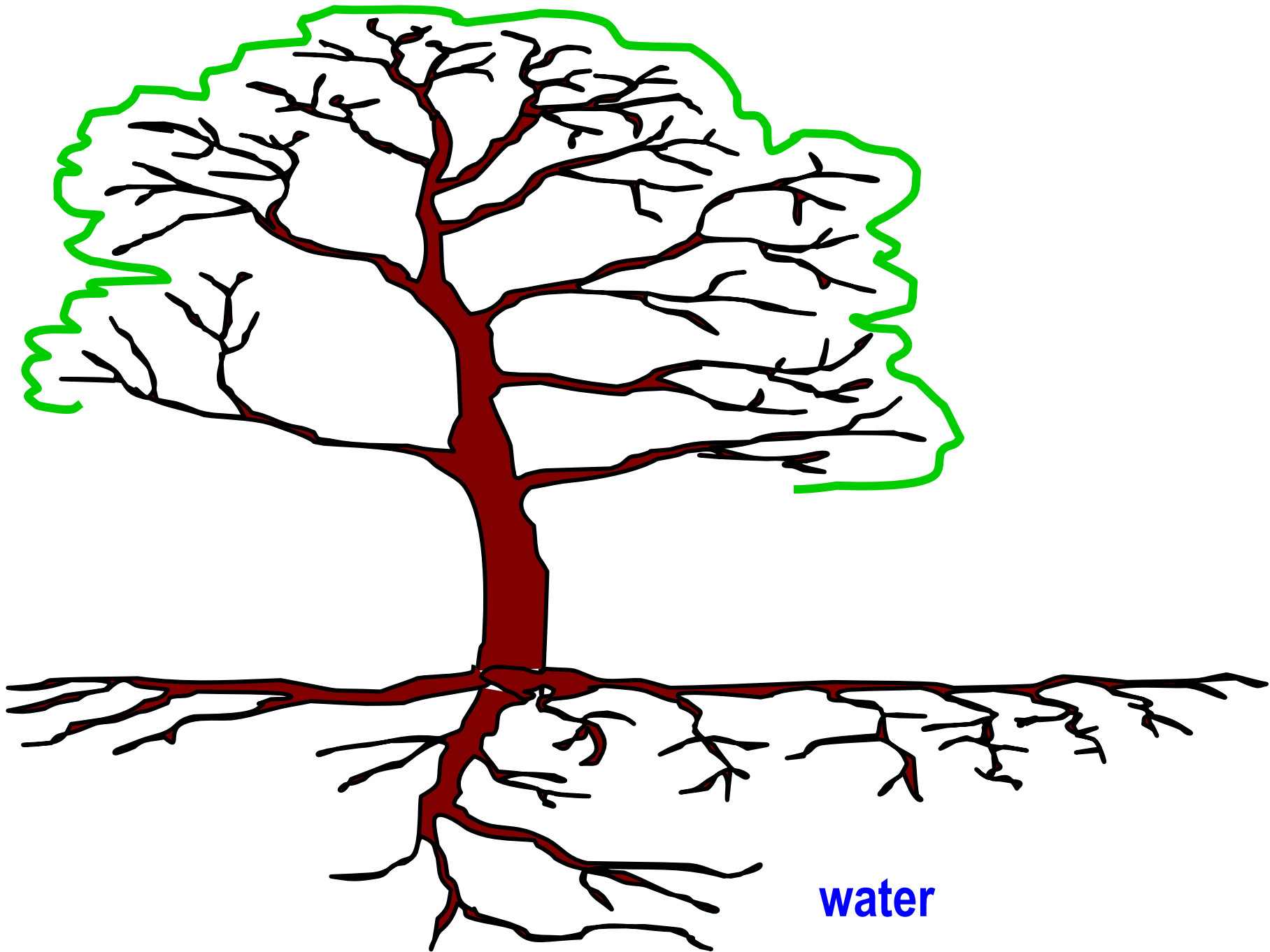


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water

# Roots: Horizontal Distribution

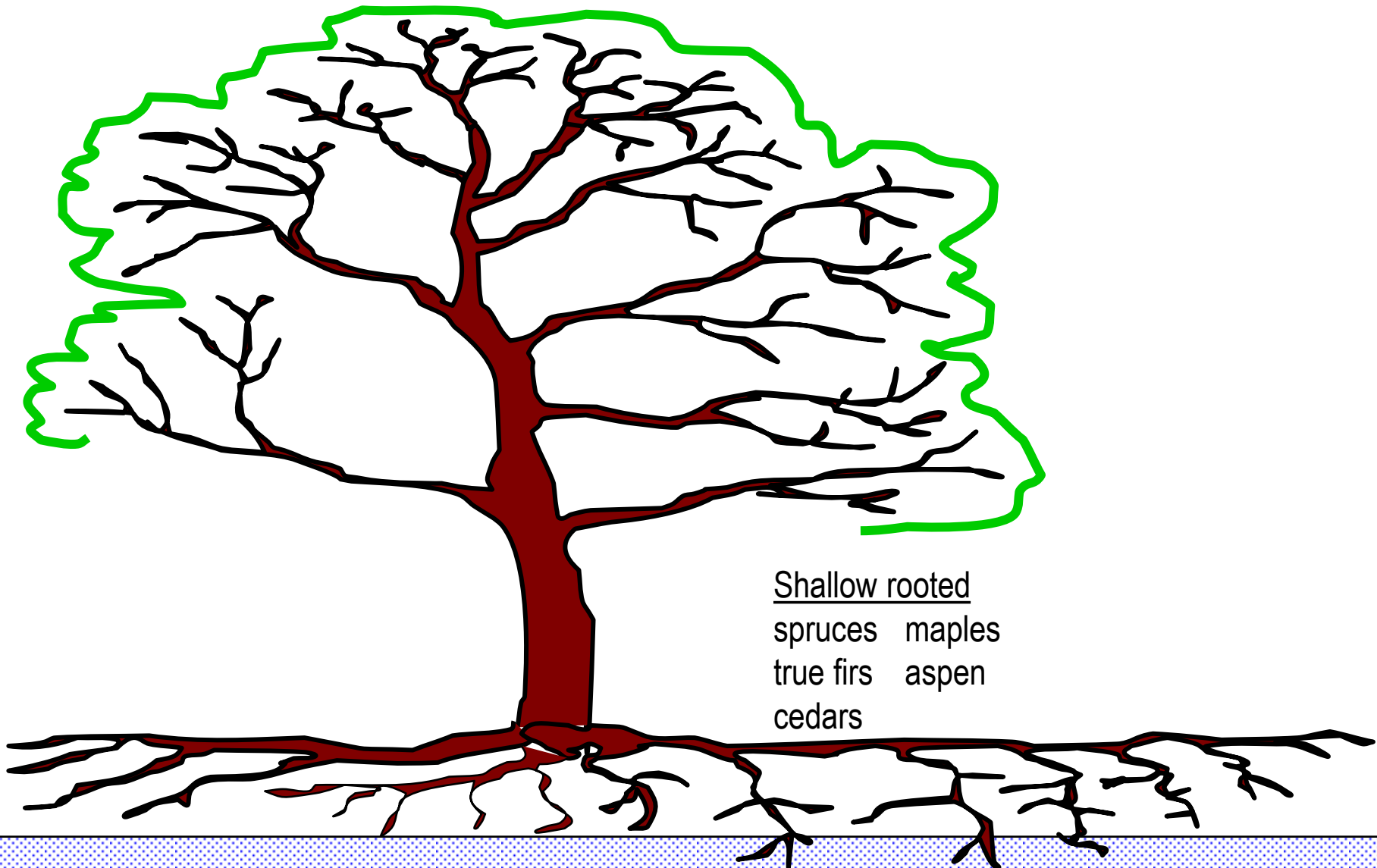


Figure 2. This excavated ginkgo (*Ginkgo biloba*) tree root system illustrates that healthy trees need a substantial amount of underground space (from Dunn).









Shallow rooted  
spruces    maples  
true firs    aspen  
cedars

**High water table**



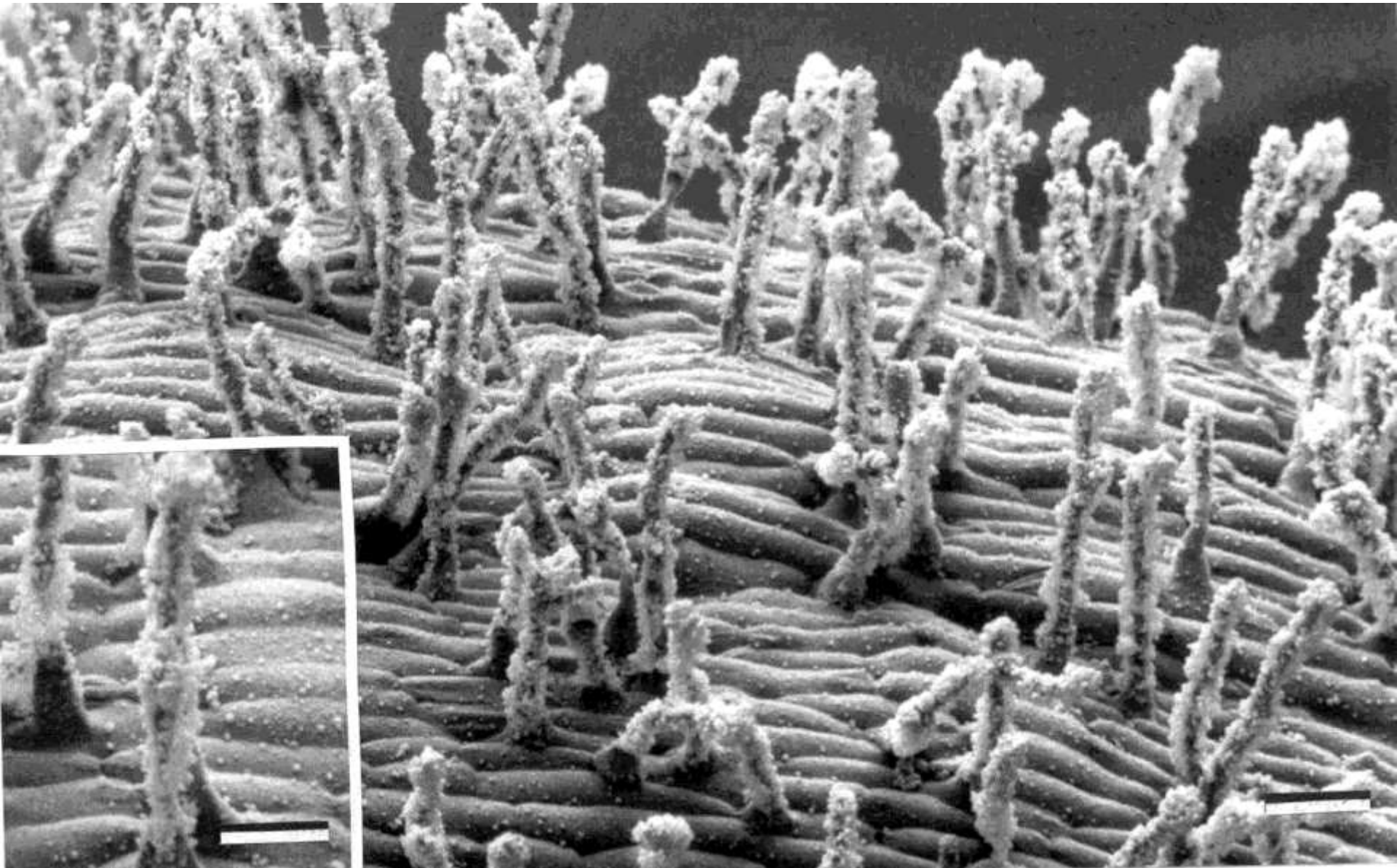






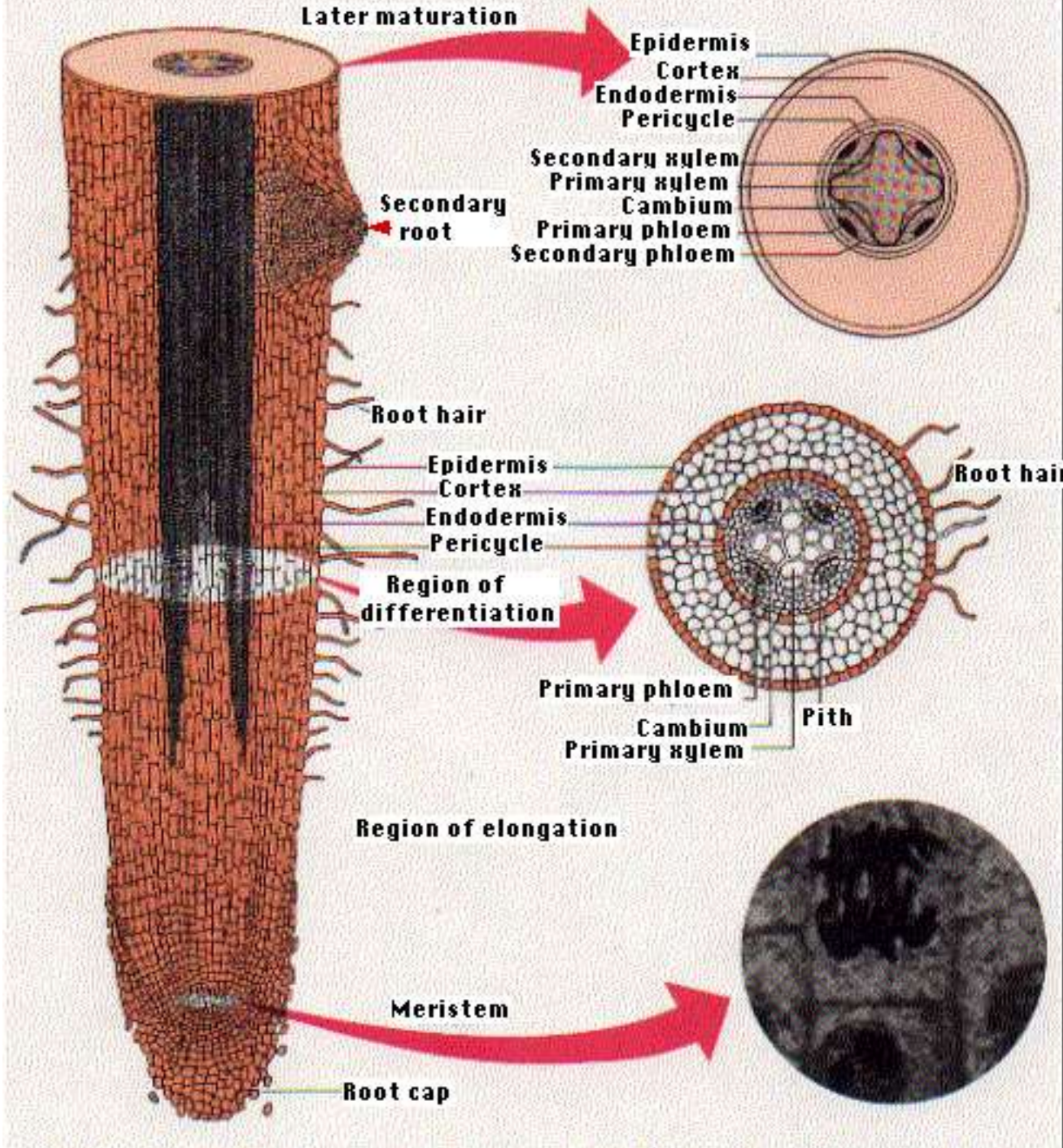


# Root Hairs





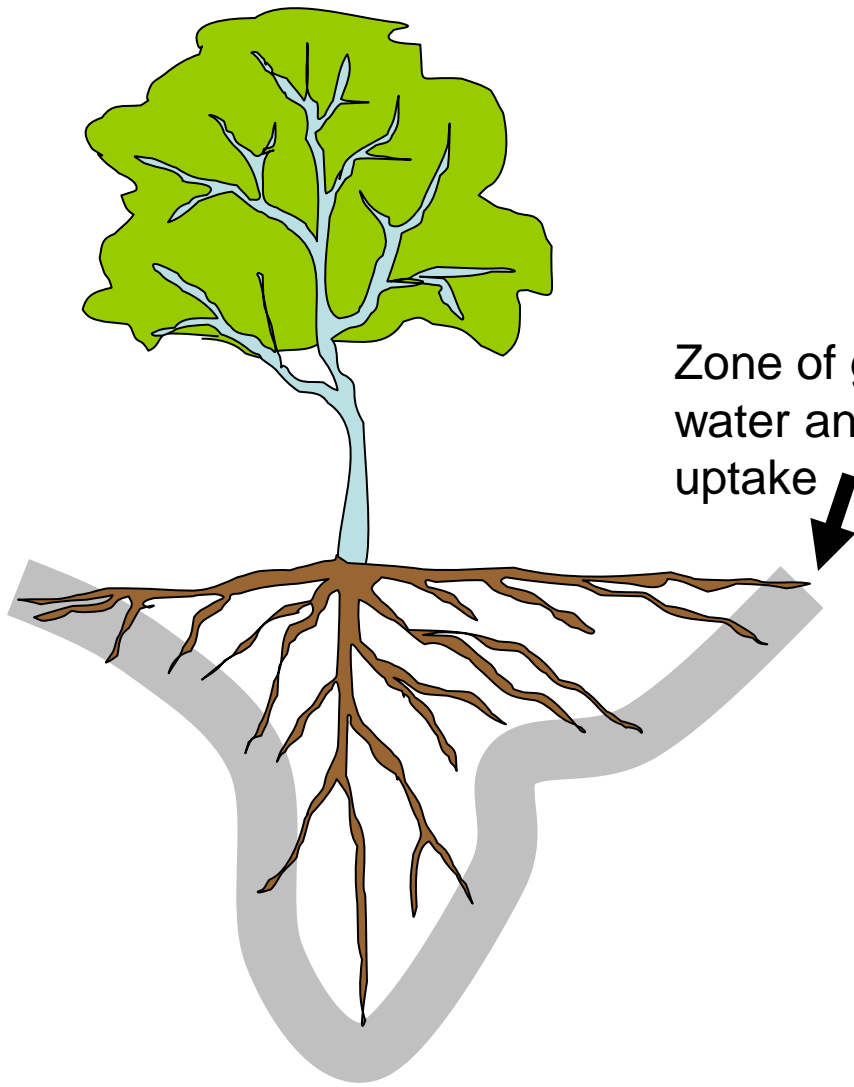
# Root Morphology



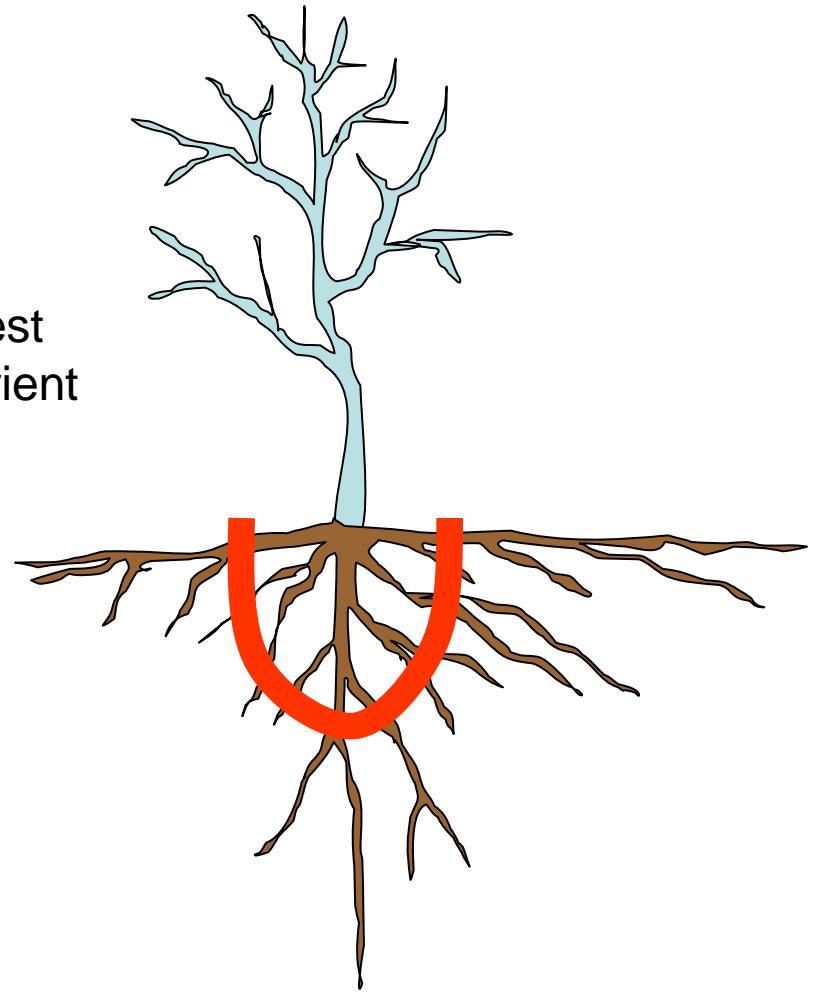






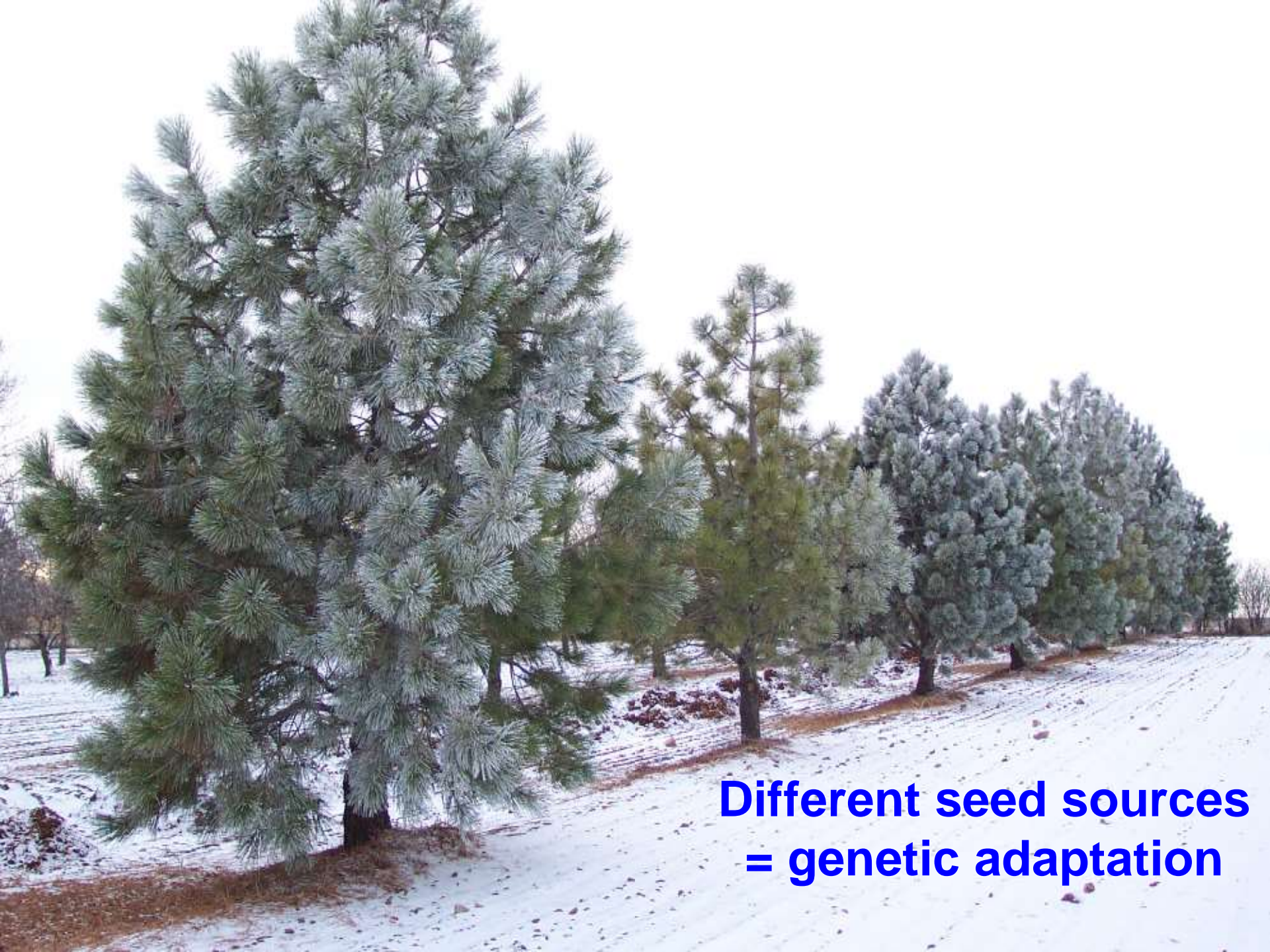


Root system of a naturally established growing tree



Root system captured by a typical root spade for transplanting





**Different seed sources  
= genetic adaptation**